Development of Geocentric Spatial Language and Cognition

An Eco-cultural Perspective

Pierre R. Dasen and Ramesh C. Mishra

CAMBRIDGE STUDIES IN
COGNITIVE AND PERCEPTUAL DEVELOPMENT

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Development of Geocentric Spatial Language and Cognition

Egocentric spatial language uses coordinates in relation to our body to talk about small-scale space ("put the knife on the right of the plate and the fork on the left"), while geocentric spatial language uses geographic coordinates ("put the knife to the east, and the fork to the west"). How do children learn to use geocentric language? And why do geocentric spatial references sound strange in English when they are standard practice in other languages? This book studies child development in Bali, India, Nepal, and Switzerland and explores how children learn to use a geocentric frame both when speaking and performing non-verbal cognitive tasks (such as remembering locations and directions). The authors examine how these skills develop with age, look at the socio-cultural contexts in which the learning takes place, and explore the ecological, cultural, social, and linguistic conditions that favor the use of a geocentric frame of reference.

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An Eco-cultural Perspective

Pierre R. Dasen

and

Ramesh C. Mishra

CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore,
São Paulo, Delhi, Dubai, Tokyo

Cambridge University Press
The Edinburgh Building, Cambridge CB2 8RU, UK

Published in the United States of America by Cambridge University Press, New York

www.cambridge.org
Information on this title: www.cambridge.org/9780521191050

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First published 2010

Printed in the United Kingdom at the University Press, Cambridge

A catalogue record for this publication is available from the British Library

Library of Congress Cataloguing in Publication data
Dasen, P. R.
Development of geocentric spatial language and cognition : an
eco-cultural perspective / Pierre R. Dasen, Ramesh C. Mishra.
p. cm. – (Cambridge studies in cognitive and perceptual development ; 12)
Includes bibliographical references and index.
ISBN 978-0-521-19105-0
1. Child development–Cross-cultural studies. 2. Space and time in language.
3. Cognition. I. Mishra, Ramesh Chandra, 1952– II. Title. III. Series.
HQ767.9.D38 2010
305.23109–dc22
2010023743

ISBN 978-0-521-19105-0 Hardback

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Preface

This book reports a cross-cultural study of child development in Indonesia (Bali), India, Nepal, and Switzerland, particularly in the area of spatial language and cognition. It examines a particular skill that is unfamiliar in Western contexts, which consists of using large-scale ("geocentric") spatial directions such as north, south, east, and west (NSEW) when talking about the location of objects inside a room. Various ecological and socio-cultural conditions that favor the development of this skill are examined.

The geocentric spatial frame of reference (FoR) was first described and studied in anthropological linguistics by scholars at the Cognitive Anthropology Research Group (CARG) of the Max Planck Institute for Psycholinguistics in Nijmegen, the Netherlands. The findings are summarized in Levinson's (2003) book *Space in language and cognition*. This linguistic research, carried out through extensive field-work mainly with adults, examined over forty, mostly unwritten, languages spoken in small-scale, traditional societies, languages that favor a geocentric FoR. The argument is that when such a frame is used in language, it will also be used in non-linguistic cognition, such as memory and reasoning. Hence, Levinson (2003) and his group take a fairly strong "Whorfian" point of view of linguistic relativism.

One of us (P. Dasen) was made aware of this research in the early 1990s through Professor Jürg Wassmann, who had spent some time with Levinson's team, an anthropologist who was interested not only in cognitive anthropology (Wassmann, 1993a) but also in linking it to developmental psychology (Wassmann, 1988). Wassmann and Dasen (1994a/b) had carried out some research together in Papua New Guinea on number concepts and classification, and in 1994 the opportunity arose for a common study of the development of geocentric spatial language and cognition in Balinese children (Wassmann & Dasen, 1996, 1998, 2006). This study raised a number of interesting questions, which the authors of this book tried to tackle in a first study in India and Nepal in 1999–2000, and then again in what we call the main study, field-work for which was carried out from 2002 to 2007. Hence the research reported here has been a long-standing project, and we try to communicate to the reader some of the suspense we have experienced over these years somewhat like a detective

story. Every result leads to a next question, which is what keeps us going as researchers. But we now feel that we have a coherent body of information, and that it is time to share this in the form of a single volume.

The book is organized in four parts. In Part I, the theory and research questions are presented in chapter 1, which gives us the opportunity to review our understanding of the wider area of "culture and cognition" from a (cross-)cultural and developmental perspective. Throughout the various studies, some of the tasks remained the same to ensure comparability, while some tasks were modified along the way to take more recent developments into account, and still other tasks are specific to particular studies. The methods that are common to several studies are described in chapter 2. Similarly, chapter 3 provides a description of the various locations in different countries, including their relevant cultural and linguistic characteristics.

The second part of the book presents the main results, chapter 4 of the initial study in Bali and the subsequent first study in India and Nepal, and chapters 5 to 9 the results of the main study in different locations, i.e. Bali (Indonesia), Varanasi (India), Kathmandu (Nepal), Panditpur (India), and Geneva (Switzerland).

These chapters have much in common, since some of the research questions and the methods remained the same across locations, but each chapter also deals with a specific problem. Chapter 5 recounts a replication study in Bali, where we went to check on our initial results with much larger samples and more complete methods. The results point to the importance of traditional Balinese culture and language, which help to maintain the use of geocentric language and cognition, while the impact of acculturation through schooling, urban life, and in particular the use of Bahasa Indonesian as a language, contributes to the choice of a more egocentric FoR. In Varanasi (chapter 6), we examine in particular the importance of Hindu religious practices in fostering a geocentric FoR. The study is organized as a comparison of Sanskrit-school and Hindi-school pupils. In Kathmandu (chapter 7), we follow up on one of the findings from Bali, namely the impact of bilingualism with a language that usually favors an egocentric FoR, i.e. English. The comparison, in this case, is between English and Nepali school groups. Research in this location also includes full details of the relationships between using geocentric (G) language and G cognition (encoding) and various socio-cultural background variables. Chapter 8 reports a study in a rural location in India where it seemed that an egocentric FoR was predominant, which turned out not to be the case, and chapter 9 deals with Geneva as a sort of "control" group, i.e. a location in which the geocentric FoR is just simply never used.

The studies in Bali, Kathmandu, Panditpur, and Geneva provide developmental information on a large range of ages, namely 4 to 12 years, while in Varanasi we purposely studied an older group of children, 11 to 15 years. It is

in this age group that individual differences in the choice between an egocentric and a geocentric spatial FoR seem to be most marked. This also provides us with an opportunity to study in more detail the relationships between using G language and G encoding and other aspects of psychological functioning, such as spatial ability and psychological differentiation.

In Part III, we report a series of additional studies, additional not because the questions they seek to answer are less important, but because these studies are specific to particular locations or samples. Chapter 10 recounts a study carried out in rural Nepal and rural India on mothers' spatial language addressed to children of various ages, from 12 months to 12 years. It is an attempt to describe the linguistic models children hear and learn to imitate. Chapter 11 deals with a study of spatial gestures, using these to guess which FoR young children in Kathmandu use when their language is ambiguous. In chapter 12, we carry out some micro-analyses on how children organize a spatial display depending on the FoR they use. For example, do they use the same description of a display from various positions when they move around it or when the display is rotated? Which schemes do they actually use to subdivide a display of three objects, and how do these change with age in the different groups we have studied?

Chapter 13 deals with neurophysiological correlates of using a geocentric FoR. It examines in particular the role of peripheral and central brain lateralization. It is commonly assumed that differences in neurophysiology cannot be cultural, i.e. these processes are either assumed to be universal, or differences are attributed to genetics. This is not necessarily so. While basic processes are no doubt universal, a diversity in brain functioning may develop through the exposure to particular experiences and practices (Fox, 2006). The question therefore arises whether using a geocentric FoR rests on, or produces, different neural pathways than using an egocentric frame. This is the part of our research, using a split-half visual field technique with children in Varanasi and Kathmandu, that comes closest to laboratory research. It is complemented by an exploratory study with twenty patients having undergone surgery for right-hemispheric brain damage.

In chapter 14, we report a study that seeks to test the limits of how people who use a geocentric FoR are able to carry spatial orientation with them. In this experiment, children in Varanasi were not only able to keep track of cardinal directions inside of a building, but some of them were able to do so even when blindfolded, turned around and led blindfolded to another room. Interviews with these "experts" tried to tease out how this process of dead reckoning functions and how it is acquired.

Part IV of the book is devoted to chapter 15, the general discussion of our results and conclusions. We link these back to an integrated theoretical framework for the cross-cultural study of human development that is presented in

chapter 1. Our general conclusion is that the development of geocentric spatial language and cognition occurs in a complex eco-cultural system, which is adaptive and functional. The choice between an egocentric and a geocentric FoR is akin to a cognitive style. Consequently, on the basis of a review of the cross-cultural psychological literature and of the results presented in this volume, we argue that cultural differences occur not in the presence or absence of particular cognitive processes, but in the preference for particular cognitive styles.

Acknowledgements

The research reported in this volume has been supported by the Swiss National Scientific Granting Commission (grants 11–54101.98 and 113–67178.01 to P. Dasen). The drafting of this volume was greatly facilitated by a Fellowship at the Netherlands Institute of Advanced Studies (NIAS) attributed to R. C. Mishra.

Organization of programmatic research away from home requires help from colleagues and friends at various places. In our case it has been possible with the active participation and support of two good colleagues. Jürg Wassmann, Professor of anthropology at the University of Heidelberg, introduced P. Dasen to Bali in Indonesia, and we twice did field-work there. The main study in Bali was facilitated by Professor I. Gde Pitana, Udayane University, Denpasar, Bali, and Professor Wayan Nurkancana and Dr. I. Nyoman Adil, IKIP, Singaraja, Bali.

In Nepal our task was made easier by the active participation of Dr. Shanta Niraula, Professor at Tribhuvan University of Kathmandu, in organizing and supervising studies at the remote rural setting of Dolakha as well as in the city of Kathmandu. She shared the major responsibility of field-work in Nepal by arranging local research assistance and traveling to field sites for regular supervision of data collection, and providing us with regular feedback on the progress made on the work. In addition, she was a wonderful host during our visits to Nepal.

The success of any research depends on the sincerity and dedication of assistants and we feel quite privileged because we had highly motivated research assistants at all locations. We take this opportunity to thank them all and sincerely acknowledge their contributions. At Varanasi, Ms. Neha Acharya, Ms. Nishat Afroz, Ms. Vanadana Chaubey, Mr. Girish Chandra Chaubey, Ms. Shweta Kumary, and Dr. Surabhi Prakash rendered valuable help in data collection in different phases of the study. Dr. Akhilesh Chandra Chaubey and Dr. Aparna Vajpayee played a major role as research supervisors. Ms. Sunita Singh played multiple roles in the whole research program.

In Nepal, Ms. Laksmi Shrestha and Mr. Padma Ghimire collected data at Dolakha, and Ms. Rena Shrestha and Mr. Purushottam Tandon in the city of

Kathmandu. In Bali, our initial study in 1994 was carried out with the help of Mr. Nengah Danta, and the second study with Mr. Made (Kadek) Aryawan Adijaya and Mr. I. Nyoman Pasek Hadisaputra. In Geneva, data were collected with the help of Ms. Marie Anne Broyon, Ms. Anahy Gajardo and Dr. Yvan Leanza (who is now Professor at the Laval University in Quebec City). Ms. Milena Abbiati and Dr. Nilima Changkakoti, also from the University of Geneva, helped with the coding of video data for the gesture study, together with Mr. Harold Foy, of the University of Quebec at Rimouski.

Several others have helped us in organizing field activities in or near Varanasi. We sincerely acknowledge the support of Akhilesh's family at Roopchandpur village for making a part of their house available for testing, arranging appointments with participants, and rendering great hospitality to the research team during the field-work in the village, and similarly Mr. G. C. Tripathi and his family in the city of Varanasi. Dr. Shabana Bano rendered her help whenever we called for it. For the second study in Varanasi we feel extremely grateful to Mr. Lalit Bahadur Singh, Manager, Malviya Shiksha Niketan, not only for making his own house available for research work, but also for his personal care. We also feel highly grateful to Ms. Prabha Singh, Principal, Malviya Shiksha Niketan, for welcoming us to work with children at her school. The work would have not been so smooth without their help and constant support.

Research work in Nepal would not have been possible without the all-round support of Mr. H. S. Niraula. He made us feel at home in Kathmandu by extending a very kind hospitality, and was functional in the field by arranging local contacts, research assistants and all the facilities for our stay and work in Dolakha. On several occasions he took the pain of traveling and staying with us. We sincerely thank him for his support. We also thank Professor Ayan Bahadur Shrestha, former Professor and head of the Psychology Department, Tribhuvan University, Kathmandu. He was not only a great source of inspiration for the whole research team during the field-work, but also a great source of information about the life and culture of people in Nepal.

The late Professor Babban Misra of Gorakhpur University was instrumental in organizing research at Panditpur. He was a wonderful host and a good research supervisor. Ms. Jyotima Pandey, Ms. Ragini Rai and Ms. Shilpa Singh carried out all testing and interviews at Panditpur. Mr. Hari Madhav Pandey welcomed us in his village and introduced us to the village surroundings and the school teachers.

On several occasions during this project, we were able to discuss preliminary data and research issues with interested colleagues, in particular at workshops and conferences. We thank particularly the Cognitive Anthropology Research Group (CARG) at the Max Planck Institute for Psycholinguistics in Nijmegen, the Netherlands; this group includes Steve Levinson, Melissa Bowerman, Gaby Cablitz, Daniel Haun, Olivier Le Guen, Asifa Majid, Bhuvana Narasimhan,

Günther Senft, Edith Sjoerdsma, and David Wilkins. We especially thank Penny Brown, who painstakingly read through our very rough drafts while she was herself on field-work in Papua New Guinea; any errors and misinterpretations are of course our responsibility and not hers. Colleagues from other locations who contributed ideas and discussions include Symen Browers, Pascale Cottereau-Reiss, Marie-Noëlle Chamoux, Fabienne Tanon, Bertrand Troadec, and Gisela Trommsdorff, as well as three anonymous reviewers.

We particularly thank Dr. Rudo Niemeijer for his expert help with statistical analyses, during many work meetings in Holland, Portugal and Switzerland, as well as at a distance.

Part I

Introduction and methods

1 Theory and research questions

Introduction

"Put the knife to the north side of the plate, and the fork south!" To many readers of this book, this motherly instruction to her child will seem rather bizarre. Why not right and left of the plate? Because this mother is using a "geocentric" frame of spatial reference (FoR) instead of an egocentric one; in other words, she is using a large-scale orientation system (such as cardinal directions, but there are others) to talk about small-scale table-top space inside a room.[1] While it is possible to do this in English, it is hardly ever done and comes across as strange. In some other languages, however, like Balinese, Hindi or Nepali, it would not sound strange at all; in fact, it is standard practice, and could be heard by any child old enough to set the table.

How do children learn to use a geocentric FoR? This question has never been addressed in mainstream developmental psychology, because a geocentric FoR is quite unfamiliar to Western children and psychologists alike. They may use a geocentric frame when navigating in a North American city laid out in a grid pattern, or on interstate highways, or when map reading, but not when talking about the location of objects inside a house. Yet many of the children in Bali, in India or in Nepal where we carried out our research (and in several other locations world-wide studied by Levinson, 2003, and his colleagues) use a geocentric FoR with ease. In this book we explore how they do this when they speak as well as when they perform non-verbal cognitive tasks (such as remembering locations and directions), and how these skills develop with age. We also look at the socio-cultural contexts in which this learning takes place, and we explore the ecological, cultural, social, and linguistic conditions that favor the use of a geocentric FoR.

Because this study is about child development in interaction with culture in its broadest sense, it is part of "cultural psychology"; because we examine this

[1] According to Freundschuh's (2000, p. 129) typology, we are dealing with "manipulable object space", as opposed to non-manipulable object space (which requires locomotion to view all parts), environment space, geographic, panoramic or map space.

in several locations, it is also a comparative study, and hence is part of "cross-cultural psychology." The latter is inherently multidisciplinary, and draws heavily on anthropology, in this case cognitive anthropology in particular. The research deals with language and cognition, and examines these with a developmental perspective; therefore, linguistics is also relevant (although we do not claim to be experts in this field), and of course developmental psychology, and especially cross-cultural human development.

Before looking at the geocentric FoR in particular, we start with a small survey of research on "culture and cognitive development" and its main conclusions, and propose a theoretical framework that we believe to be most suitable for this type of research.

General "culture and cognition" issues

"How does culture influence the way we think?" is a very old question. "How do culture and mind make up each other?" is its current reformulation. Are there cognitive processes that are common to all humankind, in other words, universal? And at what level does cultural diversity play a role? These are some questions that have accompanied both of us throughout our careers, and we have had several opportunities not only to contribute our own empirical research, but also to review (cross-)cultural research findings. Dasen initially concentrated on cross-cultural Piagetian psychology in early summary papers (Dasen, 1972; Dasen & Heron, 1981) and two books of readings on "Culture and cognition" (Berry & Dasen, 1974; Dasen, 1977), followed by wider and more recent surveys in sections of two textbooks of cross-cultural psychology (Berry, Poortinga, Segall, & Dasen, 2002; Segall, Dasen, Berry, & Poortinga, 1999). Maynard (2008) provides a look back over four decades of this field. Mishra has reviewed research on culture and cognition in two handbooks (Mishra, 1997, 2001) as well as in the context of his own research in India (Mishra, Sinha, & Berry, 1996). Together, we have examined the prospects of cross-cultural developmental psychology in the (ethnocentrically Western) "new millennium" (Dasen & Mishra, 2000), the cognitive impact of schooling (Mishra & Dasen, 2004), and methodological issues of combining anthropology and psychology (Mishra & Dasen, 2007). We do not intend to repeat here this material in any detail, but only to raise a few issues that are directly relevant to the study at hand.

The first major question is whether there are cultural differences in basic cognitive processes, or whether these are universal. The controversy is still current, although it is not new. Advocates of "great divide" theories (see Segall *et al.*, 1999, p. 132) have usually made an opposition between Western and non-Western thinking, under different labels: civilized vs. primitive, literate vs. illiterate, abstract vs. concrete, etc. Lévy-Bruhl (1910), for example, characterized

Table 1.1. *Western vs. Asian thought according to Nisbett (2003)*

Western (Analytic)	Asian (Holistic)
Focus on object and its attributes	Focus on field in which the object is located
Use attributes to categorize	Relationship between object and field
Use universal laws about categories to control events	Absence of universal laws, means control is difficult
Laws are deterministic and linear	No tradition of formal logic; reliance on experiential knowledge
Use formal logic	Dialectical approach: the middle way

thought "in inferior societies" as "pre-logical." According to him, "primitives perceive nothing in the same way as we do" (1910, p. 10). Under the attacks of anthropologists like Boas and Malinowski, who advocated both cultural relativism and the "psychic unity of mankind," Lévy-Bruhl (1949) reconsidered his statement somewhat and wrote "I should have said: primitives perceive nothing *exactly* in the same way as we do" (p. 245).

While the vocabulary become more politically correct, several "great divide" theories emerged during the twentieth century, the most recent one being linked to the bandwagon of cross-cultural psychology, namely the opposition between individualism and collectivism (see Kagitçibasi, 1997; Kim, Triandis, Kagitçibasi, Choi, & Yoon, 1994; Triandis, 1995). The proponent of this modern version of a basic dichotomy is Richard Nisbett (2003) who opposes Western and Asian thought: "Two utterly different approaches to the world have maintained themselves for thousands of years. These approaches include profoundly different social relations, views about the nature of the world, and characteristic thought processes" (Nisbett, 2003, p. xx). His theory is summarized in Table 1.1.

Nisbett and his colleagues support their claim with a large number of experiments usually involving United States Americans and Chinese or Japanese informants, with Asian-Americans showing intermediate results. They conclude: "The research shows that there are indeed dramatic differences in the nature of Asian and European thought processes" (Nisbett, 2003, p. xviii).

We shall come back shortly to how we would interpret these results somewhat differently.

Another recurrent trend is to attribute cognitive differences to "racial" or genetic factors. In this case, the theories usually assume that the differences are not qualitative but quantitative: for example, "intelligence" measured as IQ (intelligence quotient) derived from standardized psychometric tests. An early example is Porteus (1917, 1937) who peddled his maze test all over the globe and placed societies in hierarchical order according to their performance,

interpreting the "results" with evolutionary innuendos. More recent examples are Jensen (1969), Eysenck (1971, 1988), Herrnstein and Murray (1994), and Rushton (1995). Quite obviously, we do not share these views (for a rebuttal, see Segall *et al.*, 1999, pp. 137ff).

Note that both of these paradigms claim to find important differences in cognition, but they interpret them in opposite ways. The former defines qualitative differences, and the question remains open whether these are interpreted in a judgmental form or not, in other words, whether they have ethnocentric or even racist connotations or not. Even Lévy-Bruhl did not see pre-logical thought as a-logical or anti-logical, nor even as a stage prior to logical thought (despite the prefix *pre-*), but simply as a totally different worldview. In some ways, it is an extreme form of cultural relativism. The second paradigm partakes of what Berry *et al.* (2002, p. 324) have called an "absolutist" orientation: cognitive processes are assumed as universal and measurable with standardized instruments without taking cultural and contextual variables into account; quantitative differences are therefore attributed to biological factors.

Everything we know from cross-cultural research on cognition, that of others and our own, including what will be presented in this book, leads us to disagree with both of these extreme paradigms, and to advocate an intermediate position.

Opposed to the two paradigms claiming qualitative or quantitative differences in cognition, are claims to the universality of cognitive processes, including those measured by standardized (although usually translated and adapted) tests such as the (Wechsler Intelligence Scale for Children (WISC). Georgas, Weiss, van de Vijver, and Saklofske (2003) make such a claim on the basis of a comparative analysis of normative data across sixteen (mainly Western) countries. The basic idea is first to check the structural equivalence across the samples with factor analysis and other statistical techniques; once this is done and proves successful, any remaining country variations can be studied against the background of this commonality. Georgas *et al.* provide convincing data for "a remarkable similarity in factor structure across these countries. The factor equivalence suggests cognitive universality in the WISC-III across these cultures" (p. 289). One problem with the conclusion of "universality" in this study is the sampling: all the samples come from highly literate, industrialized and fairly affluent countries. What about the rest of the world, the "majority world"?[2] The authors attribute the (fairly small) country differences

[2] The "majority world" is a phrase coined by Kagitçibasi (2007) to refer to the non-Western world, which is ignored in most psychological research even though it represents the majority of the world's population. Dasen and Akkari (2008) have used it to point to a similar ethnocentrism in educational research.

to "educational factors." However, because the samples were not selected purposely according to some theoretical scheme, this explanation remains rather unsatisfactory. Furthermore, the procedure cannot deal with possibly different definitions of intelligence, since it imposes one particular sampling of skills to define IQ.[3]

It will have become obvious that we also have some reservations with regard to this approach, which leans towards absolutism and tends to disregard cultural variability, or at least considers it as less interesting than the demonstration of core universal processes. It is what Poortinga, van de Vijver, Joe, and van de Koppel (1987) have called "peeling the onion called culture," which, in the extreme, amounts to throwing the baby out with the bath water. So, from our point of view, it is important and interesting to document both universality and cultural differences, and neither of these can be assumed ahead of time, but have to be empirically demonstrated. This is why we need comparative cross-cultural research. As long as we confine our study to one single society, be it Euro-American or any other (as so-called "indigenous" psychology would typically do – cf. Berry, Irvine, & Hunt, 1988; Heelas & Lock, 1981; Kim & Berry, 1993; Kim, Yang, & Hwang, 2006), we logically cannot find out what is common to two or more societies, let alone demonstrate universality. Hence what we need is culturally sensitive research (such as advocated by cultural or indigenous psychologies, or by ethnography or anthropology), but in a culture comparative design. This is what we set out to demonstrate in this book.

Regarding empirical results concerning cross-cultural research on cognition, one summary conclusion we agree with was formulated by Cole, Gay, Glick, and Sharp (1971, p. 233): "Cultural differences in cognition reside more in the situations to which particular cognitive processes are applied than in the existence of a process in one cultural group and its absence in another."

In other words, basic cognitive processes are indeed universal, i.e. they are potentially available, at least as an underlying competence, to all normal humans. However, the way they are used or combined, the contents and contexts to which they are applied, vary widely. What do we mean by "basic" cognitive processes? Classifying, remembering and forgetting, solving problems and making inferences, and reasoning logically, for example by using syllogisms, are classical examples. For each of these, research by Cole and his colleagues in Liberia, Mexico and elsewhere, and by many other researchers, points to the fact that the basic process exists in all populations, but that these processes can take different forms.

[3] For a study reporting a culturally specific African definition of intelligence, see Dasen, Dembélé, Ettien, Kabran, Kamagate, Koffi, and N'Guessan (1985), summarized in Dasen (1984). Later comparative research in a rural area of Switzerland confirmed these findings (Fournier, Schurmans, & Dasen, 1999; Schurmans & Dasen, 1992).

Take classifying, the way information is simplified to make it more manageable, a basic process without which language itself would be impossible. When we think of a "chair" as a piece of furniture to sit on, we can include a vast number of different objects under that same category. But in some societies, chairs don't exist; one sits on stools, or on carpets, or on the ground. Never mind, what exists everywhere is the basic process of classification, of using a prototype or best example for a noun category. Yet classification can take different forms. One form that is particularly valued in the Western world, and fostered by formal schooling, is taxonomic classification, i.e. classifying into subordinate categories: chairs and stools and tables are all furniture. This choice is opposed to functional grouping; for example, instead of putting the knife with the machete because they are cutting tools, and the cassava with the yam because they are root vegetables, the knife is grouped with the cassava, because it is used to cut the tubers.

In mainstream developmental psychology, taxonomic classification is considered as more "advanced" than functional grouping, because it is found in older (and hence more schooled) children. However, there are now several studies that show that in many contexts, functional grouping is the preferred mode (e.g. Berteaux, 2007; Troadec, 1999) even for adults (Wassmann & Dasen, 1994a). Ciborowski (1980) reports an anecdote from the studies by Cole and his colleagues in Liberia. On a sorting task, the majority of adult Kpelle systematically produced functional groupings. When one of the researchers probed for reasons for the groupings, his informants said that this was the clever way to do it. "Acting on a hunch, Glick asked a subject to do the classification task as a stupid Kpelle person might do it. The result was dramatic. Under the new instructions, the subject produced a perfect taxonomic grouping" (Ciborowski, 1980, p. 283).

Whether this story is true or has to be taken with a grain of salt, the implication is that the Kpelle informants had at their disposal several ways of solving the task. Choosing one or the other may be dependent on circumstances, on how the informant interprets the instructions and gives meaning to the task, or on previous experience with similar situations, the familiarity with the testing materials, and so on. In other words, it is not the absence or existence of the cognitive process that is at stake, but whether and how it is applied.

In his studies of cognitive development according to Piaget's theory, Dasen (1984; Dasen & Heron, 1981) came to a similar conclusion. By using training techniques, Dasen and his colleagues (Dasen, Lavallée, & Retschitzki, 1979; Dasen, Ngini, & Lavallée, 1979) found that after the age of 12, children who apparently could not solve Piagetian tasks at the concrete operational level could do so after a very short training sequence, suggesting that they had the underlying competence for this type of reasoning, but did not use it spontaneously in the testing situation (i.e. at the performance level). This leads to the

conclusion that concrete operational reasoning is a universal at the competence level, cultural differences being found in the way this competence is actualized in particular settings. This is not to deny that there may also be cultural differences in the rhythms of development (i.e. the age at which particular stages occur), under the influence of the value attributed to each conceptual area in each society. For example, there is a more rapid development of spatial concepts in hunting and gathering societies, and of quantitative concepts in sedentary, agricultural societies (Dasen, 1975).

Another illustrative example is syllogistic reasoning. An early cross-cultural study was carried out in Central Asia (Uzbekistan and Kirghizistan) in the 1930s by Luria and Vygotsky, although it came to public attention in English only much later (Luria, 1976). The researchers presented illiterate adults with problems of the following type:

> In the north, where there is snow all year, the bears are white;
> Novaya Zemlya is in the far north;
> What color are the bears there?

Illiterate peasants typically said: "How should I know what color the bear was? I haven't been in the north. You should ask people who travel. We always speak only of what we see; we don't talk about what we haven't seen."

After one year of literacy training, the same adults had no problem answering the syllogism in the expected way. Luria (1976) concluded that literacy produced new reasoning processes, namely hypothetico-deductive or "theoretic" logical reasoning.

Scribner (1979) found similar results in Liberia when comparing illiterate and literate adults, except that she also presented syllogisms that corresponded to the informants' daily life. On those, they had no problem using syllogisms according to the rules of logic. For syllogisms with unfamiliar or hypothetical content, on the other hand, they either refused to answer, or changed the premises to suit personal experience and knowledge, which is what Scribner called the "empiric" mode. She concluded that verbal logical problems are a special genre, a style of discourse, that is frequently used in school, which explains why the "theoretic" mode is common among schooled informants; the willingness to engage in this style does not reflect a different form of thought, but the habit of applying a common form of logical reasoning to a new context.

A preference for this empiric mode has also been found by Schliemann and Acioly (1989) in adults with limited schooling in Brazil. As part of a larger study, twenty lottery bookies (with levels of schooling from zero to eleven years) were given permutation problems with different (familiar and unfamiliar) content. For example: "Find out all the possible ways to arrange the letters A, B, C, and D" or "the letters in the word *casa*." All informants were

equally efficient in solving permutation of numbers problems at work, but the unschooled group refused to attempt to solve the unfamiliar problems. For example Felix, a bookie with no schooling, gave the following answer to the problem with the word *casa*:

F: This one is worse because I don't know how to read.
E: But you don't have to read. (Repeats problem)
F: This one is too complicated because to read is more difficult than to deal with numbers.
E: What if you do it like this: The C stands for number 1, the A for 2, S for 3, A for 2? Couldn't you do it?
F: No, because one thing is different from the other. (Schliemann & Acioly, 1989, p. 206)

This informant does not lack the cognitive process to solve permutation problems with numbers in the context of his job, when he sells lottery tickets, but refuses to transfer this skill to the context of letters, which he considers foreign to him because he cannot read and write. The process exists, but the situation in which it is applied has to be familiar and meaningful: a typical example of the empiric mode.

A preference for the theoretic mode may be brought about by schooling (because most activities in school are decontextualized), or possibly by literacy, because writing and reading imply a double abstraction from reality (Goody & Watt, 1963) although there are indications that it is Western-type schooling and not literacy per se that is effective (Berry & Bennett, 1991; Scribner & Cole, 1981).

Nisbett (2003) considers the theoretic mode to be a Western inheritance from early Greek philosophy. He reports that, independently of educational level, East Asians (in this case, Koreans) "are more likely to set logic aside in favour of typicality and plausibility of conclusions. They are also more likely to set logic aside in favour of the desirability of conclusions" (p. 171). However, Nisbett's interpretation is similar to that of Scribner, namely that this is not a difference in the *capacity* for logical thinking: "There is no question of this difference being due to the Korean participants being less capable of performing logical operations than the American participants. Koreans and Americans made an equal number of errors on the purely abstract syllogisms" (p. 170).

If it is not a difference in the capacity for cognitive processes, it is a difference in cognitive styles.

Cognitive styles

What do we mean by cognitive styles? They can be defined as "an individual's preferred and habitual modes of perceiving, remembering, organising, processing, and representing information" (Dörnyei, 2005, p. 125), or even

more generally as "one's preferred way of processing information and dealing with tasks" (Zhang & Sternberg, 2006, p. 3).

We are in the presence of a cognitive style when different individuals (or different groups) react differently to a cognitive problem (task, test, experiment, etc.) in some systematic way even though they have the same underlying cognitive capacity or competence. They "choose" to react in this particular way under the influence of a variety of factors such as their age, gender, previous experience, socialization, etc. Of course, this is not necessarily a conscious "choice"; it is in fact more likely to be unconscious, linked to habits, customs or preferred values – in other words, to "culture." An important aspect of cognitive styles is that there is no judgmental aspect to this choice. It is not inherently "better" or "more advanced" to react one way or another.

We believe that we can usefully reinterpret many of the cross-cultural findings in terms of cognitive styles. For example, the fact that the universal competence for concrete operations is actualized or not in terms of performance on particular Piagetian tasks, or Scribner's empiric vs. theoretic mode, functional vs. taxonomic classification, and also the Asian vs. Western modes of thought can all be interpreted in terms of cognitive style. Nisbett (2003) would no doubt disagree, since he writes that "the research shows that there are indeed dramatic differences in the *nature* of Asian and European *thought processes*" (p. xviii, our emphasis). In fact, Nisbett's own colleagues are more moderate in this respect. The following quote could easily be interpreted in terms of cognitive styles: "Although both systems of thought are in principle cognitively available to all normal adult humans, cultural experiences may encourage reliance on one system at the expense of another, giving rise to systematic cultural differences. These differences in cognitive orientations are believed to be rooted in the different social worlds of East Asians and Westerners today" (Norenzayan, Choi, & Peng, 2007, p. 578).

Riding (2001, 2002; see also Dörnyei, 2005, pp. 128–129) subsumes a series of cognitive style theories in the contrast between holists and analytics. The former see a situation as a whole and appreciate the total context, the latter see a situation as a collection of parts. This typology includes what is probably the best known cognitive style, field dependence vs. field independence (FDI), on the basis of Witkin's (1978; Witkin, Dyk, Faterson, Goodenough, & Karp, 1962) theory. This is a dimension on which people can be positioned anywhere, but there is evidence for coherence, so that people who tend to be on the field-independent side will show analytical cognitive functioning and will not be easily influenced by social opinion, and those who are field dependent function globally and show social empathy. Analytical cognition is marked, for example, by the ability to pick a single element out of a complex figure quickly. Witkin's theory also links psychological differentiation to child-rearing patterns and to differential brain functioning.

FDI is the only cognitive style that has led to extensive cross-cultural research, notably by Berry (1976, 1979) and his colleagues. Some of the early findings were reviewed by Witkin and Berry (1975) and more recent research by Mishra *et al*. (1996). Berry (1976) found a strong eco-cultural factor when studying FDI cross-culturally across a wide range of societies: members of nomadic hunting and gathering societies tend to be more field independent than members of sedentary societies living from subsistence agriculture. However, FDI was also found to be influenced by acculturation, probably because of test-taking familiarity linked to education or employment in the "modern" sector.

In an attempt to test the eco-cultural dimension in a single geographical area, Berry, Van de Koppel, Sénéchal, Annis, Bahuchet, Cavalli-Sforza, and Witkin (1986) studied children and adults in Central Africa, drawing samples of the Biaka (Pygmy hunters and gatherers), the Bangandu (mainly agriculturist, but with some hunting and gathering), and the Gbanu (full-fledged agriculturist) cultural groups. Findings offered support to the fact that different cognitive styles were encouraged in different eco-cultural contexts. Furthermore, highly acculturated individuals were more field independent than low acculturated individuals.

In a more recent study Mishra *et al*. (1996) studied parents and children of the Birhor (a nomadic hunter-gatherer group), Asur (recent settlers pursuing a mixed economy of hunting-gathering and agriculture), and Oraon (long-standing agriculturists) tribal cultural groups in the state of Bihar (now Jharkhand) in India. In each group, both low and highly acculturated individuals were included. Parents' emphases on compliance or self-assertion during socialization were assessed through a combination of observation, interview and testing. The results provided evidence for the existence of "cognitive styles," which could be reliably related to ecological, cultural and acculturation characteristics of the groups. It was also possible to predict the cognitive style of children and adults on the basis of variables like parental helping and feedback. Similar results have been obtained in another study carried out with children of hunting-gathering, agricultural and wage-earning samples of the Tharu culture in the Himalayan region of India (Mishra, 1998).

Dasen, Berry, and Witkin (1979; also Berry, Dasen, & Witkin, 1982) have argued for a value-free interpretation of cognitive styles (and even cognitive development more generally) in the context of cross-cultural studies. To be field independent is not inherently better than being field dependent, although it is what tends to be valued in many situations. Furthermore, males tend to be more field independent than females, and psychological differentiation increases with age, which may unavoidably give it the connotation of being more advanced, as was argued by Cole and Scribner (1977). However, someone who is more field dependent has more empathy, more social skills, can fit in better with a group, and see things in a more holistic fashion. Note the

similarities to Nisbett's Asian mode of thinking, or to collectivism as opposed to individualism!

One problem with keeping the field dependence/independence cognitive style value free comes from the way it is measured. Some of the tests show a strong association with ability, or even with general intelligence (Dörnyei, 2005; Sternberg & Grigorenko, 2001a; Zhang & Sternberg, 2006). Some tests devised by Witkin to measure psychological differentiation, such as the so-called Rod and Frame Test (RFT), are quite specific: the subjects are presented with a line surrounded by a tilted square, and they have to adjust the line so that it looks vertical. Field-dependent people are influenced by the square, so they tilt the line in the same direction as the square, while field-independent people set the line independently of it, according to their body perception of verticality. In this case, it is rather easy to accept that there are two ways to react to this situation, and that one is not inherently better than the other (although it is the independent people who can follow the instructions more carefully, and turn the line to the "true" vertical!)

In other tests, such as the Embedded Figures Test (EFT), where small elements have to be found in a complex drawing, field-independent subjects find the elements more easily (and take less time to solve the task, if it is timed), so it is difficult not to find their performance more efficient than that of the field-dependent individuals. Still a step further, some standard psychometric tasks, such as the Block Designs Test (BDT, also called Kohs Blocks) or Raven's Progressive Matrices were found to correlate with RFT and EFT, and were therefore also considered to be measures of psychological differentiation (see for example Berry, 1976). This issue may seem somewhat abstract at this stage, but we will come back to it in later sections of the book, since we have used some of these tests in parts of our research. We consider them to be measures of spatial ability.

Dörnyei (2005) makes a clear distinction between cognitive styles and learning styles, the latter being defined as "an individual's natural, habitual, and preferred way(s) of absorbing, processing, and retaining new information and skills" (p. 121). He considers that "the theoretical basis of cognitive styles is more solid than that of learning styles," and makes a further distinction between styles and strategies. The former are considered to be fairly fixed for an individual, and may even have a physiological basis, while the latter are learned and less stable across time and situations. Also, styles operate without individual awareness, whereas strategies involve a conscious choice of alternatives (Dörnyei, 2005; Sternberg & Grigorenko, 2001a).

We have dealt with cognitive styles in some detail, because what our review of cross-cultural research leads to is the following conclusion, rephrasing slightly the one by Cole *et al.* (1971) quoted above: cultural differences in

cognition reside more in *cognitive styles* than in the existence of a process in one cultural group and its absence in another.

We think that this general conclusion is also true for the processes of spatial cognition, and in particular for the central topic of this book, the "choice" between the egocentric and the geocentric spatial frames of reference. But before we come to this central topic, we would like to present a theoretical framework that has guided our research over the years, including the research presented in this book. It is a framework that is particularly suited to the cross-cultural study of human development.

Theoretical framework

The "integrated" theoretical framework that is presented in Figure 1.1 was first published in 2003 (Dasen, 2003), but its elaboration has been a long process (see for example Dasen, 1998). It attempts to combine a variety of theoretical frameworks that have appeared over three or four decades, and that have guided our research for a long time.

The basic idea is that the individual's behavior, and particularly the child's development, occur in interaction with contexts. Super and Harkness (1986, 1997) have presented this under the concept of the "developmental niche," namely the system formed by the developing individual, the physical and social settings in which it occurs, child-rearing customs, and parental ethnotheories (see also Sabatier, 1994; Grigorenko, 2001). This is an open system, which is in turn interacting with the wider ecological and cultural contexts. The links between individual psychological variables and background variables at the population level, in particular the ecological and socio-political contexts and the biological and cultural adaptations to these, have been formulated by Berry (1966) as the eco-cultural framework. It has guided much of his and our own research over the years (Berry, 1976; 1995; Berry *et al.*, 1986; Dasen, 1973, 1974, 1975; Mishra *et al.*, 1996), and has also served as the backbone for two textbooks of cross-cultural psychology (Berry *et al.*, 2002; Segall *et al.*, 1999). Very important in the framework are the processes that link background to psychological variables, in particular cultural transmission. Berry's eco-cultural framework is very close to Whiting's (1977) psychocultural model and has longstanding roots in anthropological research (Jahoda, 1995). It is widely accepted as the most influential theoretical framework in cross-cultural psychology (Troadec, 2001).

In terms of Bronfenbrenner's (1989) ecological systems theory, the developmental niche forms the microsystem which is in closest contact with the developing individual; process variables are in the mesosystem, and the larger ecological and socio-political contexts in the macrosystem (exosystem). Graphically, this is illustrated in Figure 1.1 by concentric circles (but see

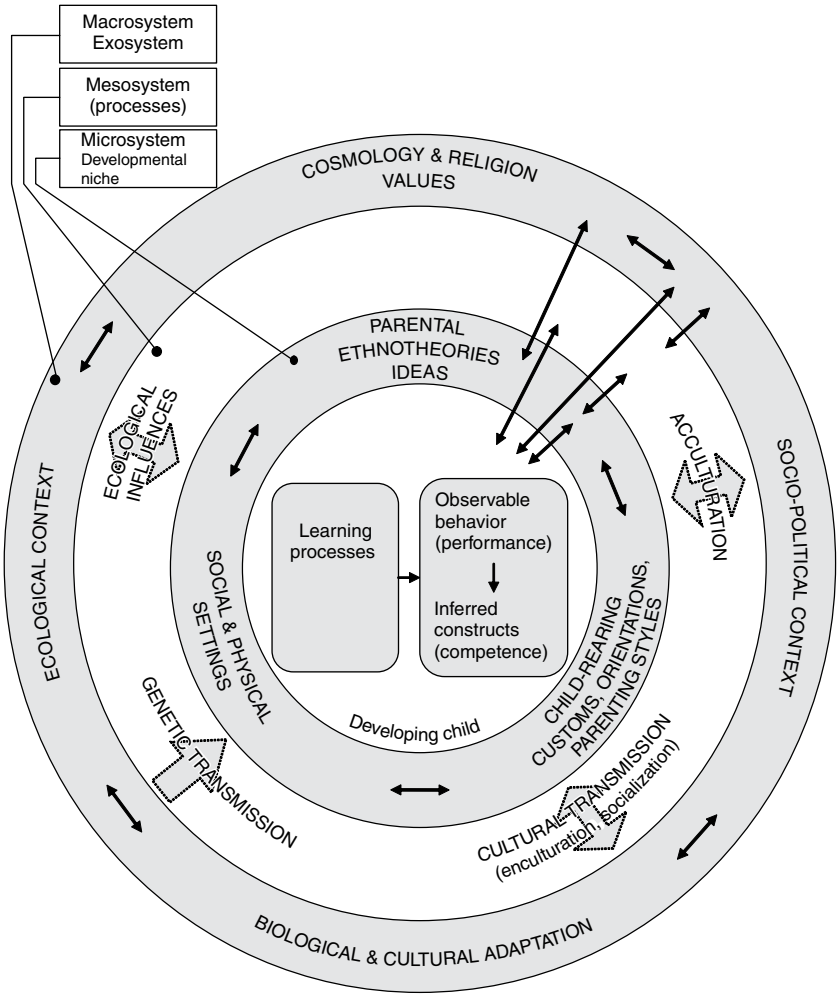


Figure 1.1 An integrated theoretical framework for cross-cultural human development

Sternberg & Grigorenko, 2001b, for an interesting challenge to this notion of embeddedness).

This integrated framework is not a static, deterministic model in which the individual is shaped by the contexts, instead it is a dynamic one in which there are interactions within and between all the components. Graphically, the multiple interaction arrows are inspired by the ecological and social cross-cultural model of the family proposed by Georgas (1988). This is of course a heuristic

idea, and it may be difficult to illustrate empirically all possible interactions. "Culture" as an anthropological concept at the population level occurs explicitly in the macrosystem as each society's particular way of adapting to the demands of the ecological and socio-political contexts.[4] This takes, in particular, the forms of cosmologies, religions and values. However, culture is in fact all-pervasive in the framework, because it is also part of the process variables of cultural transmission and acculturation (when societies are in contact with each other), and of the developmental niche. The individual is in culture, but culture is also in the individual. The two are co-constructed, they make up each other. Note that the framework also includes biological adaptation along with cultural adaptation. Biology and culture are not seen as opposites, but as complementary (Keller, Poortinga, & Schoelmerich, 2002).

According to B. Whiting (1980) the major way culture influences human development is by providing particular settings. Things are learned or not learned because they are available or not in the child's environment. Language is a good example. Biologically, human infants are able to learn any language, but will learn only the language(s) spoken around them; in the course of time, they will even lose the ability to pronounce sounds that they have not learned early on. And the impact of culture is obvious on child-rearing customs, and on parental ethnotheories, i.e. the ideas that adult caretakers have about children and how they should be raised.

Cross-cultural research on human development provides well-documented facts about all these components and their interactions. This is not the place to summarize these, because that would take many pages; the interested reader may find more information in Segall *et al.* (1999; see also Gardiner, Mutter, & Kosmitzki, 2005; Greenfield & Cocking, 1994; Greenfield & Suzuki, 1999; Harkness & Super, 1996, 2002; Kagitçibasi, 2007; Keller, 2007; Keller *et al*., 2002; Munroe, Munroe, & Whiting, 1981; Valsiner, 2000).

In the integrated framework, we also draw attention to the importance of studying the individual's learning processes (Bril & Lehalle, 1988; Dasen, 1988a). These occur in interaction with the developmental niche, sometimes through observation and imitation during incidental immersion in what is to be learned, and sometimes through intentional interactions with a master or teacher (Dasen, 2000, 2008; Segall *et al.*, 1999). Greenfield (2004), for example, reports a longitudinal study of learning to weave in a Mexican Maya community, where the learning processes changed over time, under the influence of economic and social change, from scaffolding (a learning/teaching process in

[4] There is one change in Figure 1.1 compared to the framework as it was first published in 2003: the arrow of the process of ecological influences now figures as bidirectional. Quite obviously, ecology does not only influence the microsystem and the individual, but the latter also influences the ecological context.

which the master does whatever appears to be too difficult for the apprentice) to independent trial-and-error learning.

Finally, the framework draws attention to the important distinction between observable behavior and inferred constructs. Almost everything psychologists are interested in, be it personality or intelligence, values, emotions or motivation, or indeed any psychological concept, is a construct that is derived or inferred from a sampling of observable behavior. Intelligence cannot be observed directly; it is inferred, and depending on one's definition of the concept, inferred from very different sets of behaviors, observed with very different methodologies. The validity of this process of inference has to be assessed constantly; it is problematic at all times, but even more so when working in foreign cultures and doing so comparatively. For example, contrary to widespread practice (e.g. Georgas *et al.*, 2003), we do not believe that it is possible to assess children's intelligence validly through IQ tests, especially not across widely different cultures.

To take an example closer to our current concerns, when we say "This child is using a geocentric FoR," we make an inference on the basis of what that child did or said in particular experimental settings that we have set up to solicit linguistic or non-linguistic behavior about space. "Is this inference valid?" is a question we have to keep constantly at the back of our minds. Of course, we believe that it is, and will try to demonstrate it; otherwise, the analysis of results would make no sense. But this validity can always be challenged.

Beyond this important methodological caveat, what guidance do we take from our theoretical framework? First of all, it shows that the unit of analysis has to be the child in context. Mainstream (experimental, developmental) psychology usually tries to isolate the individual from disturbing outside influences, in order to study intra-psychic processes in controllable conditions. Anthropology is typically interested in describing the wider cultural and sociohistorical contexts at the group level. What we are trying to do is to combine psychology and anthropology, in order to study the individual in context (Jahoda, 1982; Mishra & Dasen, 2007; Super & Harkness, 1986, 1997).

The second lesson is not to shy away from complexity. Human development occurs in this complex system of components, levels and processes, all interacting with each other. Of course, we cannot hope to study, let alone measure them all in a single research project. We therefore have to look at different facets of the system in a set of separate studies, trying as best we can to combine the results in a coherent fashion. But there will inevitably be some loopholes and contradictions. In the final chapter of this book, we will come back to this theoretical framework, and discuss in some detail which parts we think we have been able to cover.

It is now time to examine more closely the research background that led to the current study of children's development of geocentric frames of reference. This comes from two areas of research: developmental psychology, particularly the theory of Jean Piaget (who was based at the University of Geneva), and

comparative anthropological linguistics, particularly the research of Stephen Levinson and his colleagues at the Cognitive Anthropology Research Group (CARG) of the Max Planck Institute (MPI) for Psycholinguistics in Nijmegen, the Netherlands. We will now briefly review these two lines of research which we are trying to combine.

Spatial cognition and its development

Our research is about spatial cognition, and more particularly about how spatial cognition develops during ontogeny. It would be beyond the scope of this book to review the research in this area. What we will do here is present specifically the research concerning geocentric space, and some elements of developmental and cross-cultural psychology, as well as comparative linguistics to situate the topic. A slightly broader review of the literature, dealing with spatial frames of reference in mainstream developmental and experimental psychology, is presented at the end of this chapter. That research deals with the allocentric vs. egocentric space, but basically ignores the geocentric frame.

One point of departure for our study is the research by Piaget and Inhelder (1948/1956) on spatial cognitive development. Piaget and Inhelder's theory establishes the developmental sequence of topological, projective and Euclidean spatial concepts. Briefly, topological space refers to purely qualitative relations such as neighborhood, separation, ordinal relationships, and closure, i.e. notions such as open/closed, inside/outside, on, next to, in front of, etc.[5] Projective space introduces the point of view of an observer, i.e. the idea of a straight line and perspective, and notably the concepts of left and right. Euclidean space is metric, with a concept of distance and precise measurement, and notably locating objects in a grid of orthogonal coordinates.

Piaget and Inhelder's initial qualitative research in Geneva was replicated with more standardized tasks and larger samples by Laurendeau and Pinard (1968/1970) in Quebec, Canada, and became the generally accepted theory of spatial concept development. The distinction between these three types of spatial concepts is still current in more recent developmental psychology. Taylor and Tversky (1996, p. 372), for example, refer to three kinds of spatial reference frames: intrinsic or object-centered, deictic or viewer-centered, and extrinsic or environment-centered.

These three frames also come close to Levinson's (1996, 2003) distinction between intrinsic, relative (egocentric), and absolute (geocentric) frames in

[5] Johnston (1988) finds that locative spatial language in English is acquired in the following order: in, on, under, next to, between, back/front, and this learning is complete by age 5. The first five prepositions are all topological. "In front of" is topological/intrinsic only in relation to a fronted object, as in "The ball is in front of the child." With non-fronted objects, it is more likely to be projective/egocentric, i.e. "The child is in front of the ball" is true only from the viewpoint of the speaker.

Table 1.2. *Spatial frames of reference in developmental psychology and in linguistics*

Piaget & Inhelder (1956)	Topological	Projective	Euclidean
Taylor & Tversky (1996)	Intrinsic: object-centered	Deictic: viewer-centered	Extrinsic: environment-centered
Levinson (1996, 2003)	Intrinsic, allocentric	Relative, egocentric	Absolute, allocentric
Dasen & Mishra	Intrinsic	Egocentric	Geocentric

linguistics. Within an intrinsic frame, locations of target objects are described in relation to a ground object's front, back, sides, or other body parts. In the egocentric frame, the locations of objects are described in relation to an individual viewer's left, right, front, and back (LRFB); they are therefore viewer-centered. In the geocentric frame, objects are located according to a coordinate system that is external to the scene. The correspondence between these three frames in developmental psychology and in linguistics is summarized in Table 1.2.

Although this scheme seems simple enough, it is not without some difficulties and controversies. In particular, the correspondence between Piaget's three geometries and Levinson's three frames is intuitively tempting, but the fit is not perfect. We will discuss some of these problems towards the end of this chapter.

Developmental sequence of the three frames

It seems to be well established that topological space comes first in child development,[6] and cross-cultural research has shown that the use of topological features is most likely universal (Jahoda, Deregowski, & Sinha, 1974; Saxe & Gearhart, 1990). Dasen (1975) found full acquisition[7] of the topological concept of order by age 8 in Inuit children in Canada and Australian Aborigines (both hunting and gathering populations, where spatial concepts are highly valued) and by age 10 in a sedentary agricultural population (the Ebrié in Côte d'Ivoire), where spatial concepts are less valued.[8] This represents a much smaller age difference than found in the same study for projective and Euclidean space.

[6] Piaget was fascinated by this idea, because it refutes the idea that ontogeny recapitulates the history of science: in geometry, topology was invented last!

[7] In developmental studies, age of acquisition is usually defined by a success rate of 75%.

[8] Dasen, following Berry (1966, 1976), argues that spatial skills and concepts are highly valued in nomadic populations, while they are less valued than quantitative concepts in sedentary, agricultural populations.

Some doubts about the primacy of topological space (and about the accuracy of Piaget's use of that mathematical term) have also been raised. For example, Mandler (1988) considers that "there is sensitivity to both types of information [topological and Euclidean] from birth, with primary reliance on topological information at all ages. In this view, no qualitative change takes place, but with development, there is increasing accuracy in the use of both types of information"(p. 424). There has been, generally speaking, a movement in developmental psychology away from Piaget's constructivism to more nativist positions, and away from a qualitative stage theory to models that emphasize the constant (quantitative) increase in computational complexity (Hatwell, 1990). This is the case, for example, in many so-called neo-Piagetian theories; one problem we have raised concerning these is that they have never been subjected to any systematic cross-cultural replication (Dasen & de Ribaupierre, 1987), and this state of affairs has not really improved over the last two decades.

While topological (intrinsic) space clearly develops first, Piaget and Inhelder's (1948/1956) proposed sequence between projective and Euclidean concepts is less clear, and seems to be more of a logical than an empirical implication. The sequence derives from the general Piagetian notion of decentration: children first take only their own point of view into account before they are able to switch to someone else's perspective or to a more general and abstract spatial scheme such as coordinates. Thus, for example, children master left/right on their own body at age 5 to 6, but not on another person until age 7 to 8 (in Swiss, French, United States, and Canadian data, reviewed by Laurendeau and Pinard, 1970, p. 275). Concepts of verticality and horizontality are notoriously difficult and appear relatively late (Dasen, 1975), which is explained in Piaget's theory by the fact that they imply a coordinate system. Empirically, however, much seems to depend on any particular task's demands and complexity. Laurendeau and Pinard (1970) therefore remain very cautious in their conclusions. While they confirm the existence of "a pre-Euclidian and pre-projective level of spatial conceptualization, based exclusively on elementary topological concepts" (p. 424), they opt for a co-construction of projective and Euclidean space. Laurendeau and Pinard (1970, p. 17) state:

> Euclidean space also derives from topological space and is constructed parallel with projective space, from which it is distinct but to which it is closely related. While projective space is limited to co-ordinating different perspectives of an object … Euclidean space co-ordinates the objects among themselves with reference to a total framework or to a stable reference system … It is quite clear that this conservation of Euclidean relations would not be possible without the concomitant structuring of projective relations … It is for this reason that the development of Euclidean space is parallel to that of projective space.

Whether Euclidean space develops at the same time or after projective space, there is certainly no suggestion anywhere in the developmental literature that it might appear before projective space. This is an important issue in our study, because we are going to report a fairly early development of a geocentric FoR, which, if equated with Euclidean space, might represent a reversal of stages, or at least a developmental path not previously reported.

There have been a large number of studies exploring infants' abilities to locate objects according to egocentric, body-oriented vs. allocentric landmarks in the sensori-motor period (e.g. Acredolo, 1990; Bremner, 1989; Lepecq & Lafaite, 1989). Some nativists aside, there seems to be agreement that the baby first uses his or her own body as a reference before establishing outside, independent landmarks, and most of the research has concentrated on the exact age at which this shift occurs. The main findings are that this is earlier than Piaget had thought, but depends almost entirely on the precise way the task is set up. Some of the more recent research on this topic is reviewed later in this chapter, and shows that the use of allocentric space may be more fundamental than was initially thought. Note, however, that this concerns intrinsic/topological allocentric space, and not geocentric space.

An important distinction in Piaget's theory is that between sensori-motor space and later representational space. The former occurs in the first two years. In this period, infants and babies base their understanding of the world on action. The acquisition of language (and more generally what Piaget calls the semiotic function) marks the end of the sensori-motor stage. According to Piaget, children then repeat a similar sequence of sub-stages, and move from egocentrism to decentration, but at the representational level. However, the concept of "spatial representation" is also subject to controversy; for example, Mandler (1988) ascribes it to sensori-motor behavior, and it is used in cognitive science and artificial intelligence even for machines (for a discussion, see for example Clark, 2003; Holenstein, 1993).

In any case, in our research, we are not concerned with the sensori-motor period. Except for the study reported in chapter 10, in which the language used by mothers with babies down to 12 months of age was observed, our study starts, for practical reasons, with children of age 4 years: with our techniques (presented in chapter 2), it was not possible to test children younger than that age. In our study, we are therefore well into Piaget's representational period.

Within that period, the theory that spatial representation is basically built up from the point of view of the human body is still current:

> One of the first aspects of space that we confront is our own bodies. Our bodies have three axes, that formed by our heads and feet, that formed by our fronts and backs,

and that formed by our left and right … Space as we perceive and experience it is anchored, asymmetric, and biased. These facts about the space of our bodies and the world they interact form the basis for our conceptions of the spatial world. (Tversky, 1996, p. 3)

The idea that space is initially constructed on the basis of what has been called the "canonical position" (Clark, 1973, p. 34), and that our first intuitions about space are in terms of "up" and "down", "left" and "right," and "back" and "front," dates back to 1768 with Kant (van Cleve & Frederick, 1991). At first sight, this seems obvious and "natural," among other reasons because sensory information provided by the visual, auditory and haptic senses are all egocentric because the sensory apparatus is bound to the human body with its two eyes, ears and hands (Landau & Jackendoff, 1993; Paillard, 1991).

One problem with the whole area of spatial concept development is that it has almost completely relied on research with Western samples. The assumption that the egocentric FoR is more "natural" than the geocentric one might be ethnocentric (Wassmann, 1994). Could it be that the very centration of the individual's construction of space on the basis of his or her own body is a bias, due to Western individualism (Chamoux, 2004; Cohen-Emerique, 1991; Kagitçibasi, 1997)?

Comparative linguistics: Levinson *et al.* and the geocentric FoR

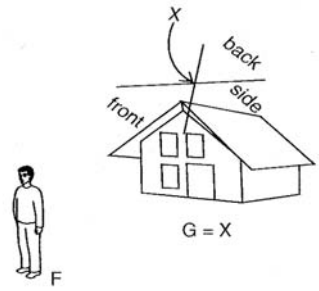
As we have mentioned above, the existence of a geocentric FoR in some languages has been documented by Levinson and his team over a period of more than a decade, and has been summarized best in a single volume in 2003 (for an excellent shorter summary, see Majid, Bowerman, Kita, Haun, & Levinson, 2004). In the following section, we shall mention some of these findings.

First of all, Levinson (2003) provides a detailed account of the three FoRs and their implications that we will not repeat here. These frames are illustrated in Figure 1.2 which illustrates the fact that a figure object always has to be located in relation to some ground, for example another object; in this particular case, a house is a so-called fronted object, which allows the intrinsic frame "in front of the house." The three frames have interesting properties under rotation. For the intrinsic and the geocentric frames, the speaker/viewer can move all around the display and still produce the same description, while the egocentric description changes. If the ground object is rotated, only the intrinsic description changes, but if the whole array is rotated, only the intrinsic does not change.

Levinson and his team are comparative anthropological linguists, so they have studied a large number of languages, and they work like anthropologists,

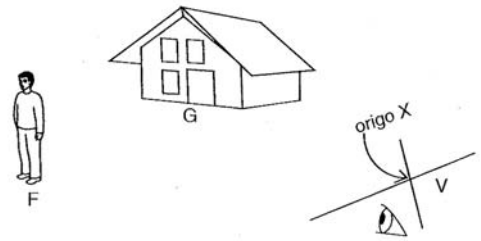
INTRINSIC

"He's in front of the house."



RELATIVE

"He's to the left of the house."



ABSOLUTE

"He's north of the house."

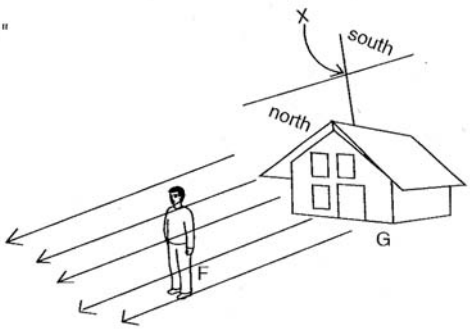


Figure 1.2 Three spatial frames of reference (FoR)
Reproduced with permission from Levinson (2003), p. 40

Table 1.3. *Languages studied by Levinson* et al. *(2003, p. 182)*

Predominant FoR	Languages	Preferred FoR in tasks
Geocentric (G)	Arrernte (Australian), Hai//om (Khoisan), Tzeltal (Mayan), Longgu (Austronesian)	G
Intrinsic (I)	Totonac, Mopan (Mayan)	I
Egocentric (E)	Dutch, English, Japanese	E
All three FoR	Belhare (Tibeto-Burman)	G
	Kgalagadi (Bantu)	E, G, I
	Kilivila (Austronesian)	G, I, R
	Yucatec (Mayan)	I, R
	Tamil	E (urban) G (rural)

sometimes in very remote locations, so they have included many non-Indo-European languages. Some of these are listed in Table 1.3 together with the actual FoR that is preferred in each case (in linguistic tasks, but, as we will see later, in fact also for non-linguistic cognitive tasks).

All of the societies mentioned in Table 1.3 have the intrinsic frame in their languages, which supports the claim to its universality mentioned above. Some languages in Mexico seem to have a strong preference for the intrinsic frame.[9] Indo-European languages (as well as Japanese) have, in principle, all three FoRs available, but the geocentric frame is hardly ever used to describe spatial relationships in table-top space.

More surprising is that there are languages that apparently don't have the egocentric frame at their disposal, or at least never use it, and use only the geocentric frame. Two out of the four listed in Table 1.3 are from nomadic, hunting and gathering groups, living in desert conditions, and it is tempting to think of an ecological explanation: we know from research in anthropology and cross-cultural psychology, including our own, that spatial concepts are extremely important and valued in such groups (Berry, 1976; Dasen, 1975; Mishra *et al.*, 1996). It is therefore not surprising to find that they are very proficient in using geocentric orientation systems, they keep their position updated continuously through dead reckoning, and are able to point to distant locations with great precision (see Levinson, 2003, pp. 227ff). However, there is also Tzeltal, spoken

[9] This is supported by Chamoux (2001) for the Nahuatl. Le Guen (2009) reports some interesting research among Yucatecan Mayas of Quintana Roo, who produce mainly intrinsic language but actually use a geocentric system in their gestures.

Table 1.4. *Available FoR and preferred frames in the languages of this study*

Language	Location	Available FoR	Preferred FoR
Balinese	Bunutan, village	G, I, E	G
	Sambangan, village	G, I, E	G
	Singaraja, city	G, I, E	G, E
Hindi	Roopchandpur, village	G, I, E	G
	Varanasi, city	G, I, E	G, E
Newari	Dolhaka, village	G, I, E	G
Nepali	Kathmandu, city	G, I, E	G, E
French	Geneva	E, I, G	E, I

by a sedentary Mayan community living from agriculture, which precludes any simple ecological functionalism. Majid *et al*. (2004) argue against ecological determinism on the basis of a meta-analysis of the comparative linguistic data. We will come back to this issue in chapters 4 and 15.

In the last group of languages in Table 1.3, all three frames are available, but preferences vary. The list includes Tamil, a South-Indian language studied by Pederson (1993), who found that Tamil speakers in a village setting had a clear preference for the geocentric frame, while in the city, the egocentric frame was also used or even preferred.[10] In our study, we also have rural and urban settings where the same language is spoken, in Bali and in India (with Hindi), so Pederson's study is directly relevant to our project.

In comparison, the languages included in our own study would all be in this last group, as shown in Table 1.4.

Pederson (1993) provides an interesting classification of subtypes of geocentric systems:

- north/south/east/west (NSEW); monsoonwards; towards sunset/sunrise, etc.
- uphill/downhill
- inland/seaward
- conventional landmark (CL), e.g. "towards the headman's house," used to designate distant direction (usually beyond the horizon)
- situationally based local landmark (SL), e.g. "towards the video camera," used to designate direction with respect to landmarks that are temporary or moveable, or that are nearby inside the room ("to the window").

[10] As we will see, the interpretation of this finding may differ. We think it is an obvious example of an ecological (urban/rural) difference. But Levinson (2003, pp. 190–191) interprets it as a difference in language (dialect), and even concludes that it is evidence against the impact of any ecological factor.

Our own system for categorizing language (Table 2.1 in chapter 2) is based on Pederson's, except that while we count his first three categories as geocentric (G), we keep both landmark categories separate. Their status will be discussed below, because we are not convinced that they are really geocentric.

One of the main questions in both Levinson's research and ours deals with the consequences of using one FoR rather than another, particularly for non-linguistic cognitive tasks. Levinson (2003) asks this question at the group level: if a language shows a strong preference for one of the frames, do speakers of that language tend to use that frame also in non-linguistic tasks? Research by Levinson's group provides overwhelming evidence that they do. A whole series of non-verbal tasks has been devised for this purpose, in the specific area of spatial coding in memory. They all follow the same "rotation paradigm" illustrated in Figure 1.3.

A stimulus is presented on table 1, which is oriented according to the main axes of cardinal directions (or their local equivalent). It may be a series of toy animals, geometric figures, a maze, or any other objects. The precise format of the tasks used in our research is described in chapter 2. Suppose it is actually an arrow (or a pencil). Subjects are required to memorize its position and orientation in order to be able to identify on table 2 (after a 180° rotation) which of the arrows is most like the one previously seen. If the subjects identify the one pointing to their right, they are most probably using an egocentric frame (because the coordinate system is rotating together with their body). If they choose the one pointing north, they are using the geocentric FoR.[11] Except for understanding the basic instructions given by the experimenter (which contain no directional information), the task can be performed without using any language; subjects only need to point.

In the Levinson *et al.* (2003) work, experiments using the rotation paradigm (with two to five particular tasks in each group) were carried out with adult subjects (with N varying from eleven to thirty-seven per group) speaking the languages listed in Table 1.3. As expected, those speaking English, Dutch, Japanese, and Tamil in an urban setting all tended to use egocentric encoding, while those speaking Arrernte, Hai//om, Tzeltal, Longgu, Belhare, and Tamil in the rural setting tended to use geocentric encoding.[12] "These results confirm that language is a good predictor of non-linguistic performance on such non-verbal tasks" (Levinson, 2003, p. 185).

Levinson's own team has worked consistently with adults, and although a few children may occasionally have been included in a sample, there has been,

[11] We will see later that, in either case, they may be using the intrinsic frame (e.g. aligned with the table edge), and some safeguards are needed in this respect.

[12] Levinson (2003) uses the term "coding", while we use "encoding", without any strong reason for this choice. Dan Slobin (personal communication) remarked that "encoding" might suggest only "linguistic encoding"; this is not the way we use the term, which we keep for the non-verbal memory "encoding tasks."

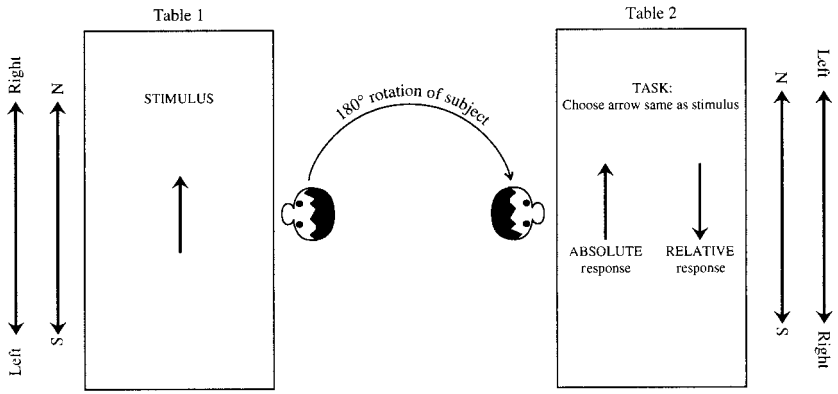


Figure 1.3 The basic design of the rotation paradigm
Reproduced with permission from Levinson (2003), p. 132

to our knowledge, no developmental research on non-verbal encoding with the rotation paradigm. On the other hand, the team has published some research on the development of the geocentric FoR in language.

In her study in Mexico, de León (1994) found that Tzotzil-speaking children begin to master the geocentric system between age 4 and 9, in a succession of stages. After an initial stage where locative terms are used randomly, a first contrast appears between "here" (the village) and "downland." The contrast "downland/upland" starts to be used at age 4; at age 5, "the opposition represents a socially conceptualized space with more emergent locations on the local map … At a final stage, around age 9, the upland/downland contrast is associated with the path of the sun and becomes a terrain-independent system of geocentric location" (p. 878). These stages represent a shift from an intrinsic frame of reference, through locally anchored references, to abstract coordinates. This sequence represents two departures from the Western developmental data: 1) "the acquisition of geocentric location appears earlier with Tzotzil children relative to the age of acquisition of left/right concepts in European children" (p. 880); 2) The egocentric (LRFB) system is absent in this language. The author concludes:

> Tzotzil children seem to acquire an orientation skill at an earlier age than is predicted by Piagetian studies of the development of spatial cognition. The data reported here thus suggest that a geocentric system in grammar may have an influence on the acquisition of a spatial skill. More comparative research between languages with and without geocentric location remains to be done to assess this preliminary finding. (de León, 1994, pp. 880–881)

De León (1995) also carried out a developmental study on language acquisition among Guugu Yimithirr (GY) Aboriginal children in Australia, between the ages of 6 and 14 years. The GY use a geocentric orientation system and

there is no left and right in the language. But, according to Haviland (1993), among the GY, geocentric directional terms are used mainly by old people; middle-aged and young GY Aborigines do not use geocentric directional terms; they use a simplified form of the traditional language, and standard and Aboriginal English.

Very young GY children (4 years) use intrinsic words (in, on, off, out) and up/down. "Left" and "right" as projective terms do not exist in the GY language, and front/back are used only in relation to motion, not position. By age 7, the children are using a locally anchored frame of reference, and by 9–10 years, contrasts of terms are built up. However, only three out of twenty-six children had acquired the full-fledged system of four GY cardinal terms, and these three children (aged 10 to 12) had learned it from their grandparents, who insisted on the importance of learning the traditional form of the language. The use of the term for "east" was found to be acquired through four stages: first it is used as a general demonstrative form ("look there") with no relationship to a precise direction; then, around age 8, children associate it to a specific beach located east of the settlement, and then with the general eastern region. Then follows the contrast with "west" (or sometimes with "south" at 90°), and finally the system with four directions, but only for the three children mentioned above.

These two studies are interesting for our project for two reasons: 1) they show how important it is to document the complexity of the sociolinguistic situation (particularly the influence of acculturation) as well as the developmental patterns of language use; 2) the overall developmental trend seems to go from intrinsic terms to locally geocentric, and in some cases to abstract geocentric terms. However, since they do not use egocentric (left/right) terms at all, the research cannot say much about the relationship between the egocentric and the geocentric systems. This shows that research is needed in locations where an egocentric system exists in the language, but is not the predominant one.

Note that these studies deal only with the development of language, from which it cannot be directly concluded, unless one advocates a strong form of linguistic relativity, that cognitive development has to follow the same sequence.

Brown and Levinson (2000) report a study of language development in children in Tzeltal (Mexico); five children were followed longitudinally from 1:6 to 4:6 years, and space-game[13] data were obtained with older children, providing a database of more than 600 hours of recordings of language production. The authors report, in particular, the following findings:

[13] Matching tasks designed to elicit spatial language are sometimes called "space games." Some of these are described in chapter 2.

Tzeltal children of 2 years of age do indeed talk about some topological relationships using the single preposition to express location at a place, and verbs to indicate motion in and out of containers. We can therefore infer that they have the corresponding topological concepts. (p. 185) …

Even when the layout of a household compound is relatively flat, children from about age 2:0 use geocentric vocabulary to talk about spatial relations within this local household space. (p. 185) … Children's first usage of the 'uphill/downhill' nouns is perhaps much like the use of place names; it is nonprojective and nonrelational … By age 3:6, some examples of explicitly relational geocentric uses are found in the children's data, showing that they are able to use geocentric coordinates to project angles. (p. 186) …

These are thus indubitably Euclidean notions, which do not rely on a physical slope; they are used to establish spatial relationships even on completely flat terrain, even in the dark and at night. (p. 173)

Thus, Tzeltal children seem to learn geocentric spatial language at the same time as topological/intrinsic language. The authors conclude:

The pattern of acquisition of Tzeltal absolute and intrinsic forms seems to provide evidence against a universal course of acquisition for spatial language (based on a scale of cognitive complexity) in favour of a view that children are capable of learning cognitively complex frames of reference remarkably early, if this is what is used and what is useful in their language environment. (p. 194)

In the same community, using language production data on a matching task with children from 5:7 to 16 years and some adults, Brown and Levinson (2008) analyze a total of 5,332 spatial language items. Virtually no age trend appears in the data. Intrinsic and geocentric items occur at all ages for about 25 percent of the occurrences, and the deictic[14] "coming/going uphill/downhillwards" about 40 percent. Egocentric language is never used. Landmarks is the only category showing a change with age, namely an increase from 3 percent at 5–7 years to 25 percent in adults. Hence there is no evidence in these data that landmarks (the status of which is to be discussed below), because they are more concrete, might be used as a stepping stone for the more abstract geocentric system. In fact, landmarks are used by Tzeltal adults mainly when they speak to other adults in order to reach a level of precision that cannot be communicated by the abstract geocentric system of quadrants. To give more precise angles, local landmarks are used.

Research into the geocentric FoR is not without some problems of definition and misunderstanding, some of which come from the fact that the research is carried out by linguists, anthropologists or psychologists, who each have their own methods and jargon. Of course, there are even some controversies within these disciplines.

[14] As explained in chapter 2, we also use a "deictic" category, but in a different sense, only when children say "this way, that way." In our two locations that use an "up/down" system, we categorize "going up/down" as geocentric.

Levinson's use of "relative" and "absolute" is perfectly clear to us, but apparently not to everybody. As we will see, the Balinese orientation system is geocentric, but it is not necessarily absolute, insofar as it is locally adapted to the particular situation on the island. We have therefore come to use egocentric (E) and geocentric (G), but we consider these as synonyms to Levinson's relative and absolute and use these terms occasionally (especially, of course, when we quote his work).

Linguistic relativism

A widely held notion about language is that it is a cultural product. It is also held that language makes human beings different not only from animal species, but also from other humans who do not speak the same language. Cross-cultural psychologists consider language as the most important medium of cultural transmission from one generation to another. Sharing of ideas, experiences, feelings, and a variety of knowledge is possible only through language. Naroll (1971) considers language as a significant basis for distinguishing between two independent cultural groups, called "cult-units," which could be used as an important criterion for their comparison on a variety of parameters in holocultural anthropology.

While language and concept learning represent independent fields of research in their own rights, a major question is whether the concepts are independent of language, or are constructed through language that children seemingly acquire through verbal interaction with adults.

Hickmann and Robert (2006, p. 10) summarize this opposition in the following way:

> Linguistic representations depend on particular spatial systems, each displaying its own internal organization, but perceptual or cognitive processes contributing to our spatial representations have been assumed to be universal and independent of language. A major debate now opposes two contrasted views. The first assumes that linguistic and non-linguistic spatial representations are relatively independent from one another, the second that they are intimately related.

The latter position is adopted mainly by the linguists who believe that language forms the fundamental basis of concept acquisition. This view is represented in the linguistic relativity hypothesis (Whorf, 1956), which argues that the users of different languages perceive and conceptualize their worlds in different ways. This hypothesis has continued to survive until today with recent empirical support for at least a moderate form of linguistic relativity (Gumperz & Levinson, 1996; Levinson, 2003; Levinson & Wilkins, 2006). This viewpoint suggests that language comes first and the concepts appear later.

The opposite position is taken by the cognitive scientists who believe that concepts have an independent existence, and their acquisition does not require construction through language. They hold that language is merely an input/output device. As Pinker (1994) argues, knowledge of a language allows us to know how to translate concepts (mentalese) into a string of words or vice versa. People without a language also have concepts, and babies and many nonhuman animals also use concepts without language. From this point of view, language comes into play only for the expression of concepts, not for their acquisition. A third view, mainly presented in developmental psychology (e.g. Tomasello, 1995), claims that language and concepts develop in a parallel manner, and they mutually make each other up. This proposition is very difficult to test, because it requires a technology that could tap the earliest grasp of language and the earliest understanding of concepts, and so far this has not been possible, even with the use of newer techniques, which have their own limitations.

Some researchers have attempted to examine concept development using research on primates to infer its relationship with language (e.g. Langer, 2001) on the assumption that these animals do not have the linguistic sophistication of human beings. Other researchers have worked with infants (who also do not have linguistic sophistication) or speakers of other languages (who have sophistication in another language). A basic assumption in these studies is that the concepts exist and can be discovered. It is also indicated that in early years the concepts are more uniform, but as children grow, the concepts start showing variations. Factors like the increase in vocabulary, greater experience with language through interaction with others and the development of cognitive flexibility in language use create a language-specific bias in conceptualization of the world that comes to dominate the non-linguistic classification in later years of childhood (Lucy & Gaskins, 2001). These factors seem to facilitate the writing of the "syntax of thought" (Braine, 1994) among older children in a manner that is different from that of the younger children.

Levinson's (2003) paradigm provides an empirical test for the so-called "Sapir-Whorf" hypothesis of "linguistic relativity," which states that it is habitual language use that constrains thought. Throughout its history since the 1950s, this theory has had many ups and downs, which have been summarized by Lucy (1997) and Berry *et al.* (2002, pp. 149–162), among others. Recently, there has been a notable revival of this hypothesis (Bowerman & Levinson, 2001; Gentner & Goldin-Meadow, 2003; Gumperz & Levinson, 1996; Levinson & Wilkins, 2006; Pederson & Nuyts, 1997). The research by Levinson and his group, although it is very carefully expressed, does lean towards a strong form of this hypothesis. For Levinson (2003), it is clearly language use, and that alone, which determines which FoR guides non-verbal cognition.

For example, Levinson (2003, pp. 188ff) reviews various studies carried out by members of his group that looked into the effects of different ecological and

socio-cultural variables, such as urban/rural contexts, schooling and literacy, acculturation and social change, as well as individual characteristics such as age and gender. He brushes all these aside:

> I conclude that there is distinct evidence … that ecological factors, or factors to do with material culture, or indeed religion or other cultural variables, do not seem to have a decisive role to play in non-verbal coding. (Levinson, 2003, pp. 190–191)

Levinson is careful to state that "it has to be conceded that there are difficulties in assessing some of these variables or categorizing them in a valid and reliable way" (p. 196) and further: "most samples are simply too small for clear results – if N does not exceed twenty, as in the majority of actual comparisons, subgroups of eight to ten people would have to be extremely homogenous to show substantial differences. Thus caution is in order" (p. 197).

Despite these methodological caveats, he concludes:

> One way to test for confounding variables is to see whether gender, literacy or other factors are indeed good predictors of frames of reference used in non-verbal tasks … The basic finding is that none of these factors can be serious confounds. (p. 193) … On the evidence we have in hand, there is no reason to think that any of these factors – gender, literacy, cultural conservatism – are serious confounds in the language-cognition correlation. (p. 197)

Although we hail Levinson's seminal work, and although we are going to use his paradigm for our research, our own position differs in two respects. First of all, we have a slightly more moderate reading of the research literature on linguistic relativity, and secondly, we believe that language is just one aspect of culture, and that all the variables listed above, together with language, could be of importance in determining which FoR is used in non-linguistic tasks.

On the first aspect, we have to admit to some bias, which may come from an early imprinting in Piaget's theory for at least one of us. For Piaget (1983) and his main collaborator in psycholinguistics, Hermine Sinclair (1967, 1975), cognitive development was considered to be a necessary condition for language development, and not the reverse; furthermore, cognition can take place, at least to a certain extent, independently of language. Research with deaf children had shown this quite clearly (Furth, 1973; Lenneberg, 1967; Liben, 1978). Of course, Piaget's neglect of language can now be seen as concomitant with his neglect of culture,[15] and we have distanced ourselves somewhat from his position towards a more Vygotskyan point of view (e.g. Vygotsky, 1962; cf. Segall *et al.*, 1999). The point remains that we see the relationships between language and cognition as most likely going both ways.

[15] Piaget (1974, 1977) paid lip service to the importance of testing his theory cross-culturally, but in fact he strongly believed that the factor of cultural transmission was rather unimportant compared to the general factor of equilibration.

Furthermore, the data from empirical cross-cultural psychology, although complex and convoluted, finally do not come out in favor of a strong version of the linguistic relativity hypothesis, but a rather moderate one. Berry *et al.* (2002, p. 163) conclude their review of the topic in the following way: "Numerous examples … seem to show that at the lexical level of expression … language may facilitate the processing of certain information in ways that are less available in another language" (p. 163). And further:

> All in all, the available evidence in experimental psycholinguistics indicates that language as an instrument for thinking has many cross-culturally invariant properties. As humans we may not all be sharing the same thoughts, but our respective languages do not seem to predestine us much to different kinds of thinking. (Berry *et al.*, 2002, p. 168)

As to our second reason for favoring a moderate form of linguistic relativity, it comes from the integrated theoretical framework presented above. In fact, language does not figure in the framework explicitly, but of course it comes in at every level of the system. First of all, it is an important aspect of learning processes within the developing child, and in the child's interaction with the microsystem. As part of the developmental niche, language is often cited to exemplify physical and social settings. And language is of course part of the macrosystem, as a shared component at the group level, and should be added to cosmology, religion and values; in other words, it is part of cultural adaptation, and in the mesosystem, it is of course part of cultural transmission (enculturation and socialization).

Before we move to the research questions of our own study, we feel the need to review some of the literature on spatial cognition, particularly that dealing with spatial frames of reference.

Review of research on spatial cognition

Mainstream developmental and experimental literature

We include here a review of research studies in what we call "mainstream" psychology, i.e. experimental and developmental psychology as practiced by the majority of researchers but in the minority world (i.e. in North American laboratories mainly), without any attention to cultural factors. We felt it important to carry out this review, particularly insofar as the studies deal with spatial frames of reference. However, this does not necessarily mean the geocentric FoR. Indeed, as became obvious to us only after a long search and extensive reading, most of the research deals with the allocentric frame, meaning in fact the intrinsic (or topological) and not the geocentric one.

Researchers consider space as the part of the environment in which objects are located, activities are carried out and events are created. Space may be

small scale or large scale, near or distant, visible or invisible, and real or imagined. Besides its physical meaning, space also carries cultural, social, religious, and spiritual meanings. Since space occupies a central place in all forms of life, its understanding has been a major theme of discussion and research for centuries. The voluminous research and theoretical developments during the last few decades have led to the development of spatial cognition as an independent area of inquiry within the broader domain of cognition.

Spatial cognition refers to the ability of individuals to understand, represent and describe their own location as well as the location of other objects in space. The ability to do so requires use and transformation of spatial information in certain understandable ways. It is essential not only for navigation through a geographical space, but also for describing object locations or routes to specific locations. Communication about space either verbally or through symbolic representations (e.g. maps and diagrams) forms an important dimension of spatial cognition, especially among human beings. The way human beings develop the abilities related to spatial functioning (e.g. understanding, representation and communication) and the way they use it in day-to-day life have been lively issues of research for a long time but have gained prominence in recent years in cognitive science, from neuropsychology to robotics (Denis, 1997; Hickmann & Robert, 2006). As in the case of other aspects of cognitive development, much of the debate about spatial cognition revolves around the nature versus nurture controversy (Spelke & Newport, 1998; Sternberg & Grigorenko, 1997, 2001c), often focusing on the innateness or otherwise of spatial cognition.

The roots of the study of spatial cognition go down to the great philosophical traditions of early centuries, and it has continued to occupy an important place even in later stages of development of psychological knowledge. For example, spatial ability has been regarded as one of the major components of intelligence since the early days of psychological testing, and perception of space has been a major theme of research for the last several decades (Delorme & Flückiger, 2003). On the other hand, the quest for good models of spatial cognition appears to be a relatively recent pursuit (Denis, 1996). Foreman and Gillett (1997) argue that the elusive nature of spatial abilities, ambiguity over what is meant by the term "spatial," and the ambiguous nature of "spatial cognition" has not allowed optimal development of this field in psychology for several decades.

At the present time, however, spatial cognition represents a broad field of enquiry that emerges not only from psychology, but also from a range of disciplines, such as geography and environmental sciences at the macro end of the scale, and cell biology or receptor physiology at the other end. In more recent years, cognitive scientists and neuroscientists have also taken considerable interest in the study of human spatial cognition and behavior. The diversity of approaches presented by these different disciplines has attached a variety

of meanings to the term "spatial." Its study has also employed different paradigms and methods, each focusing on disparate aspects of spatial cognition in a wide range of behavioral contexts. These disciplinary orientations also carry with them some overt (but even more often covert) ideological preconceptions (see Berry *et al.*, 2002, for a discussion of paradigms and their implications; see also Dasen & Saraswathi, 1997). Anthropologists and anthropological linguists obviously favor the importance of either culture or language, or both. Cognitive science and much of current developmental psychology, on the other hand, have a strong bias towards what Berry *et al.* (2002) call absolutism, i.e. the assumption that cognitive processes are universal because of their innate biological base. This is what leads to controversies such as the one between Gallistel (2002a/b) and Majid (2002), or between Li and Gleitman (2002) and Levinson, Kita, Haun, and Rasch (2002). While cross-cultural psychologists can be found at the absolutist or the relativist ends of the spectrum, we and many of our colleagues prefer the mid-line, as should become obvious in this volume.

How do infants, children or adults encode their ambient world? What kind of spatial representations and frames of reference do they use to understand and interact with their surroundings? How do they make spatial judgments? How do they go about searching among multiple spatial locations? How do they find their way from one place to another? These and similar other questions have been commonly addressed in research in the field. While a considerable amount of work has been carried out by using behavioral techniques of assessment, advances in neuroimaging and computer simulation techniques in the last decades have promoted our understanding of neuroanatomical bases of spatial cognition.

Analysis of actions and verbal description are two important means of understanding people's knowledge about their environment. Both of them allow us to infer the underlying processes an individual may be employing in dealing with various environmental realities. While actions are visible and partly understandable right from the time of a child's birth, language is neither so visible nor understandable for quite some time. The nativist theorists (e.g. Chomsky, 1957) hold the idea that all children are born with a language acquisition device, but indicate that children understand and speak in a rule-oriented manner later when they pick up enough words. Techniques for probing into linguistic knowledge before the stage of language production have been developed during the last decades (Golinkoff, Hirsh-Pasek, Cauley, & Gordon, 1987). The lack of correspondence between language and action in infancy has led many developmental psychologists to postulate a simultaneous development in the structural and functional features of language and cognition only in later years of life. Relatively recent studies using sophisticated technological devices seem to claim that even young infants possess the ability to understand

the world and grasp abstract concepts like numbers (Keil, 1989; Spelke, 1993; Wynn, 1992) and they also possess some linguistic knowledge even before language production begins (e.g. Golinkoff *et al.*, 1987). Although it is difficult to track down the existence of language and its nature among infants early in their life, it is indicated that "the ontogenetic onset and developmental stages of human cognition precede the onset of language by about a year" (Langer, 2001, p. 35). There is some indication that many of the spatial categories are formed among infants well before language gets into their behavioral repertoire and starts shaping their mind (Aurnague, Hickmann, & Vieu, 2007).

Main handbooks and full volumes

During the last decade several important publications have appeared on spatial cognition that present the most recent state of affairs in the field. For example, Foreman and Gillett (1997, 1998) produced *A handbook of spatial paradigms and methodologies*, and Landau (2002) describes the state of affairs in the field mainly from a neuropsychological perspective. Newcombe and Huttenlocher (2000, 2006) present a consolidated perspective on how children construct and understand space based mainly on experimental studies. A volume edited by Plumert and Spencer (2007) includes studies of the blind and deaf and an integration of the theoretical neuroscience perspective.

There are also some specialized volumes that present an account of brain bases of spatial cognition: Berthoz (2002), Burgess, Jeffery, and O'Keefe (1999) and Paillard (1991) are popularly cited volumes in the field. A widely referred book by Nelson, Thomas, and de Haan (2006) includes a chapter on the development of spatial cognition that briefly examines the neural processes underlying mental rotation, pattern processing and spatial navigation. Allen (2004) has edited a volume that specifically examines the issues related to memory for locations and Allen (2007) explores a variety of applications.

Allocentric vs. egocentric space: experimental studies

Studies of spatial cognition have been carried out mainly in laboratory settings, using the experimental paradigms of research, most often with undergraduate university students. The majority of them focus on memory of objects in spatial layouts, mainly in the context of viewing conditions. Some studies also take into consideration the spatial frames of reference in examining their linkage with encoding and subsequent memory of objects. A good number of studies attempt to map out different aspects of spatial behavior in different brain regions by relying on sophisticated scanning devices.

A distinction is often made between "egocentric" and "allocentric" reference frames with respect to encoding of spatial information in experimental studies.

Egocentric is defined as a "body-centered" or "viewer-centered" frame, a frame in which one's body is used to remember the location of objects (e.g. the cup is left of me). In contrast, the "allocentric" is defined either as an "object-centered", or "environment-centered" or a "landmark-centered" frame. In all these instances, reference is made to something that is external and not linked to the body for encoding spatial information. These studies have been carried out generally within closed rooms, where the allocentric cues include the color of walls, and some objects either hung on the wall or placed somewhere in the room. Researchers assess the memory of object locations under different conditions of experimental manipulation (e.g. variations in the angles of display during presentation and test, rotation of the display, rotation of the subject, etc.). Comparison is made of performance (e.g. memory of objects) of the subjects who use an egocentric frame with those who use an allocentric frame.

It may be noted that the way the allocentric frame has been conceptualized in these studies corresponds to Piaget's topological spatial frame, or what Levinson (2003) calls an "intrinsic" spatial frame of reference. The focus is on how objects are encoded either in relation to each other or to some local features of the display. Hence, it is not surprising that studies report quite an efficient use of an allocentric frame by children much earlier than the use of an egocentric frame.

Empirical studies with children

Much of the empirical research on development of spatial cognition is inspired by the work of Jean Piaget, who explained infants' understanding of space mainly through their interaction with the world in a sensori-motor manner. According to this view, infants initially understand the location of objects in terms of the physical actions required to make contact with them in the surrounding environment. Understanding of object locations in terms of physical actions gives rise to the notion that objects have a permanent existence, and that they can be associated with certain visible landmarks. These conclusions were based on Piaget's observations that, in the first six months or so, infants completely failed to search for hidden objects. During the next six months or so, their search was dominated by their memories of physical actions that had been successful in retrieving hidden objects in the past.

Piaget's proposition has been questioned by authors who suggest that infants possibly hold the idea of "object permanence" earlier than 6 months (perhaps from birth), but they lack specific abilities to show their competence (Newcombe & Huttenlocher, 2000, 2006). The evidence that children encode objects in relation to the surrounding environment has been taken to show that they function in an allocentric manner from early infancy. In some early studies (e.g. Acredolo, 1978; Bremner & Bryant, 1977) infants were shown objects

located to their left or right, and then moved to the opposite side of the array so that the positions were reversed. In these studies it was found that, during the first year, infants continued to search on the side on which they had originally seen the objects. In the early part of the second year, however, they were able to use external landmarks to track the location of objects.

Later studies suggest that infants' ability to use external landmarks is linked to their salience. When the cues are highly salient, children are able to use them by the age of 6 months (Acredolo & Evans, 1980; Bremner, 1978; Lew, Foster, Crowther, & Green, 2004; McDonough, 1999). Studies also indicate that infants who can crawl show less egocentric responses than infants of the same age who cannot crawl (Bai & Bertenthal, 1992; Bertenthal, Campos, & Barrett, 1984; Campos, Anderson, Barbu-Roth, Hubbard, Hertenstein, & Witherington, 2000). Hatwell (1990) remarks that the choice between egocentric and allocentric references is highly dependent on the testing procedures; minor changes that do not affect the structure of the task nevertheless produce major differences in observed behavior.

Haun, Rapold, Call, Janzen, and Levinson (2006) used Levinson's rotation paradigm with a concept learning paradigm, which allows experiments not only with humans but also with animals. The participants first watch the experimenter place a target under one of five cups on table 1, rotate by 180° to a second table, and there are trained over thirty trials to search for the object according to an egocentric, intrinsic (object-centered) or geocentric reward condition. When this procedure was used with Dutch and Hai//om adults and children (age 7 to 11 years), both children and adults were more accurate and faster to learn the pattern that matched the FoR dominant in their language. The intrinsic condition produced intermediate results in all groups. However, the Dutch were almost as fast in learning the unfamiliar (geocentric) condition, which was not the case for the Hai//om, who performed at chance level for the egocentric condition. The authors nevertheless conclude that "clearly, human cognitive competence encompasses all three FoRs … Cross-cultural differences in spatial cognition therefore concern preference and proficiency and not absolute ability" (p. 17570).

A similar paradigm was used in another experiment with German preschool children (aged 5 years), and some nonhuman great apes (orang-utans, bonobos and chimpanzees). All participants (including *Homo sapiens*) showed faster learning in the allocentric rather than egocentric condition, which leads to the conclusion that Hominid spatial cognition is fundamentally allocentric, but that "this inherited bias toward the allocentric coding of spatial relations can be overridden by cultural preferences, as in our own preference for egocentric or relative spatial coding" (p. 17572).

However, only three instead of five cups were used in the second experiment in order to adapt to the shorter attention span of the nonhuman participants. This means that the training was able to compare only allocentric and

egocentric conditions, losing the essential distinction between object-centered and geocentric. This is unfortunately true of most if not all of the experimental literature.

Nardini, Burgess, Breckenridge, and Atkinson (2006) studied the development of spatial frames of reference in children aged 3–6 years, who retrieved hidden toys from an array of identical containers bordered by landmarks under four conditions. Children as young as 3 years favored spatial representations that were not purely egocentric. On the other hand, viewpoint-independent recall based mainly on the array and bordering landmarks was not noted before 5 years. There was no evidence that this later-developing ability, which implies object-referenced (intrinsic) representations, depended on verbal encodings. The findings indicate that core components of adult spatial competence (including parallel egocentric and non-egocentric representations of space) are present as early as 3 years, and these are supplemented by later-developing object-referenced representations.

In general, these findings suggest that coding of spatial locations in early life may rely on a number of factors. While the presence of salient visual cues may be an important factor in coding of spatial information, differences in interacting with the physical world (e.g. visual or motor) provide another important basis of spatial coding. Self movement (e.g. crawling, walking) creates a clear difference in how spatial locations can be encoded.

Experimental studies with adults

In several studies of spatial cognition university students have been used as subjects. The main goal of these studies has been to examine the role of egocentric and allocentric FoR in updating spatial memories (e.g. Mou, Fan, McNamara, & Owen, 2008; Mou, McNamara, Rump, & Xiao, 2006; Mou, McNamara, Valliquette, & Rump, 2004). While most of this research has taken place in the laboratory, in some studies real-life space has also been used (e.g. McNamara, Rump, & Werner, 2003). Some studies also use virtual space on computers (e.g. Gugerty & Brooks, 2001; Taylor & Rapp, 2004).

Researchers have used visual as well as haptic tasks (e.g. Coluccia, Mammarella, De Beni, Ittyerah, & Cornoldi, 2007; Kappers, 2004, 2007) in order to examine the coding of information in egocentric and allocentric frames. Some of the research using blindfolded conditions is reviewed in chapter 14.

These experimental studies examine the functioning of egocentric and allocentric spatial frames under different conditions of manipulation. While research with children suggests that the allocentric frame governs spatial behavior much earlier in life and much more effectively than the egocentric

frame, studies with adults present mixed results, and do not tell us much about the use of a specifically geocentric FoR.

Individual differences in spatial frames

Numerous examples from day-to-day life may be drawn to demonstrate that some people are really good at dealing with spatial information, whereas others often experience difficulties. Fitting various objects into the suitcase while preparing for a journey, or finding ways in strange cities are fairly common examples that indicate substantial individual differences is spatial functioning. Since spatial abilities seem to be linked to success in a number of occupations (e.g. engineering, drafting, piloting, surgery, computer science, mathematics, and the physical sciences), understanding how children develop a range of abilities in spatial tasks has been set as an important goal in several studies (Hegarty & Waller, 2005; Shea, Lubinski, & Benbow, 2001).

Much of the work on individual differences in spatial cognition focuses on gender-related differences. A number of publications have appeared during the last few years (e.g. Halpern & Collaer, 2005; McGillicuddy-De Lisi & De Lisi, 2002). Studies carried out with adults generally indicate a male advantage on spatial tests/tasks, such as tests of mental rotation and tasks that require defining a horizontal or vertical line while ignoring distracting cues (Linn & Petersen, 1985; Voyer, Voyer, & Bryden, 1995). Men tend to use cardinal directions in their navigation strategies, while women use landmarks and left/right directions (Dabbs, Chang, Strong, & Milun, 1998; Miller & Santoni, 1986; Ward, Newcombe, & Overton, 1986). For some tests these differences are reported to be diminishing with historical or cultural changes (Feingold, 1988), but for others (e.g. mental rotation), they seem to suggest an increasing trend (Voyer *et al.*, 1995). There is evidence for greater variability in the performance of males (Hedges & Novell, 1995). Halpern and Collaer (2005) indicate males to be more skilled at using geometric information regarding distance and direction in navigation, and in using maps to gain geographical knowledge.

Some developmental studies indicate sex differences to be evident by the age of 4 years (Levine, Huttenlocher, Taylor, & Lanerock, 1999), others report clear evidence of sex differences at about age 9 or 10 years (Johnson & Meade, 1987; Kerns & Berenbaum, 1991), which tend to increase in size during the period of adolescence (Linn & Petersen, 1985; Voyer *et al.*, 1995). However, the question of earliest appearance and developmental course is difficult to address for a number of reasons. Studies indicate mental rotation as one of the spatial functions in which the largest gender difference is often reported. The explanation of these differences has been an issue of discussion both from a biological and socio-cultural point of view (McGillicuddy-De Lisi & De Lisi, 2002; Self & Golledge, 2000; Silverman & Eals, 1992). From the biological

side, evidence exists for the hypothesis that sex hormones are the proximate cause of sex-related differences in spatial abilities (Collaer & Hines, 1995; Halpern & Collaer, 2005). On the other hand, the absence of sex differences in spatial abilities in hunting and gathering societies (Van Leeuwen, 1978), but their existence in agricultural societies seems to rule out the hormonal explanation of sex differences in spatial abilities by suggesting an ecological explanation. Studies which indicate that training can enhance spatial performance (Baenninger & Newcombe, 1989, 1995; Loewenstein & Gentner, 2001), including input during schooling (Huttenlocher, Levine, & Vevea, 1998), further cast doubts on spatial ability being biologically fixed.

Another aspect of individual differences in the use of spatial frames of reference comes from neurophysiological/neuropsychological and clinical studies. The neurophysiological studies examine the use of spatial frameworks by recording brain activity in different areas of the left and right hemispheres with the goal of mapping out the brain regions that are activated with the use of different frames. On the other hand, clinical studies focus either on brain-damaged patients as a result of injury or abnormal growths (e.g. tumor) in the brain region, or on patients suffering from certain disorders in which spatial ability seems to get significantly affected (e.g. Williams syndrome or Turner syndrome). This line of research is reviewed in chapter 13.

Conclusions

The studies discussed above indicate a sustained interest of developmental psychologists and cognitive scientists in the study of spatial FoRs during the last decades. Developmental studies tend to claim to have discovered that the allocentric frame is used by children much earlier in life than the egocentric frame. The way the allocentric frame is conceptualized in these studies is in fact the intrinsic FoR. This is therefore not something new. Piaget reported this a long time ago concerning topological space, which is the first type of space developed by children, but is also often used by adults in preference to the egocentric frame. The study of the real geocentric frame is ignored in research with children as well as with adults. This state of affairs encourages us to examine the development of the geocentric FoR in non-Western settings, in locations where this frame seems to be normative, and where a variety of social and cultural practices are organized in a manner that reinforces its acquisition quite early in life. That is what we have tried to do in this project.

Time frame of the study

It is time to come to our own research questions, for which the reviews of theory and research, even though they have been very brief and even

superficial, should have provided enough background. But first of all, we need to situate the project in a time frame. We were first made aware of the existence of a geocentric FoR through our contact with Levinson's team in 1993, which occurred when J. Wassmann spent some time at the MPI in Nijmegen. Wassmann and Dasen (1993, 1994a/b) shared an interest in bringing anthropology and cognitive developmental psychology together, and they had carried out common field-work in Papua New Guinea. This is what led to our first study in Bali in 1994 (Wassmann & Dasen, 1996, 1998) which is summarized in chapter 4. This first study, because it was carried out with a fairly small sample,[16] could now be considered as a pilot study in need of replication. However, because we found the use of the geocentric FoR in very young children (as young as 4–5 years), it promoted considerable interest, and stimulated developmental research by other colleagues (to be reviewed briefly below).

The second part of the project took place in India and Nepal in 1999–2000. In the meantime, P. Dasen and R. C. Mishra had met over many common interests, including everyday cognition and research with hunting and gathering groups (see for example Mishra, 1988, 1996; Mishra & Tripathi, 1996; Mishra *et al.*, 1996). Dasen was thus made aware of the fact that a geocentric FoR was used in large parts of the Indian sub-continent. Mishra had supervised Ph.D. research on geocentric language, spatial representation and cognitive style in Nepal (Niraula, 1998; Niraula & Mishra, 2001a/b), and S. Niraula joined the team to carry out a segment of the research in rural Nepal. Although field-work for this second part lasted only one year, a considerable amount of data was collected. Most of the results have been published, and will be summarized in chapter 4.

Finally, this second part of the project led to the main study, for which field-work was carried out from 2002 to 2005, first again in Bali (and again with the help of J. Wassmann), then in several locations in India, in Nepal (in the city of Kathmandu) and in Geneva. While some preliminary data have been presented at a conference on cognitive science in India in 2004, and subsequently published (Dasen & Mishra, 2008; Dasen & Wassmann, 2008; Mishra & Dasen, 2008; Vajpayee, Dasen, & Mishra, 2008), and a short overview has appeared in French (Dasen, Mishra, Niraula, & Wassmann, 2006), this volume is the first complete report of this third part of the project.

Because of the long time span over which this research has evolved, some of the research questions have changed and some of the techniques have been

[16] Because of the nature of Wassmann's research permit for an ethnographic study, we could not work in schools, which is the easiest way to have access to large samples of children. Note that for Wassmann, the anthropologist, a sample of twenty-eight (plus ten very young children for one task) was considered to be quite large, while for Dasen, the psychologist, it seemed to be too small (Wassmann, 1995; Wassmann & Keck, 2007).

adapted, which may occasionally seem to produce some anachronisms and inconsistencies. Basically, we summarize the results of the first two parts of the project in chapter 4 and present the details of the results of the main study in all subsequent chapters. In chapter 2 on methods, we will note some of the changes introduced along the way, and in chapter 3 on samples and settings, we cover the whole range of the study.

Research questions

As a first overview, we summarize our research questions in the following way:

- links between language and encoding at the individual level;
- development with age of the geocentric FoR;
- influence of ecology, religion, schooling, socio-economic status, acculturation, bilingualism, etc.;
- task specificity;
- links with other cognitive processes.

Let us look at these in more detail.

Links between language and encoding at the individual level

Comparative linguistics and cognitive anthropology tend to work at the group level. Even though individuals are being questioned, individuals participate in "space games" organized to elicit spatial language, and individuals are tested with non-verbal memory encoding tasks, they are treated as groups. For example, Levinson (2003, p. 184) adds up the subjects of the locations "where geocentric linguistic conventions prevail" (i.e. Tzeltal, Hai//om, Belhare, rural Tamil, etc.; N = 85) and compares these as a group to those who use egocentric references in their language (Dutch, Japanese, urban Tamil, etc.; N = 99). Overall, the first group tends to use predominantly geocentric encoding, and the second group egocentric encoding, leading to the conclusion that "there is a significant difference in non-linguistic coding between the two groups" (p. 185).

This is what we call the group level. In our research, we will also use the group level quite frequently. For example, within the Varanasi sample, we will compare one group schooled in traditional Sanskrit schools and one in Western-style Hindi schools, and treat these as groups using some summary measures. However, within each sub-group, we will also consider individual variations in both language use and non-verbal encoding. In all of the locations we have been studying, in Bali, India and Nepal, all three FoRs can be used, and there is individual variation in which frames are actually used. Within each

of the groups, we can therefore look at the correlations between the individuals' use of language and their type of encoding. This is what we call the individual level.

Occasionally, we can go even further into micro-analysis; for example, on the memory encoding tasks, we can ask the subjects for a verbal explanation of their non-verbal behavior, and we can then look at the correlation between language and encoding across individuals on a particular task.

Development with age of the geocentric FoR

Our study is systematically developmental. Our main question is how this cognitive process of using a geocentric FoR – unknown in mainstream (Western) developmental psychology – actually comes about. We will therefore look both at language development and at how non-verbal encoding may change with age. We will also study briefly how very young children are likely to learn geocentric language from what they hear around them (chapter 10).

Influence of ecology, religion, schooling, socio-economic status, acculturation, bilingualism, etc.

As mentioned above, we derive from our integrated theoretical framework an interest in studying how a large number of ecological and socio-cultural variables may influence the development of whatever we are studying. Most parts of our project are therefore organized so as to be able to compare sub-groups differing on these variables (urban/rural, schooled/unschooled, Hindi vs. Sanskrit schools, or English vs. Nepali schools), or we collect background information that allows us to measure the variation in the variables we are interested in (socio-economic status, acculturation, spatial mobility, etc.).

For each of these variables, there is of course an underlying hypothesis, so the sub-groups are not chosen for reasons of convenience, but because there is a hypothesis to be tested. These hypotheses will be presented and justified whenever appropriate. For example, we may expect children who are taught in English to use more egocentric language and more egocentric encoding than those who are taught in Nepali language, in which a geocentric spatial orientation system prevails. Researching this question should answer Pavlenko (2005, p. 442), who concludes a review of bilingualism and linguistic relativity with the following plea in reference to space: "It is therefore critical to see how bilinguals whose languages favour different frames of reference would behave on non-verbal tasks of the kind used in the study of Pederson *et al.* (1998)."

Task specificity

As early as in our pilot study in Bali, we found that the choice of FoR was dependant to a large degree on the particular task being presented. We were well aware of this phenomenon, called "horizontal décalage" when using Piagetian tasks; in other words, a child is not necessarily situated at the same cognitive stage or sub-stage for each conceptual area being studied, and for each particular task. This is quite a strong limitation in a structural theory, where a particular cognitive structure is supposed to be applicable to a large set of situations or contents.[17] So it seems to be for the geocentric FoR: any particular individual is not necessarily egocentric or geocentric in cognitive functioning, as a sort of inner state like personality, but may be using one frame in one situation, and the other frame in another. Hence, as psychologists, we need to study such task specificities, i.e. what are the task demands that are more or less likely to foster the use of a geocentric FoR.

Under the same heading, we might put some other experiments that can tell us more precisely how the children we are studying go about handling our tasks, depending on whether they use a geocentric or an egocentric frame. For example, in chapter 12, we examine how they organize a spatial array of three objects into different "schemes," and we test the hypotheses linked to rotating the display or moving around the display.

Links with other cognitive processes

Are there any implications of using a geocentric FoR in language and in non-verbal encoding for any other aspects of cognition? For example, is the geocentric FoR linked to spatial cognitive development more generally (which we study in the second part of the project by using Piagetian tasks) or to a field-independent cognitive style (which we study using tasks of psychological differentiation)?

Furthermore, are there any neurophysiological correlates of using a geocentric vs. egocentric FoR? We examine some aspects of this question in chapter 13 through a study of brain lateralization, and a small study with brain-damaged patients.

Levinson (2003, pp. 216ff) examines in great detail the consequences of using a geocentric FoR for wayfinding and pointing accurately to distant landmarks. The assumption is that people who use a geocentric frame have to update their spatial orientation constantly wherever they are and wherever they

[17] Piaget of course recognized the existence of horizontal décalage, and attributed it to "the resistance of the object" (1977, p. vi) comparable to friction in physics, for which a general theory is difficult to establish.

go, otherwise they would be unable to speak accurately about spatial positions and events. This process is called "dead reckoning." Levinson (2003) reports experiments with Australian Aborigines and Hai//om San of the Kalahari desert who, even when brought to unknown territory over large distances, have the capacity of pointing very accurately[18] not only towards their home, but to a number of other known far-away landmarks.

For nomadic hunting and gathering people, such as Australian Aborigines, there are of course other cultural features, in addition to using a geocentric FoR and dead reckoning, that allow them to build up accurate cognitive maps over very large areas. There is, for example, the elaborate criss-cross of "song lines," linked to the mythological events in the "dream time" (Elkin, 1943; Glowczewski, 1991), which gives meaning to what non-Aborigines would consider as a monotonous landscape in which it is easy to get lost. We had intended to work with Adivasi hunting and gathering groups in India, since R. C. Mishra had carried out extensive research with such groups on other psychological (Mishra *et al.*, 1996) and educational (Mishra, 2008; Mishra, in press) issues. Unfortunately, the political and social conditions were not appropriate at the time of our field-work.

We have not been able to include any experiments on wayfinding or pointing, but we do report an experiment with dead reckoning under blindfold conditions in a more restricted environment (chapter 14).

One aspect that has been of interest in previous research carried out independently by both authors, is to ascertain which daily experiences are likely to foster spatial skills during a child's development. Munroe and Munroe (1971) had found a relationship between the distance Logoli Kenyan children played from their village and the development of their spatial skills. In a longitudinal follow-up study, Munroe, Munroe, and Brasher (1985) reported that directed distances traveled from home (e.g. while herding or running errands) appeared to be a major predictor of spatial skills among boys, but not among girls.

Based on research in Western contexts, Cohen and Cohen (1985) report similar results in respect of boys' spatial memory, and interpreted this as an outcome of adult-defined goal-directed activity. Poag, Cohen, and Weatherford (1983) have reported adult-controlled spatial experiences to be a hindrance to the development of spatial knowledge, whereas children's opportunity for the exploration of space under their own control has been found to promote spatial understanding. It appears that interference by others during spatial exploration is a crucial variable in the development of spatial cognition. To the extent

[18] Their accuracy is almost perfect (mean angular deviation 3° to 14°), more so than homing pigeons (26°), or the Tzeltal (31°), even though they use an absolute FoR, and certainly much more so than even experienced Dutch or English bushwalkers.

that the exploration process remains uninterrupted (despite being directed) by adults, one can expect a positive contribution to the development of spatial thinking.

In a study of Kikuyu children in Kenya and Baoulé children in Côte d'Ivoire, Dasen (1988b) used a large number of so-called "spot observations," in which the researcher records the whereabouts of the individuals in the sample at random times of the day, to quantify children's daily activities. He found that being away from home (more than 3 km) and the variance of the distances from home (an index of the variety of places visited by children) were correlated with spatial concept development (assessed with Piagetian tasks), but for boys only. These measures did not apply well to girls, since they were found to be within 200 m from home in 87 percent of the observations.

Mishra (1996) has also studied the cognitive style of unschooled children of the Birjia cultural group in Bihar (India). Distances traveled by children away from home (either in the forest or within the village) and their self-directed activities were assessed. It was found that children moving into the forest generally traveled longer distances and engaged in more self-directed activities than those moving in the village surroundings. The former demonstrated greater psychological differentiation, which was attributed to high differentiation demands placed on children in the forest settings.

These findings suggest that prior experience in a setting, demands associated with subsistence activities of children, their day-to-day activities, and cultural practices, which encourage and support a particular kind of activity in a given cultural context, are useful in comprehending the development of spatial cognition. For some of the samples in this study, we therefore include some data on daily activities that are possibly related to spatial skills. These are derived from questionnaires addressed to the children and/or their parents, since we were not able to include actual behavior observations.

These are some of the major research questions of this project. More details will be provided as appropriate in the various sections. It is interesting to note that, while we were well into the third part of the project, Majid *et al.* (2004, p. 113) drew up the following list of important questions for future research:

- What are the neurocognitive underpinnings for linguistic frames of reference? How much plasticity is there?
- How do children learn linguistic frames of reference? And when do linguistic frames of reference begin to influence spatial cognition?
- What are the cognitive consequences of being a bilingual in languages that rely on different frames of reference?
- Not all rural societies use a geocentric frame of reference, but urban languages appear to use an egocentric frame of reference. Why is this?

- What mechanisms do speakers of geocentric languages use to keep track of directions in the geocentric frame of reference?
- Are speakers of geocentric languages better than speakers of egocentric languages at view-independent object recognition?

We were quite pleased to find that our ongoing project was likely to answer all of these questions, except the last one, or at least contribute information to an answer.

2 Methods

In this chapter we present the psychological methods used in this study. The situation is rather complex, because we basically used the same set of tasks in different locations, but some changes were introduced during the course of the program, and some additional tasks were used on some occasions. What we will do here is present this basic set, commenting on the variations in time and place, and leave additional methods to be presented in the relevant chapters.

But first a few comments on our conception of methodology in cross-cultural psychology (for more details, see Berry *et al.*, 2002; Mishra & Dasen, 2007; Segall *et al.*, 1999). Wassmann and Dasen (1994a) defined their basic three-step research strategy on the occasion of a collaborative study in Papua New Guinea: first get a thorough knowledge of the culture through ethnography (both by reading whatever documents are available and by one's own fieldwork), and then start asking informants; not just one or a few key informants, but people from different segments of the population. Indeed, in our research in Papua New Guinea, we found that even knowledge about the number system (Wassmann & Dasen, 1994b), supposedly shared by everyone, was in fact unevenly distributed in the group. Old men used a different and more complex body count system than young men, women claimed not to know it at all and children learned only the base ten Western system in school. As a second step, because people don't always do what they say, one has to observe behavior in everyday settings (for more details, see the chapter on everyday cognition in Segall *et al.*, 1999).

However, when studying something like a cognitive process, it may well be that one cannot ask about it directly, because people practice it unconsciously, and one has problems observing it routinely, because it may not occur very often, and when it does, it may be difficult to interpret. This is why it may be necessary to place informants in a constrained situation, where they have to do something like solving a problem, most likely in an unfamiliar situation (what Widlok, 2007, p. 274, calls "uncommon tasks"). Indeed, an answer given in a routine situation may be difficult to interpret as a process; it may be just a procedural answer, learned by heart, and without understanding. Devising

such situations, which psychologists will call tasks or tests, for cross-cultural research is quite a challenge. The researcher has to be sure that the informants understand the task in the way the researcher intended, and that it is culturally appropriate. This is why constructing and using such constrained situations can only be done meaningfully as a third step in the research procedure, in other words, after a good understanding of the culture (which of course includes language) has been achieved.

Comparative cross-cultural research sets the additional challenge of making the tasks culturally appropriate in each of the locations to be compared, yet structurally similar to be sure one is comparing the same process. With complex social behavior or highly inferential concepts such as "intelligence," this may be very difficult or even impossible. With the topics we are studying in this project, in contrast, namely eliciting spatial language, and establishing which spatial FoR is used in a non-verbal memory task, we believe it is possible. The situations about to be described should be assessed against this criterion.

Pre-testing

If some of the procedures have been slightly changed during the course of our project, as we shall see shortly, it is because of our search for better, more reliable tasks. The impact of these changes will be analyzed along with the results. However, we were able to keep these changes to a minimum, first of all because the procedures that had been devised by the CARG team had already been devised with cross-cultural comparative research in mind (in anthropological linguistics), and we found them – at least the ones we decided to use – quite suitable in each of our own locations. This, however, did not come without a considerable amount of pre-testing.

For the language elicitation tasks, for example, the CARG team use so-called matching tasks or space games (Levinson, 2003; Senft, 2007) in which two native speakers of the language under investigation interact with each other over a situation set up by the researcher as a game. For example, one of them has to pick out a particular photograph from a set, according to the description given by his or her partner. Or the "matcher" has to follow a path on a model landscape according to instructions given by the other player, the two being separated by a screen. J. Wassmann used these space games for our first research in Bali (Wassmann & Dasen, 1998), but we later found that they had a series of disadvantages when used with children. For example, some children speak a lot and easily, but others remain absolutely mute in a space-game situation, when not prompted item by item by the researchers. Or some children give very scant descriptions, according to which it is quite impossible for the "matcher" to take any decisions, but many children, in contrast to the adults used as informants by the CARG group, will not actively ask for more

information. What these children are likely to do is to disregard the screen and peer over it, or they get frustrated to the point where the "game" is no longer fun. Senft (2007) mentions similar problems when testing adult Trobriand islanders with the "man and tree" photo-matching task. The photographs were found to be "much too abstract … and probably too Eurocentric" (p. 241).

Another problem we encountered with the space games is that the amount of language produced varies a great deal from one person to the next. It is like getting a spontaneous road description, which we occasionally did with adults: some describe the road in every detail, others just give the bare minimum outline. Yet we wanted to quantify the language categories used by each individual. We could of course have done so by calculating the proportion of each category over the total amount of language spontaneously produced, but we felt that this was introducing unreliability. Compared to the CARG space games, our language tasks are more constrained: the informants play the game with one of the research assistants, the latter being able to prompt for additional information when the spontaneous production is too ambiguous or otherwise insufficient.

It is well known that in cross-cultural research, tasks and tests become more reliable if there has been sufficient training, so as to familiarize the informants with the situation and make the instructions absolutely clear. Introducing training helps individuals to actualize their real underlying competence (see for example Dasen, Ngini, & Lavallée, 1979). We therefore meant all the situations to have this learning component. The non-verbal cognitive encoding tasks explicitly start with a fairly extensive training phase, but we also introduced it, to a lesser extent, in the language tasks.

On the Road task (see below), for example, if the child says "turn north" when the path actually goes south, the assistant can actually walk north (or move the model car off the road towards north); the child will first be surprised, and then correct its instructions. For the child, this game with an adult can be good fun, even though the situation is more school-like than were the original CARG space games. However, being school-like is not altogether inappropriate, since a large part of our research was carried out in schools (although half of our sample in the first study were unschooled, and tested outside of school settings).

Testing situations

For our first study in Bali, India and Nepal (chapter 4), and the study of language addressed to children reported in chapter 10, we organized testing where best we could, usually in a room of a private house. The research assistants would contact children and their families and make appointments. Sometimes the children were coming from far away, especially in Dolakha, Nepal, and had

to be fed for lunch. Since half of the sample in the first study in India and Nepal consisted of totally unschooled children, this somewhat clumsy way of recruiting informants was quite appropriate. It also meant that we could usually work in fairly good and silent conditions.

For our main study, all our testing was carried out on school premises. Usually, we were provided with an empty classroom, or the headmaster's office; this meant that we sometimes had to vacate these rooms because they were suddenly needed, and some of the testing was actually carried out outside in the school yard, between recess periods. While all the schools did their best to accommodate us and to welcome us warmly, the testing situation was not always ideal. Some schools can be quite noisy; there are pupils walking around and peeking in, wanting to take part in the "games." So, quite often, there was a fair amount of distraction, in any case, quite far from the calm of a psychological laboratory.

We usually asked two children to come together for testing, being taken out of their classroom at a time when the teachers felt it was appropriate. Having a mate was important in making the situation less stressful. We felt that this was sufficiently important to make up for some possible interference when testing the two children in the same room. The testing either occurred concurrently in different parts of the classroom, with different research assistants, or one child was asked to sit down and produce a drawing while waiting for the turn to be tested. We repeatedly noticed that there was no influence of this co-presence on the answers produced by the children. Sometimes the training sessions for the encoding tasks would be carried out with both children, especially if they were young, which created a nice atmosphere and helped them to understand the task.

The tasks themselves are sometimes tedious, especially for young children, because they involve repeating five to seven items that must seem identical to them, or on our Perspectives task (see below) because it asks for the same descriptions from different positions. With 4 to 6 year olds, it is difficult to maintain their interest and attention; and testing sometimes had to be interspersed with rest periods or spread over two days. For the older children, who try to guess at the real purpose of the testing, the repetition of items may carry the message that they might have done something wrong, and that they should possibly look for another strategy. On the encoding tasks, the original instructions (Danziger, 1993) asked for a delay of one minute between seeing the display on table 1 and reproducing it or choosing an answer on table 2. This is to avoid answers from short-term memory. But one minute, for a child (and for the researchers imposing the wait) seems like an eternity! We followed the rule in our first study in Bali, but later dismissed it, in favor of just walking very slowly between the two tables. Similarly, we found that changing the order of the items randomly was only needed if we wanted to study the impact of item

order, which was not the case, and it was much easier to train research assistants to use a constant order corresponding to the record sheet.

These comments will make more sense once the tasks have been described, so let us move ahead. We will describe here the tasks that have been used consistently throughout the project, and those that have been used in at least two different locations. More specific tasks and tests are described in the relevant chapters. An outline of the instructions and coding scheme are to be found in Appendix 1.

Language elicitation tasks

The three tasks we have used consistently are designed to produce spatial language systematically. The Perspectives task does this with a very simple display of three objects, which the child describes from different positions. On the Road task, there is movement along a path, so it is less static. Language recorded on two items of each of the encoding tasks allows us to study more closely the correspondence between non-verbal behavior and how it is justified verbally.

All these tasks were always used in the local language (Balinese, French, Hindi, Nepali), with the exception that, in a few cases, a child may have asked for additional information in another language (for example, English in the English-medium school group in Kathmandu; Indonesian in Bali). If the child used a language other than the local one, this was recorded (and is used in some of the data analyses).

Perspectives: description of table top display

Three familiar non-fronted objects are set on the table in a triangle. The child is asked to describe the locations of these objects. The child is simply asked: "Where is the red box? Where is the green one?" (etc.). If needed, the research assistant could point to the object under discussion. If the answer was ambiguous (such as the deictic "This way") the assistant would try to probe for a more explicit response. (For example: "Tell me more precisely. What else could you say?")

The display is the same as the one used for the Piagetian "Perspectives" task, hence its name. In the first study (chapter 4) where we actually also used this task as a measure of spatial cognition, the description was performed before the cognitive part of the task. The three objects differed from location to location, being locally purchased at a market, but were always quite distinct and of three different colors.

This task is illustrated in Figure 2.1, a photograph taken in Sambangan, Bali. In this photograph, the child is talking about the brown basket, saying "It

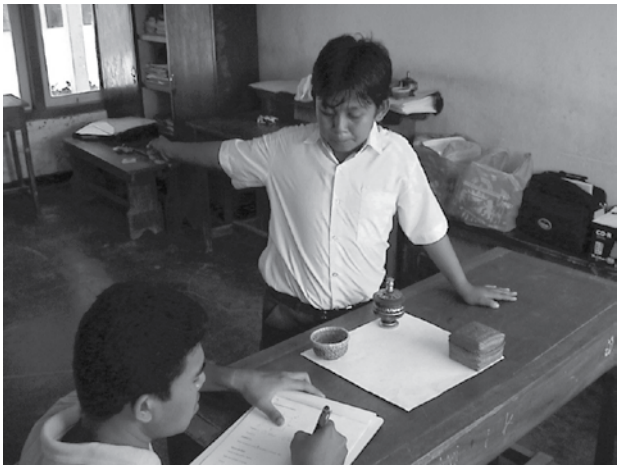


Figure 2.1 Perspectives task

is kelod" (i.e. seawards). Note the extended right arm pointing to that direction. The gestures accompanying this task have been studied in more detail in Kathmandu, and are described in chapter 11.

In the first study, the child was asked to give this description three times while moving to different positions around the display (opposite to first position, and at 90° to the right). In the main study, the child also did this three times, but instead of moving to the 90° position on trial 3, the display was rotated by 180°. This should allow the same description as in position 1 for egocentric (E) speakers, but a different description for geocentric (G) speakers; the results on this particular aspect of the task are analyzed in chapter 12. The two procedures are illustrated in Figure 2.2.

Road task

In this task, the child is asked to guide verbally one of the experimenters to move along a pathway consisting of several segments with right-angle turns, set out along the main cardinal directions, except for one diagonal. All verbalizations of the child are tape-recorded for later transcription, or noted directly by the assistant.

In study 1, the path was the same as the one used for the Reverse Route Memory task (described below), but without objects placed along the path, and the route description is carried out before the cognitive part of the task. The path had six segments for children up to age 9, eight for older children. For the main study, the path with eight segments was used for all children.

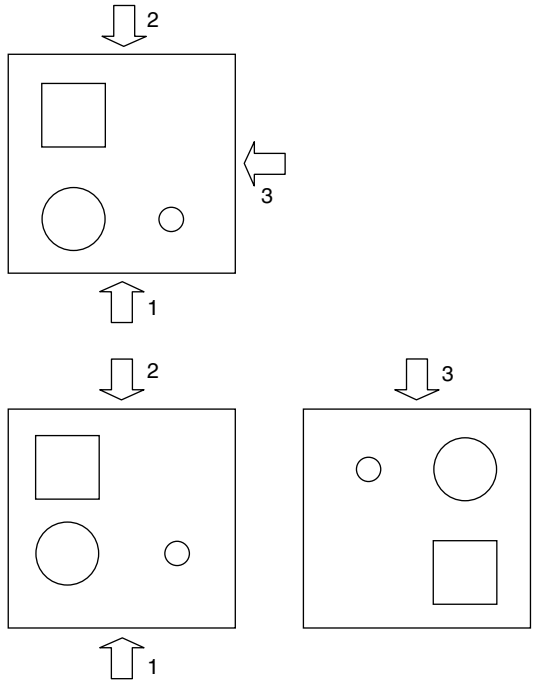


Figure 2.2 Different forms of the Perspectives task

In Bali, the child was asked to guide one of the experimenters, who was blindfolded (or at least occasionally put his hand in front of his eyes to pretend he was playing the game), to move along a pathway laid out on the ground (as illustrated in Figure 2.3). The first segment was always oriented to *kaja*, to the mountain. Thus, this task involves movement in a relatively large space.

Because the location for testing had to be changed fairly frequently, setting out the path with cut-out carpet, or drawing the path with chalk on the classroom floor, or in the sand outside, always in the same orientation, proved rather cumbersome. This is why, for the other locations of the main study, we changed to an outline model of the path (about 80 cm wide and 120 cm long). The shape of the path and number of segments was maintained. The model had some toy objects along the path, such as houses and trees. The child was asked to instruct the assistant to move a toy car along the path. The assistant would prompt to get at least one description for every segment or turn, in addition to general movement verbs such as "move", "go straight" or "turn" that were not scored.

The verbalizations of the child were recorded, noting whether these were correct or not. In case of multiple answers (e.g. "Turn left to south") we initially

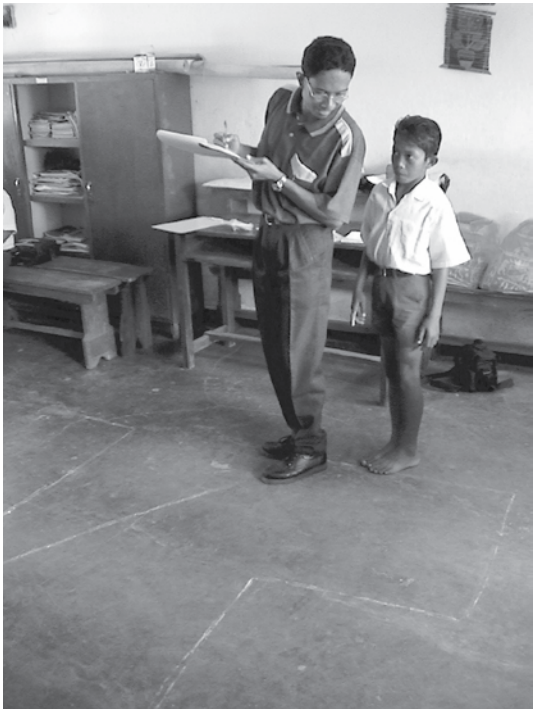


Figure 2.3 Road task, in Bali

scored multiple categories, but when we found that these were rare, we decided to use the first description of each segment for scoring.

Language in spatial encoding tasks

These include the "Animals in a Row," "Chips" and "Steve's Maze," described below. On items 4 and 5 of each task, the child is asked to explain the reason for his or her choice, i.e. what s/he did to remember the display. The language used is recorded. This is a departure from the standardized form of these tasks (Danziger, 1993; Levinson, 2003), but interferes only minimally with the non-verbal aspect of the tasks.

It is standard practice when testing children, at least in Piaget-inspired methodology, to ask the children for an explanation or justification of their answer: Experimenter: "How did you remember the animals?" Child: "They were all looking west, and the fourth one north."

This is a very natural exchange, especially in a school situation, where children are used to being asked questions. It is certainly more natural than

Table 2.1. *Language coding scheme*

Topological	I	Intrinsic	Next to, near, before, etc. (topological)
Projective	E	Egocentric (Relative)	Left, right, front, back (LRFB) in relation to speaker
Intermediate	SL	Situationally specific landmarks	Towards the window, the door (landmarks within the room)
	CL	Conventional landmarks	Towards the temple, the hospital, a locality (landmarks outside the room)
Euclidean	G	Geocentric (Absolute)	
		NSEW	Cardinal directions: north, south, east, west
		Up/down	Up represents the north and east sectors; down south and west (in Dolakha, Nepal)
		KKKK	Kaja, kelod, kangin, kauh (in Bali)
Other	D	Deictic	"This way/that way" (usually accompanied by the gesture of a finger or the whole hand or arm)

remaining silent over five or seven items! Of course, care has to be taken that this questioning is not perceived as criticism, which might induce the children to change their answer.

For our data analysis, we want to assess language and non-verbal encoding independently, since one of our main questions is about the relationships between the two. Deriving language from encoding tasks seems to violate the requirement of independence. However, this is in fact not the case. As far as we can ascertain, there is no systematic influence of asking for a verbal explanation on one item, and the non-verbal response on the following item. In fact, even on the same item (as we shall see in the data analysis), the language and the encoding do not match systematically.

Language coding scheme

The language produced on all three of these tasks was coded using a scheme adapted from Pederson (1993). This is shown in Table 2.1. Examples for each of the language categories in some of the languages used in the various locations are provided in Appendix 2.

The terms are grouped into the three broad categories of topological, projective and Euclidean according to Piagetian theory. Intrinsic answers are those that relate one object to another, such as "The red box is near the green one." On the Road task with the model display, we also coded as intrinsic the use

of toy landmarks on the display (e.g. "Go to the tree"), if further prompting did not produce a more interesting response. Note that our use of intrinsic is broader than the more stringent definition in linguistics (cf. Levinson, 2003, p. 106), where the intrinsic FoR is said to be used only to relate a reference object to the parts or regions of another object.

Egocentric references are often called "relative" because they depend on the speaker's position. Note that the difference between I and E is not always obvious. When the children say, for example, "in front" on the Perspectives task, it is difficult to know whether they mean "the red box is in front of the green one from my point of view," which would be the full egocentric sentence but which the children never use, or the ambiguous "it is in front of me" which could be intrinsic. While the research assistants attempted additional prompting whenever they felt it was necessary, this was not always successful. Hence there may be some miscoded items between the E and I categories. But, as we shall see in the data analysis, these categories are both infrequent, except in Geneva.

The reference to landmarks implies a direction away from the display and from the viewer, and hence it has projective properties; it can be considered intermediate between egocentric and geocentric language, because it implies a distancing from the display, but not the application of a right-angle geocentric grid, which means it is not Euclidean in Piagetian terms (Piaget & Inhelder, 1956). Within this category, there is also a progressive distinction between situationally specific landmarks (SL) that are nearby and inside the room, and conventional landmarks (CL) that are further or even quite far away and out of view. We will come back later to a discussion of the status of landmarks in this coding scheme.

An item is scored G when, in any given location, the large-scale geocentric orientation system is used. The standard G category is the use of cardinal directions in India and in Kathmandu, and of the Balinese orientation system in Bali (see chapter 3). In some cases, such as in Dolakha, the rural setting in Nepal, where two different possibilities exist (the up/down system and cardinal directions), these are scored separately.

Deictic (D) refers to "This way/that way," usually accompanied by the gesture of a finger or the whole hand. These gestures are indeterminate in terms of frame of reference: since a body movement is involved, they could be body related, and could mean "to the left/right"; however, the pointing could also be towards a direction independent of the body and even a far-away direction. D is used mainly by very young children, from whom it is difficult to get more precise verbal explanations; this question is discussed in detail in chapter 11.

The scores on each task are the number of items classified into each language category (out of nine for Perspectives, eight for Road, and six for encoding tasks). These scores can either be used separately for data analysis,

or combined into a language summary score. In the first study, we did this by computing the proportions of each category, and choosing for each child the predominant language category. In the main study, we computed for each task a geocentric language score, subtracting E from G items. The assumption is that if a person scores as many E items as G items, there is no evidence that this person uses a geocentric or an egocentric FoR. The use of other language categories is not informative in this respect. So using the subtraction procedure produces a score that directly presents the amount of evidence we have that a person is using a particular FoR. A low score results when more E items are being used, a high score when G items are used.

We submitted these scores (after adding a constant to avoid zero and negative scores) to a Princals optimal scaling data reduction procedure in SPSS, which will be discussed below. The outcome object score on dimension 1 of this scaling procedure is used as the summary score. Examples of these procedures are provided in detail in the relevant chapters.

Non-verbal spatial encoding tasks

All three of these tasks were initially devised by Levinson's CARG at the MPI for Psycholinguistics in Nijmegen, the Netherlands. Hence they are sometimes called the "Nijmegen tasks." Precise procedures were provided in the *Cognition and space kit, version 1.0* by Danziger (1993; see also Levinson, 2003; Senft, 2007).

Animals in a Row

This task presents the child with three animals (chosen in this study from locally available models of animals familiar to the children) aligned on a table, all facing in one direction. The child is asked to remember this display, and move to another table after a 180° rotation to align another set of the same animals the way they were shown before. Five trials, with animals oriented to right (R) or left (L) are given in the RLLRL sequence. The way animals are aligned by the child is noted, and the configuration is coded as indicating an absolute or relative encoding of the display.

The instructions for this task avoid any spatial language. After identifying the various animals, the child is told (in the respective local language): "Look at these animals. You have to remember them, so that you can put them in exactly the same way on that other table. Are you ready?" The display is hidden under a folded piece of paper, and the child is walked very slowly to the second table, with a 180° turn, where he or she is given a second set of animals. If the children hesitate, or seem to have forgotten, they are told: "Put them

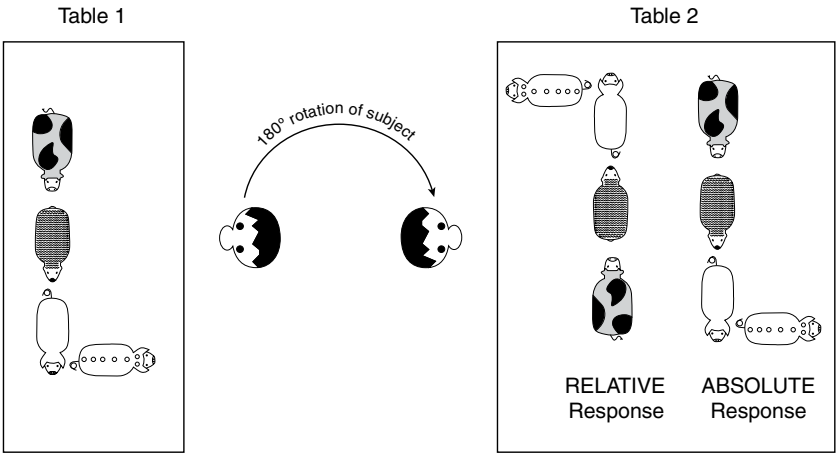


Figure 2.4 Animals in a row. Four animals and 180° rotation. Adapted from Levinson (2003), Fig. 4.11, p. 156

exactly as they were over there" and "If you have forgotten, you may return to the other table to see again."

Although the task is presented as a memory task, we are not really interested in studying the child's memory as such. The child may think that it is the order of the animals that is important, while we are in fact mainly interested in the orientation of their alignment chosen on the second table.

In our first study, only three animals were used; because these are aligned with the table's edge, an intrinsic encoding could possibly hide behind an apparently geocentric or relative one. Starting with the main study in Bali, we added a fourth animal at right angles, which creates a more elaborate display and hence a more valid coding. The configuration is coded separately for the three animals and for the fourth. Some time after beginning the testing, we also introduced two additional items, in which the child turns to a table set at 90° from the first one. These changes were made following the controversy between Li and Gleitman (2002) and Levinson *et al.* (2002) of which we had been made aware in draft form while our research in Bali was in progress.

For some of the youngest children in the study (4–5 year olds), we used two animals in a row instead of three, and one at a right angle. The Animals task with four animals and 180° rotation (first 5 items) is illustrated in Figure 2.4 and the 90° rotation in Figure 2.5 (items 6 and 7).

In our first study in Bali, as well as the first one in India and Nepal, this task was also repeated at the end of the testing in order to see if the child could shift from one encoding to the other. Depending on whether the child

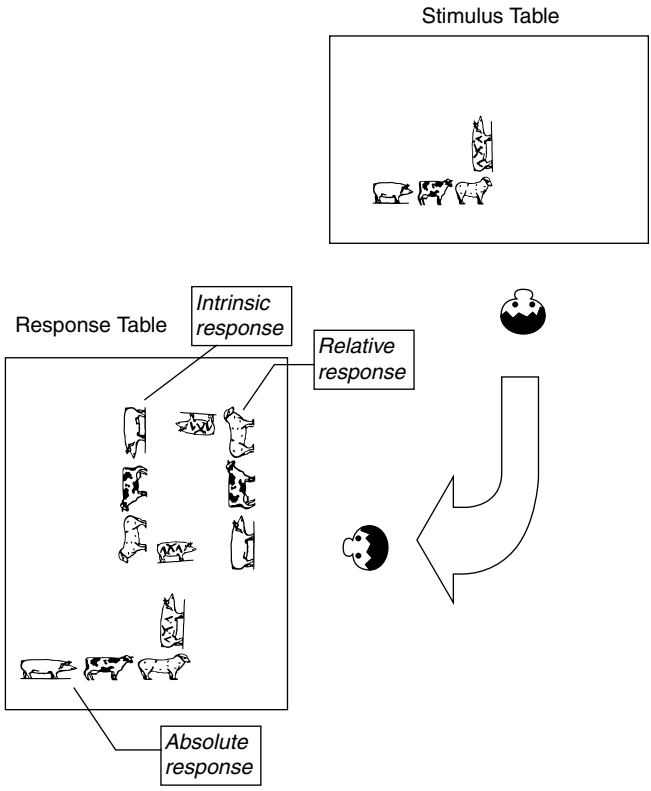


Figure 2.5 Animals in a row. Items 6 and 7 with 90° rotation. Adapted from Levinson (2003), Fig. 5.12, p. 204

had previously encoded the display in an absolute or relative manner, instructions were imparted to encourage an encoding opposite to the previous one. To induce relative encoding, the tables were placed 30° off the main direction, so that absolute encoding was less obvious. A child who produced mainly absolute (geocentric) answers on the first round, would be told: "You see, all the animals look to your right" (with an emphasis on "right") .

The Chips task

For this task, two-dimensional shapes (small or large, red or blue, and yellow or green circles and squares) are drawn on cards, two at a time. The child is shown five cards of a series, all with the same orientation, and is asked to notice that all of them are similar. Then one of the cards is rotated by 90°, and the child is asked to tell how it is now different from other cards. Following this

Figure 2.6 Chips task

exercise, the child is presented with one card oriented in a particular direction, and is asked to remember it. Then the child has to choose the one displaying the same spatial orientation as seen before from a set of four cards set out as a cross. A series of practice trials is given; the child has to be successful at least twice in a row before moving on to actual testing. The task itself includes five items, for which the child moves on to another table (after a 180° rotation).

In the main study, we simplified the task by using only red and blue squares, but we added two items with a 90° rotation (in India and Nepal but not in Bali).

If the child chooses one of the "distractor" cards, i.e. one of the cards that does not correspond either to an egocentric or a geocentric encoding, s/he is sent back to table 1 "to look and remember it again," and is hence given a second chance.

The Chips task has been described in Levinson (2003, p. 160, Fig. 4.13), and is illustrated in Figure 2.6, a photograph of a boy in Bali who is about to choose one of the four cards.

Steve's Maze task

This task, also called the "scout" game (Senft, 2007, p. 239), consists of six pictures of landscapes that depict a house, rice fields, trees, and an incomplete pathway. The child is presented with a picture and is told a story, showing the route that one can take from the end of the drawn path back to the house. The child is asked to remember this route while moving on to another table (with 180° rotation) where three cards are displayed showing three different

Figure 2.7a Steve's Maze

path segments. One of these represents a relative encoding, another an absolute solution and the third one an irrelevant choice (a distractor). One item is used for demonstration; another five items constitute the test series.

If the child chooses the "distractor" card on any one item, i.e. a card that does not correspond to either an egocentric or a geocentric encoding, the child is sent back to table 1 "to look and remember it again," and is hence given a second chance.

Steve's Maze is illustrated in Figure 2.7a, in which the assistant is holding up the landscape picture that is normally on table 1 so that it can be seen on the photograph. Figure 2.7b shows a reproduction of the scoring sheet.

For the three encoding tasks, the table is set out in alignment with the main local orientation system, so that the child initially faces *kaja* in Bali, up in Dolakha, Nepal, and north in the other locations. There is no systematic order for the administration of the three tasks. However, since Animals is the easiest to explain, it was often administered first.

Scoring the non-verbal spatial encoding tasks

The scoring of these encoding tasks changed somewhat during the different phases of the research project. Initially, in the first study in Bali, four or five items with a geocentric (A, absolute) encoding were considered as A, 3 items as A-, and similarly three egocentric items were coded R- and four or five were coded R (for relative). This was also the standard way of presenting results in the CARG group at the time. For the first study, we then followed the procedure proposed by Levinson (2003, pp. 176ff) of calculating a so-called "R-A

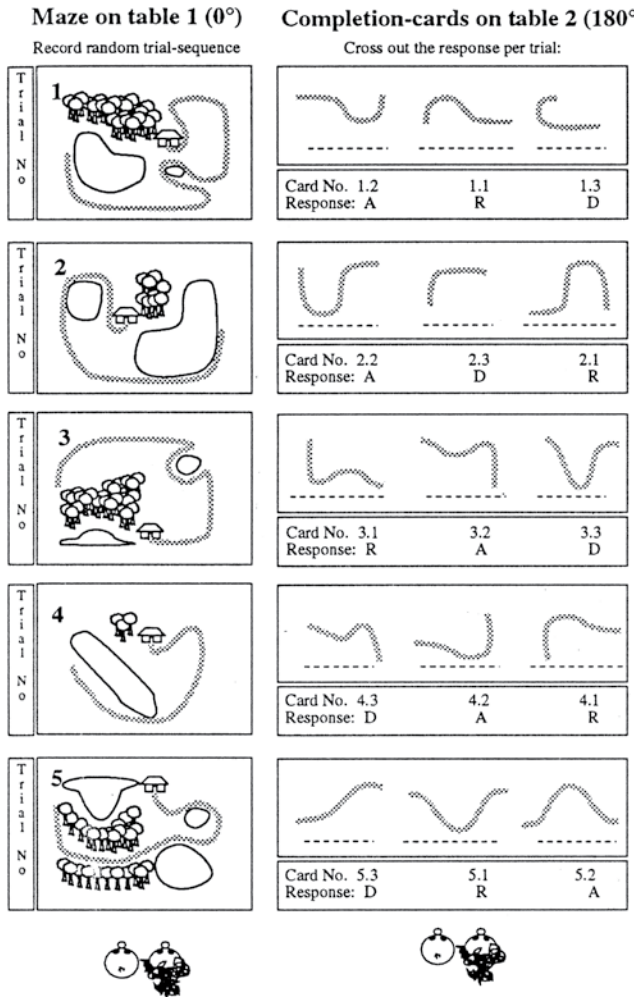


Figure 2.7b Steve's Maze scoring sheet

gradient," i.e. the proportion of items with geocentric encoding, with uncodable (distractor) items counting as a half. This procedure has the advantage of comparability, since it can be computed the same way even if the number of items is changed (for example from five to seven). In all of our locations, the number of distractor items was quite small, so that this does not affect the validity of the R-A gradient scores.

For the data analysis of the main study, we computed for each task a geocentric encoding score, for which E-encoded items are subtracted from G

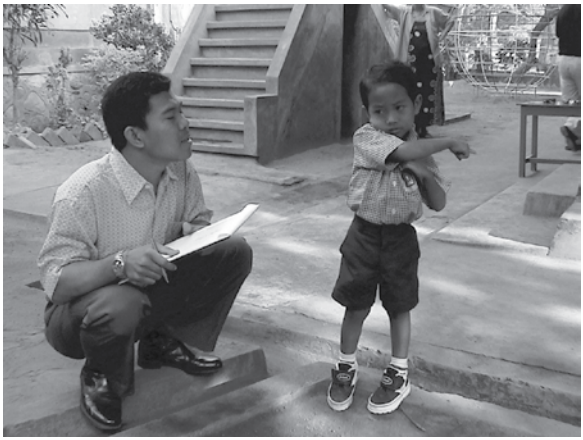


Figure 2.8 Testing the knowledge of the orientation system. Example from Singaraja, Bali.

items. These scores (with a constant added) are then submitted to a Princals data reduction procedure, producing a summary object score (dimension 1) of geocentric non-verbal spatial encoding. Examples are provided in chapters 5 to 8.

Knowledge of orientation system and egocentric references

Starting with the main study, we decided to check the actual knowledge of spatial vocabulary in relation to the egocentric and geocentric FoR. So the children were asked to indicate their left, right, front, and back (LRFB). They were also asked about the four directions of the local orientation system ("Show me where is north," etc.), and we did this first outside in the school yard, where cues such as the sun's position were available, and then again inside the room used for testing.

This procedure is illustrated in Figure 2.8, which shows a young child in the kindergarten playground of Singaraja, the city location in Bali. He is pointing to "kelod," to the sea. Note that the sea could not be seen from this place, while mountains were visible from parts of the playground. In Bali, children would preferentially use their right arm for gesturing, because they are trained early to use the right hand/arm in social situations.

In Bali, we also asked the children about the orientation system in Indonesian (which corresponds to NSEW; see chapter 3).

The scores on the different parts of this task were 0 to 4, counting the number of correct responses.

Additional cognitive tasks

First study: Piagetian concept development

In the first study, we included a series of tasks designed to assess spatial cognitive development, particularly tasks adapted from Piaget and Inhelder (1948/1956) and Laurendeau and Pinard (1968/1970).

Rotation of Landscapes This task has been described in great detail by Laurendeau and Pinard (1970, pp. 166–245), who called it "localization of topographical positions." We used a similar landscape model, but had three phases with five positions each, instead of two phases with twelve positions each, and our definition of sub-stage differs somewhat from theirs. This task is illustrated in Figure 2.9, which shows the training phase without rotation and without the screen.

Rotation of Landscapes is done in three phases. In the first phase (training), two similar models of landscapes are displayed side by side in front of the child on a table. Attention is drawn towards different parts of the landscape (e.g. house, river, bridge, hill, etc.), and their location. The experimenter (E) puts a doll on one of the landscapes, and the child is asked to set another doll in the same place and position on the other landscape. In the second phase, one of the landscapes is rotated by 180° in full view of the child, who does the same exercise as in the first phase (placing and positioning the doll). In the third phase, a screen is placed between the landscapes. The child looks at E's landscape, and on the basis of memory puts the doll in the other landscape at exactly the same place and position as seen before. The child is allowed to come back to the first display as often as needed. Five such trials are given in each phase. The task is scored in two ways: 1) a score is given for each position, taking into account the accuracy of the position and of the orientation; a total score is derived; 2) the overall performance is classified into five sub-stages, the early stages reflecting the use of topological space only, the middle stages projective space, and the last stage Euclidian space.

Horizontality A bottle half-filled with colored water is presented on a table. The child's attention is drawn to the level of water in the bottle. Then, the bottle is hidden in a cloth bag and the child is asked to draw the level of water in the outline of the bottle presented on the record sheet. The hidden bottle is presented in five different orientations: 1) right side up; 2) upside-down; 3) on its side; 4) tilted 45° to the right; 5) tilted upside-down at 45°. This task is illustrated in Segall *et al.* (1999, p. 153). For each position, the child each time draws the level of water in the outline of the bottle. The task is scored into the following stages: (0) only position 1 correct; (1) positions 1 and 2 correct; (2) positions 2 and/or 3 correct, and/or some movement of the water drawn for one

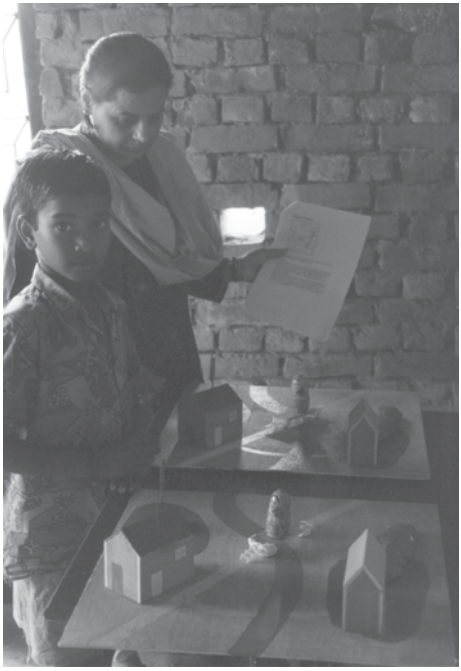


Figure 2.9 Rotation of Landscapes

position among 4 and 5; (3) movement of water in positions 4 and 5, but not horizontal; (4) correct for positions 4 and/or 5.

Perspectives task This uses the same display as described for the Perspectives language task, namely three non-fronted objects placed on a square of cardboard, as shown in Figure 2.1. The child, having first described the display from different positions, is then asked to stay at position 1 and describe the display from the point of view of the experimenter (i.e. how the latter sees the display) as s/he moves to different positions. The child is also trained to choose from a set of four pictures the one that matches with the experimenter's view of the display when the latter is opposite to the child, to the right of the child and at a diagonally opposite corner. In the last phase, the child is presented with a picture (the display seen from the left of the child) and is asked to tell where the experimenter should go to see the display as depicted in the picture. For young children (4–5 years) the task was used only for language elicitation. The task is scored as the number of correct descriptions on the four items (i.e. taking the other person's perspective into account), and the number of correct choices of pictures.

This task, in a slightly different format, has been described by Laurendeau and Pinard (1970, pp. 310–403) as the "coordination of perspectives." These authors used three circular cones to represent "mountains" as in Piaget and Inhelder's (1956) original three mountains task.

Route Memory The route description task, described earlier, was also used for the study of route memory. This task was inspired by the previous work of Gauvain and Rogoff (1989). A number of objects are placed at different points of the route. The child moves along the route, and names each object as it is encountered. On reaching the end point, in another room, the child is turned 180°, and is asked to tell how to go back to the starting point. Then the child is asked to recall the objects that were placed along the route, and arrange, on the basis of memory, the models of those objects at appropriate locations along a miniature display of the route.

The younger subjects (9 years and below) were presented with a simple path with six segments and six objects, and the older ones with a more complex path with eight segments and nine objects (however, 128 children were given both forms of this task). The two forms of the task are illustrated in Figure 2.10a and b.

The proportion of correctly recalled and correctly placed objects is counted; the score used in the data analysis is the proportion of objects placed correctly in the third phase of the task (reverse route recall with objects).

All the Piagetian tasks are presented as games. On all the tasks the child is allowed enough practice to ensure complete understanding of the tasks and the child is allowed enough time on each task.

Main study, Varanasi and Kathmandu: psychological differentiation

In two locations of the main study, we included two tasks taken to measure either (or both) spatial abilities and psychological differentiation (field-dependence/independence), following the theory of Witkin (1978; Witkin *et al.*, 1962;Witkin & Goodenough, 1981). This theory has given rise to extensive cross-cultural research (Witkin & Berry, 1975), including in India (Mishra, *et al.*, 1996). Two tests were used in our study.

Block Designs Test (BDT) This test, which is a standard of psychological testing (also called Kohs Blocks), involved the construction of pictorially presented designs of increasing difficulty with the help of four, nine and sixteen blocks within specified periods of time. A short (ten designs) version

Figure 2.10a and b Simple and complex Route Memory task

of the test (Mishra *et al.*, 1996) was used. Both time and accuracy of performance were recorded; in our data analysis, we report only the number of correct items (but we checked that similar results are obtained when using the timed measure).

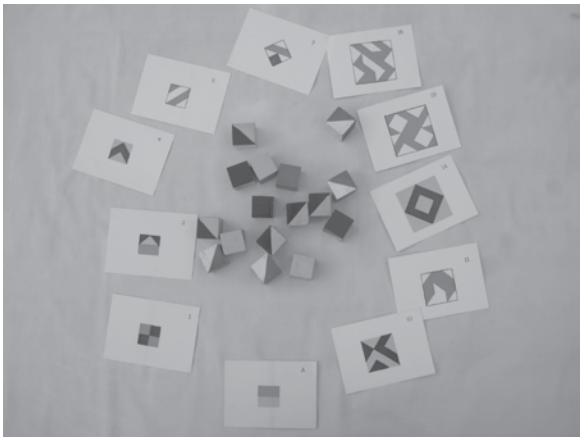


Figure 2.11 Block Designs Test (BDT)

The BDT used in this study is illustrated in Figure 2.11

Story-Pictorial Embedded Figures test (SPEFT) The SPEFT (Sinha, 1984) comprises seven sets of pictures. Each set consists of a simple and a complex card. In the simple card some objects and animals are depicted, which are embedded in a larger scene depicted on the complex card (e.g. snakes in the forest). The child has to locate in the complex card, within a maximum of 90 seconds, the objects or animals of the simple card, in the background of a story that is narrated with each card to encourage the child to locate the embedded items. Time taken and the number of objects correctly located by the child are recorded, but in the analysis of results, only the number of correct items is reported.

This test is based on Witkin's Embedded Figures Test (EFT), that uses geometric shapes, and the Children's EFT (CEFT), using drawings of real objects, which are easier to use with children. The contents of the CEFT being culturally specific, Van de Koppel and Van Helfteren (1977) produced a version appropriate for Africa, the AEFT, used, for example, in the research reported by Berry *et al.* (1986). Sinha (1984) subsequently designed the SPEFT for use in India. This has been used in research by Mishra *et al.* (1996). The SPEFT is illustrated in Figure 2.12.

In both the BDT and the SPEFT, the cognitive skill is to analyze a complex design and to isolate separate parts; so-called field-independent individuals can do that easily, while field-dependent ones tend to see the figures as a whole, and find it difficult (and take more time) to spot the composite parts. Hence Witkin (1978) takes these tests as measures of cognitive style (field-dependence/

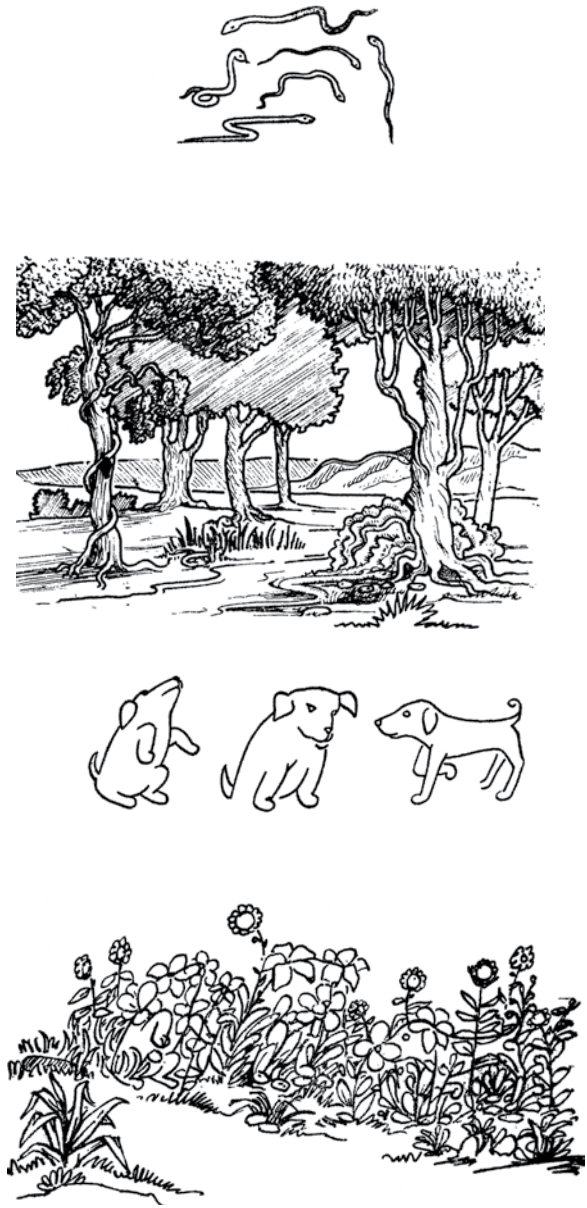


Figure 2.12 Three items of the SPEFT

Figure 2.12 (*cont.*)

independence). However, in both cases, spatial skills are also involved. In the BDT, once the figure has been analyzed into so many squares, the cubes have to be turned around to find the appropriate side and have to be oriented correctly. The SPEFT is more directly perceptual, since the simple drawings are presented in the same orientation as they appear in the complex figure, but the test is still thought to have a strong spatial component.

There is some discussion among psychologists about what tests such as these really measure. Sometimes they are claimed to reflect so-called general intelligence (also called g) or fluid intelligence (Dörnyei & Skehan, 2003; Sternberg & Grigorenko, 2001a). Indeed, they have even been included in batteries of non-verbal IQ tests. For example, McElwain and Kearney (1970) included a two-dimensional version of the BDT in their "Queensland Test" battery designed for cross-cultural use. Others claim that the tests measure one factorial component of intelligence, namely spatial ability (sometimes labeled k). The tests are indeed akin to ability measures, with right and wrong answers, and the score is computed as the number of items on which the test taker is successful (or even as the time taken to find the solution).

In this research, we will consider these two tests as reflecting spatial ability. However, we take a relativistic attitude in interpreting the results, i.e. we do

not consider that it is necessarily "better" or "more advanced" to have a higher score (Dasen *et al.*, 1979; Berry *et al.*, 1982) just as it is not "better" to use a geocentric FoR rather than an egocentric one (or the reverse). In other words, we do not use value judgments, even though we know that the scores usually increase with age, because they are developmental tests as well.

Socio-cultural background variables

Starting with our first study, we collected some social background information such as parents' education and occupation, and contact with media, as well as the family's contacts between the city and the village. In the main study, a small questionnaire that was filled out with the help of the children themselves or the teachers was used in Bali. This was expanded into a full questionnaire covering more topics, such as daily activities, the distance at which these were carried out and how the child was moving around (walking, with a bicycle, being driven, etc.). This was administered to all the children in the Kathmandu study, and to a sub-group of eighty children in Varanasi. A copy of the questionnaire and its scoring scheme appears in Appendix 1.

Secondly, a questionnaire addressed to parents was used with a sub-group of seventy-eight families in Kathmandu and sixty-six in Varanasi. The parents were visited individually by the interviewers upon making an appointment. The interviews were carried out with either the mother or the father or both, depending on who was available. Some spatial language was also elicited from the parents by asking them for a route description, and describing the position of three objects (as in the Perspectives task). The interviewers also made some observations (such as the quality of housing, etc.). A copy of the interview schedule and the scoring scheme appears in Appendix 1.

Data analysis

Much of our research being developmental, we favor line graphs by age as the main way to present descriptive data. It is true that our research is not longitudinal, so there may be some objections to using line graphs. For practical purposes, we are assuming that the older children have, at their early ages, experienced the same circumstances as the current generation of young children. Presenting the data as bar diagrams would have been another possibility, but would have made the interpretation more difficult when we dealt with age trends. These graphs are accompanied by inferential statistics as seen fit. When, in the text, we claim that there is a difference between two groups or sub-groups, it means that there is statistical evidence for this claim at least at the $p < .05$ level.

When searching for relationships between variables, one uses correlation coefficients. However, the fact that we work with a large age range may play some tricks: if two variables both change with age, which is often the case in developmental psychology, there will automatically be a correlation between them just because of this common link to age. If we want to know whether there is a real, structural link between them, we somehow have to "control" for age. We may either compute the correlations separately in each age group (but that will reduce the number of subjects), or we have to use the statistical procedure of partial correlations. "Partialing for age" means that the common effect of age has been removed.

In most cases, we will first present descriptive results separately for each task or variable derived from questionnaires, but then some data reduction is needed. For example, since we have three tasks that elicit language, or three tasks for encoding a spatial array in memory, we would like to have, for each individual participant, a summary score for language and one for encoding. The technique we have chosen for this purpose is optimal scaling through a Princals optimal scaling procedure (which is available in SPSS).[1] This is like a principal component factor analysis, but it does not require normal distributions and an interval scale, but allows variables in ordinal or even categorical scales. We consider that most of our data is ordinal: for example, producing four items with geocentric encoding is more than three or two, but it is not necessarily twice as much as two.

Princals allows us to consider a number of variables at once, and it searches for an optimal way of placing these onto a two-dimensional space. (We chose to impose two, but there is the option to consider more dimensions.) The position of the variables in this space is given by their component loadings on the two dimensions, and can easily be illustrated in a graph. The internal consistency of each dimension is assessed through a Cronbach's alpha, and the analysis also indicates how much of the variance is accounted for by each of the dimensions. The procedure also places each individual on this two-dimensional space (as in a correspondence analysis), so that each individual gets a so-called "object score" on each axis. We use the object scores on dimension 1 of the analysis as the individuals' summary score. Note that we are not using this technique as a way to construct some inherent theoretical factor which would generally require more data, but mainly as a way to produce a simple summary variable, very much like adding a number of scores and taking the average.

A further problem with research where a large number of variables are considered is that the correlations between two variables are likely to be influenced by a third or even more variables. So we have to find a way to show the

[1] We thank Dr. Rudo Niemeijer for offering his time and help with the more sophisticated statistical analyses.

complex interactions of a set of variables. We initially did this through successive regression analyses, but finally changed to a procedure of path analysis, or structural equation modeling, called Amos (which is linked to SPSS). We will summarize our findings with Amos models for Bali, Varanasi and Kathmandu (chapters 5 to 7).

Amos allows the analyst to work graphically, by selecting variables of interest, placing them on a two-dimensional space, and drawing arrows that represent relationships between the variables in order to construct a "model." This is, of course, not done at random, but following the theoretical hypotheses of the researcher. Each variable is accompanied by a so-called "error term" that represents the individual variations on the variable that are not accounted for in the model. The arrows in the model represent pathways of influence, and are accompanied by a coefficient (beta weight) that indicates the strength of this association.

In structural equation modeling, it is also possible to introduce "virtual variables" into the model, i.e. theoretical concepts that are not measured directly, but are thought to be common and well represented by a series of available measures. This corresponds to a classical way of thinking in psychology, where most concepts of interest can never be observed let alone measured directly, but have to be inferred from observable data. In our case, in some of the models we will use virtual variables that we call "traditional culture" and "spatial ability." The variables that contribute to define these virtual variables are indicated by arrows leading from them to the individual measures.

The Amos procedure estimates the fit of the model through a series of indices that have to reach certain criteria to indicate a good fit. There seem to be no absolute values for these, but consensus that the chi square (CMIN) should be low with a high (non-significant) p value (degrees of freedom are reported as well), GFI, CFI and TLI > .90 and RMSA < .05. The final models we are presenting have an excellent fit compared to these values. To obtain a good fit, one has to set some constraints on the model, including covariance between some of the variables – indicated by a circular arrow – that are not taken into account in the model.

The models that are presented in chapters 5 to 7 are those for which we obtained the best fit. They have been tested against several other alternative models, some of which were suitable according to the above-mentioned criteria, but not to the same degree. The final choice is certainly a matter of appreciation by the researcher. We present these models as a nice way to summarize graphically a set of interactions, one that illustrates quite well how geocentric language and encoding are part of a complex eco-cultural system.

3 Settings

In this chapter, we present all of the sites used in this research, starting with Bali, because that is where we carried out our very first study in 1994, and then India and Nepal (both the locations of the first study in 1999–2000 and those of the main study), and Switzerland. Although the results will be presented in separate chapters by location, it seemed to make sense to present the settings in a single chapter.

We consider this chapter to be very important in this volume, because our general interpretation of the results is that the "choice" between spatial frames of reference depends to a large extent on a set of ecological and socio-cultural variables, which we describe at the group level in this chapter. Some of these have actually been measured at the individual level, and the results are described in the relevant chapters.

The amount of detail provided for each location varies, but should in any case be enough to give a feel for the local daily life. Our emphasis is, of course, on the orientation system predominantly used in each location, including examples of its daily use, and its symbolic significance. Language used for describing space may be mentioned on the basis of ethnographic observations, while the actual language produced on language elicitation tasks is presented in each separate chapter. Actual examples for each language category in each of the languages used in the various locations are presented in Appendix 2.

Eco-cultural characteristics have been taken into account in the selection of the locations. In cross-cultural psychological methodology, we strongly advocate choosing locations and samples on theoretical grounds, and on the basis of prior ethnographic knowledge (Mishra & Dasen, 2007). In other words, our locations have not been chosen out of convenience, but because they allow us to test prior hypotheses. This choice is, of course, made under certain constraints. In Bali, for example, the choice of the first location, Bunutan, was due to the fact that J. Wassmann was working there as an anthropologist on a larger project. The subsequent choice of the town of Singaraja and the village of Sambangan was influenced by the availability of a teacher training college where we could get the help of well-trained, bilingual local assistants.

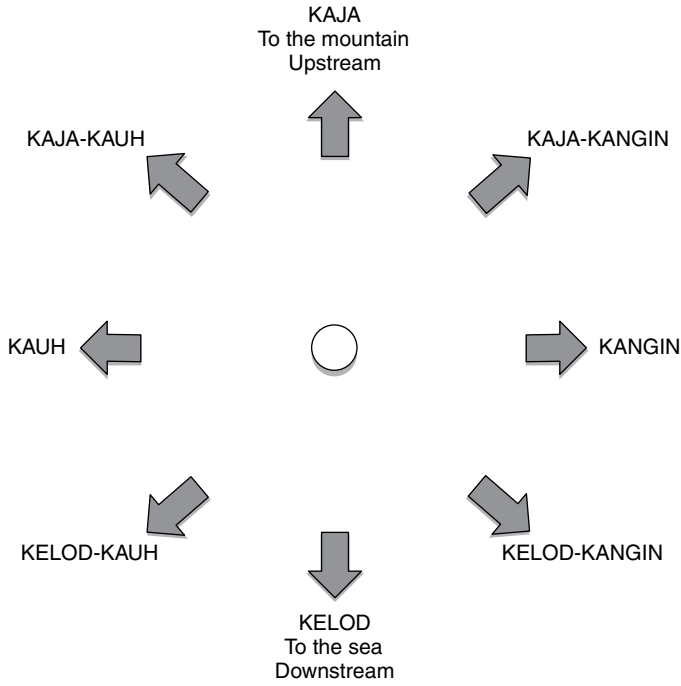


Figure 3.1 Balinese orientation system (KKKK)

However, these two places corresponded well to our design of comparing a rural and an urban location.

Bali

Kaja–kelod, *spatial and spiritual orientation in Bali*[1]

The Balinese orientation system, illustrated in Figure 3.1, is of utmost importance in Balinese culture. It has been described by many authors (e.g. Belo, 1935; Covarrubias, 1937; Eiseman, 1990; Hauser-Schäublin, 1997; Hobart, 1978; Hooykaas, 1974; James, 1973; Ramseyer, 1977).

A direction in this system describes a vector which refers not only to physical, but also to cultural, religious and social space; it also designates not only one precise direction but a segment of 45° to 90°. Orientation is geared to the uphill or "upstream" direction, to the mountain, prototypically to the central volcano, Gunung Agung (3,142 m), the dwelling place of the Hindu gods of

[1] This description is based largely on Wassmann and Dasen (1998).

Bali. This is the sacred and pure direction, called *kaja* (from *ke*, towards; and *aja*, hill, mountain) while "downstream" is the direction called *kelod* (from *ke*, towards; and *lod*, sea). It should be noted that the sea is not bad or impure in itself, only the direction towards it; on the contrary, it can purify and provide sacred water. In the anthropological writings, *kaja* is often translated in English and Indonesian as "north." This, as we will see shortly, is quite wrong, as it applies in fact only to the situation of south Bali (where most of the population and the anthropologists live). The *kaja–kelod* axis is in effect a variable direction – in the north of the island, *kaja* will be south.

This type of topography-dependent, geocentric orientation system can also be found in other languages of South East Asia and Oceania (Barnes, 1993; Cablitz, 2006; François, 2003, 2004; Ozanne-Rivierre, 1987; Senft, 1997). François (2004) describes the prototypical Oceanic geocentric system as having an undifferentiated traverse axis, labeled as "across" on both sides. Additional information, such as landmarks, has to be provided for unambiguous communication. This is not the case in Balinese, where the two directions are named differently.

In Bali, the second axis, parallel (in fact, tangent) to the coast line, is termed *kangin–kauh,* and for these terms there is no obvious translation. Again, *kangin* has often been translated as east, and *kauh* as west. Indeed in southern Bali, *kangin* is the direction where the sun rises – another important manifestation of the gods – and this direction is therefore also considered sacred. However, as we will see below, it is not as fixed as was thought by most anthropologists and linguists.

The intercardinal directions, *kaja-kangin*, *kelod-kauh* etc., are also commonly used. To each of the eight directions, as well as to the center, there corresponds a god and a color. For example, Wisnu and black are *kaja*, Brahma and red *kelod*, Mahadewa and yellow *kauh*, Iswara and white *kangin*, and Siwa is in the center. The intermediate directions also have their specific gods, such as Sangkara (green) for *kaja-kauh* (Eiseman, 1990). The entire Balinese cosmology is structured according to the triptych high, middle and low, oriented *kaja–kelod*: from the human body to the entire universe, from the structure of temples and villages to social structure and even the various life stages; the equilibrium of this structure must be preserved at all times.

Numerous aspects of Balinese life are organized according to this scheme. Villages are typically built along a *kaja–kelod* line, with the main temple on the mountain side and the cemetery on the sea side. Each temple is aligned in the same way, as well as the various shrines within the temples. The houses of a family compound are equally oriented, with the family temple in the most sacred corner, situated *kaja-kangin*. The family head lives on the *kangin* side of the compound, and everyone sleeps with their head oriented towards *kaja* or *kangin*. The layout of various parts of the house and of the furniture follows

similar rules: the kitchen will be built *kelod*, and the animals and the rubbish can be found in the least sacred corner, *kelod-kauh*.

The disorientation felt by Balinese people when they lose their bearings has often been mentioned. Geertz (1973, p. 446), for example, writes: "Balinese regard the exact maintenance of spatial orientation ('not to know where north is' is to be crazy), balance, decorum, status relationships, and so forth, as fundamental to ordered life (*krama*)." Likewise, McPhee (1944) describes the total inhibition (bordering on depression) of a young boy brought to an unknown village for a dance practice and who could not start dancing until he was shown the central volcano Gunung Agung from some neighboring rice fields. Note that, to learn dancing, directions are used: according to McPhee (1944, p. 124), the teacher will give instructions such as "take three steps *kauh*, bend *kelod-kangin*." Bateson and Mead (1942) speak of fear and anxiety associated with disorientation, saying that people can fall sick or asleep. Jensen and Suryani (1992), two psychiatrists, one of whom is Balinese, feel that this description is exaggerated and also think that what McPhee reported is atypical. They point out that when a Balinese arrives in an unknown place and cannot orient himself, he will make inquiries before falling sick; but they agree that disorientation produces tensions and a "state of confusion (*bingung*) in which it is difficult to pursue one's thoughts and speech clearly" (p. 76).

However, if the orientation system established from the learned culture of south Bali does constitute a complex system including spiritual dimensions, this aspect remains the prerogative of specialists like priests and is of little concern to the majority of the population, at least in the remote eastern part of the island. J. Wassmann carried out twenty-five interviews on this subject during our first period of field-work. No one knew the localization of the colors or the gods according to the eight directions. Our informants knew that such a symbolic system exists for the four main directions, but had not mastered the details, and explained that they would consult a specialist when they needed to. This shows that it is important to look beyond the high culture to the way common people deal with such a system in everyday life.

The orientation system in everyday life: topographical variations

Despite what has just been said about the lack of extension of the symbolic aspects of the system, it is easy to observe the importance of the orientation system in Balinese everyday life. Indeed orientation terms constantly crop up in conversation. Geocentric terms are used to describe a place where one wants to go ("this afternoon, I'm going *kauh*"), or to give directions ("turn left, then go *kangin*"); a mother might yell to her child "don't throw your shoes *kauh*," or during a meal, someone might say "please pass the dish which is *kaja.*" When reporting on a meeting, a person will be designated as "the one who was

sitting *kelod*"; it seems therefore that positions are memorized in a geocentric manner.

Whether at home or at school, children must learn to follow instructions according to this orientation system. Elementary school teachers even use this knowledge as a test of school readiness. But teaching, which is done exclusively in Indonesian, relies on cardinal directions (*utara*, *selatan*, *timur*, and *barat*, for NSEW) or on relative descriptors. For example, in order to point out the difference between the letters b and d, teachers say they use "in front of"/"behind" and "right"/"left" and only resort to geocentric directions if the children have trouble understanding.

The Balinese orientation system applies in a large number of social situations. During cock fights, for example, to determine which animal will be the favorite and to fix the odds, spectators will shout a word that designates the chosen animal; it may be the color of the feathers, but often it indicates the animal's position in geocentric terms (Geertz, 1973).

Another example of a situation where directions are constantly used is a game of chance called *kelos* or *kece*. The players are divided into four groups and sit according to the four directions. They first bet on one of the directions and the game leader then takes a handful of tokens (in fact old Chinese coins) which he throws in the center of the circle four at a time, until only four coins, or fewer, remain. The number of remaining coins determines the winning direction (1 = *kaja*, 2 = *kauh*, 3 = *kelod*, 4 = *kangin*).

If *kaja* does indeed mean "upstream," it may not necessarily designate the central mountain Gunung Agung, particularly in places where this mountain is not visible, but another mountain close by. Each direction represents a quadrant, with a focal point as a prototype indicating the best spot, but which is not necessarily at the center of the quadrant. The four main directions are commonly used, but less so the intercardinal directions, which represent the borders between the main quadrants.

Wassmann and Dasen (1998) have examined in detail how the inhabitants of various sites on the eastern peninsula of Bali use the system (see Figure 3.2). This peninsula is formed by a circular mountain range that includes Mount Seraya (1,175 m) and Mount Bisbis, which is not as high but is an important symbol because of the temple of Lempuyang perched at the top. Our observations have established that the system is not at all uniform but strongly local, that it is adapted to the topography of each site and that it can even be dependent on specific historical circumstances, because migrants seem to transfer the system of their home town to the new location. South of the peninsula, the orientation system is applied following practically the same modalities as in south Bali, that is *kaja* (code 1 in Figure 3.2), meaning north towards one of the peaks, and *kangin* (code 4), representing the geographical east. Going around the peninsula on the circular road (anti-clockwise), *kaja* remains oriented towards the closest

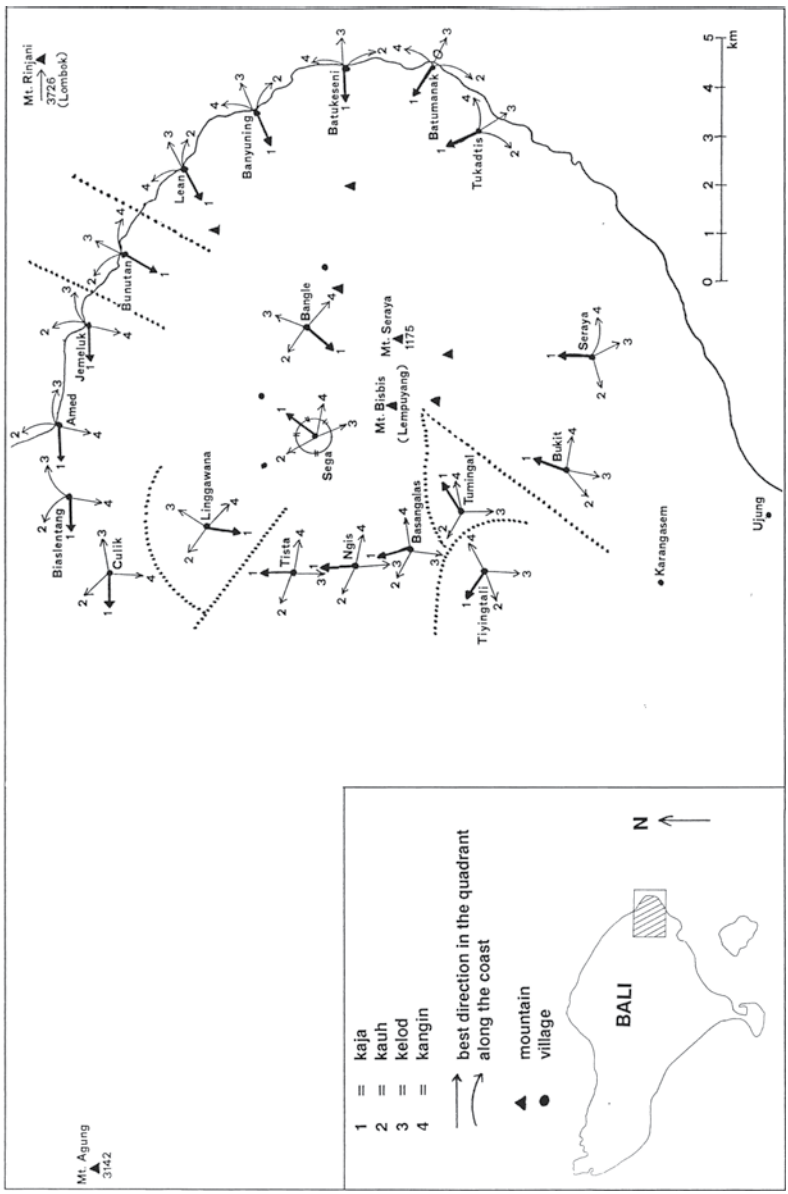


Figure 3.2 Local adaptations of the Balinese orientation system (Source: Wassmann & Dasen, 1998)

peak, while *kangin* "moves" further and further towards the north, following the curve of the coast. For the inhabitants of the easternmost cape on the island, the sun rises *kelod* (code 3) and *kangin* (4) designates the north.

One might have expected to see *kangin* and *kauh* to remain respectively right and left of the axis *kaja–kelod*, in the same way as east and west remain immutable when we go around the globe on the equator. However, this is not the case: at a certain point, the system reverses itself. If there is a reversal, one might have expected to see it at the easternmost cape, but this in not the case either: *kangin* (4) continues to be on the right side up to the village of Lean, where it designates the north-west (and where the sun rises *kelod-kauh*!), then *kauh* (2) and *kangin* (4) are reversed in the next village (Bunutan). The villagers are quite aware of this situation and, as demonstrated in the following example, they adjust their language when they visit their neighbors.

In Lean we observed a game for which players had come from the neighboring village of Bunutan and at the beginning of the game, the following surprising dialogue took place:

> Which system are we going to use, Bunutan or Lean?
> The Lean system.
> In Bunutan and here, *kaja* and *kelod* are in the same direction.
> *Kangin* and *kauh* are different.
> Here, *kauh* is this side (towards the village of Seraya).
> For *kangin*, it is four coins; *kangin* is there, Bunutan side.

An important point is that the transverse axis is defined by two named vectors, not the indeterminate "across" found in most Oceanic island systems. So, in fact, the Balinese system corresponds to a circular system which François (2004) describes as a rarity in Austronesian languages, and with the additional particularity that it does not work systematically clockwise or anti-clockwise, but changes mid-way. Within the mountain range, a fairly vast former volcano crater contains a few villages, particularly, Bangle and Sega, where the former uses the system clockwise and the latter anti-clockwise. The complexity of the local applications of the system seems to be linked both to topography and to the history of migrations in the region.

Given the wide topographical variations in the system, "north" is patently inadequate as a translation of *kaja*. The translation of these terms in Indonesian is equally problematic: *kaja* is translated as "*utara*," and *kelod* as "*selatan*," but these terms may be used in the Balinese way (as a topographically dependent axis "upstream/downstream"), or in the standard dictionary translation, as the geographical north and south of the compass. During a discussion we had with a group of primary school teachers in Bunutan, it was found that half of them were using these Indonesian words in one way, and half in the other way; a lively debate ensued, and no agreement could be reached.

The diversity of local adaptations of the orientation system also explains why calling such a system "absolute" is somehow a contradiction. It is not absolute at all, but on the contrary highly locally relative! On the other hand, it is truly "geocentric," insofar as it refers to a system of orthogonal axes with four named remote directions. These are used to describe space and spatial localizations of all sorts, including small-scale table-top space, and including space inside a house or a room.

Right and left

The Balinese language allows all of the three FoRs, the intrinsic, the geocentric and the egocentric, but with a clear preference for geocentric references (KKKK). Most of the time, the use of the egocentric FoR (LRFB) in Balinese is limited to the individual's body or to objects touching the body, as in "I have a cup in my *kenawan* (right) hand." In that case, it is in fact used intrinsically. Geocentric descriptors can also be used in the latter case ("I have a cup in my *kangin* hand"). Although they are able to designate their right and left hand, children always use geocentric descriptors, even for hand-held objects. To describe a route, adults often use phrases such as *melikuk kebot* ("turn left"), but systematically add "towards" and one of the geocentric directions (e.g. *Melikud kenawan pak kaja*, "Turn right towards the mountain").

We may hypothesize that body parts like 'left hand' and "right hand" may have acquired an extended meaning under the influence of the Indonesian language. This would explain why only older school children and adults, who tend to be bilingual, use these egocentric terms, and it may also be the reason why very often the corresponding Indonesian words (*kiri*/*kanan*) are used in Balinese speech. Hence, the current use of the egocentric FoR may be due mainly to the influence of the Indonesian language that has been established as the common national language, and due to a widespread "Westernization" (e.g. TV, traffic, schools).

It seems that left and right are mainly used in profane everyday life, but not by dancers, musicians[2] or craftsmen, who prefer the religiously loaded *kaja–kelod* during their activities (personal communication, U. Ramseyer). But there is a reason to avoid the use of left and right even in colloquial speech: politeness. Geocentric terms are valid for both the speakers and the (facing) interlocutors, and they prevent the former from putting themselves at the center, instead of being just part of the social and topographical environment. Left and right are simply too individualistic!

[2] A remarkable exception is the *wayang* shadow play. Here the two ancestor figures of Kurawa (evil) and Pandawa (good) are explicitly associated with the left and right sides respectively, and the spectators localize the two figures using "left" and "right."

The predominant use of the geocentric reference system in the Balinese language fits perfectly with its symbolic importance in Balinese culture. In other words, there is an obvious coherence between the cultural and linguistic systems.

Early socialization

Children seem to learn the use of the orientation system very early in life. According to Bateson and Mead (1942, p. 6), "the words for the cardinal points are among the first that a child learns and are used even for the geography of the body. A Balinese will tell you that there is a fly on the 'west' side of your face." The Balinese baby also learns early on that the left hand must not be mistaken for the right hand. The latter is used to handle food, while the left is used for washing; it should never be used to touch food, point to something or receive a present. In this respect, Bateson and Mead report the following observation:

> The Balinese mother or nurse carries a child, either in or out of a sling, on her left hip, thus leaving her own right hand free. In this position, the baby's left arm is free, while the right is frequently pinioned in against the breast, or at best extended behind the mother's back. Naturally, when a baby is offered a flower or a bit of cake, it reaches for it with the free left hand, and the mother or the child nurse invariably pulls the left hand back, extricates the baby's right hand – usually limp and motive-less under this interference with the free gesture – and extends the right hand to receive the gift. This training is begun long before the child is able to learn the distinction, begun in fact as soon as the child is able to grasp at a proffered object, and discontinued usually when the child is off the hip. (Bateson & Mead, 1942, p. 13)

A typical admonishment of parents to a child of 12 to 18 months is: "use your right hand, not the left one!" or, when the child starts eating food, s/he may be asked: "where is your right hand?" Note that "left" and "right" are only used to designate body sides, and are not used in terms of spatial orientation, i.e. they are not used projectively.

However, the child is also confronted with the geocentric orientation system very early in infancy, in fact for the first time when put to sleep. The baby usually sleeps in the parents' bed. After s/he is one and a half years old, a typical admonition is: "put your head towards *kaja!*" Often a phrase is used that expresses a contrast: "put your head *luan*, don't put your head *teben*."[3] An often-used proverb is "*sing dadi maluanan kelod*" ("never ever use *kelod* as *luan*"). By the age of 3 years, the child – due to this habit – reacts when

[3] *Luan*: to the head, pure place, upstream; *teben*: to the feet, dirty place, downstream; *kaja* and *kangin* are *luan,* versus *kelod* and *kauh* that are *teben*.

put wrongly (head to *teben*, i.e. *kelod* or *kauh*) in the bed. At the same age the child may be confronted with the orientation system when taken to the shrine in the *kaja-kangin* corner of the compound, with parents asking: "where are we looking?" If the child asks for the whereabouts of someone, like his father, an answer could be: "he is *kelod*" or "he works on a rice paddy that is *kelod*."

Bunutan, the location of the 1994 study in Bali

The village of Bunutan is situated on the north-east coast of Bali, which is an arid part of the island. The main subsistence activity is fishing. The men go out in the early morning and in the evening on self-made *jukungs*, small outrigger canoes. But fishing has suffered from the competition of large Japanese commercial fishing vessels, so the local catch has become dismal. There is also some subsistence agriculture, mostly on very dry hillsides without any irrigation. Some rice is grown in lower areas, and the village itself is set among banana and palm trees. There is some livestock in the form of cattle, goats, chicken, and pigs.

In 1994, the touristic development of this part of the island was still minimal. There were some dive sites in nearby Ahmed and Tulamben, with minimal facilities, and some small hotels, most of which had to have their own generator because the electricity line had not yet reached that far. The road along the eastern peninsula was quite rough, and often cut off, so there was little traffic. The closest small market was about 10 km away, and the closest small city, Amlapura (Karangasem in Figure 3.2), on the south side of the peninsula, about 20 km with no public transport. Bunutan itself had a few *warungs*, small shops with essential commercial goods, and most young people had motorbikes to move around.

Because of the rather poor living conditions, some people from Bunutan, and from the mountain villages of Bangle and Sega above Bunutan, were candidates for the controversial *transmigrasi* program of resettlement in other Indonesian islands (Hardjono, 1989; MacAndrews, 1978).

In sum, Bunutan, in 1994, was quite remote, rural and traditional, away from the Bali most tourists would have known. By 2002, when we carried out the main study in Bali, and returned briefly to Bunutan, the situation had changed considerably. Tourism had reached the eastern peninsula, which was showing rapid development despite, or possibly because of terrorist bombings in the popular resort of Kuta in the south of the island. The coastal road was now well paved, electricity had reached everywhere and many hotels had sprung up, providing some paid employment. Yet, even then, Bunutan remained more remote than the two other locations we used in the main study.

Bali, main study

One of the limitations of our 1994 study in Bunutan was the small sample size. This was due to the fact that we did not have access to the local school which would have provided us with a larger sample of children. In 1994, the testing was carried out on the veranda of the house J. Wassmann was renting in the village, and the children were recruited by our research assistant. In 2002, we were able to work with much larger samples, in schools of two different locations, as well as testing again a small sample of young children in the Bunutan area.

The city sample was obtained in a private experimental school attached to the only teacher training college of Bali, in the city of Singaraja, on the north coast of Bali. The pupils attending this school were mainly from middle- and upper-class families. Singaraja is a bustling city of about 80,000 people. It is the administrative center for Bulengeng regency, and northern Bali more generally. Historically, Singaraja was the capital of Bali during the Dutch colonial administration, with the most important port of the island. It has now lost its importance since the airport and its tourist flow are in Denpasar in the south. Vehicular traffic is quite intense, with many cars and even more motorbikes, but the streets are quite large and laid out in a square pattern.

The village of Sambangan is situated in a rural area about 15 km from Singaraja, on a northern-facing slope of the mountain, with a clear view of the sea in the distance. The parents of the children were mainly farmers, producing rice in terraced fields, and other crops on the slopes leading into the tropical rainforest. While still quite traditional, Sambangan is not as remote as Bunutan; it gives the impression of a fairly wealthy rural community. Its school was well staffed, with about ten male and female teachers. The 4 and 5 year old children attended a preschool in the same locality but closer to town; their parents tended to have paid employment in the city. Information on the family background of each child was obtained through interviews with teachers who knew the children well, or a questionnaire sent home to the parents.

The language of instruction is Indonesian, so all children are bilingual; however, Balinese is the common language used in the community in Sambangan, while Indonesian is spoken more in the city. All instructions for our tasks were given in Balinese by two local research assistants but the children were free to use Indonesian in their answers if they wished. The testing was carried out in various rooms in the school or, for the youngest age group, outside in front of the preschools.

Towards the end of our field-work period in Bali, we also returned to the Bunutan area where we had carried out our initial study in 1994, and tested a few children aged 4 to 6 years with the Animals task only; this was done at

the children's home, with the help of local interpreters and often with a large group of onlookers.

India

We consider India to be the main location of our study, because one of us teaches at Banaras Hindu University, and hence most of the research was designed and pre-tested in Varanasi. Two locations were chosen for the first and the main study, Roopchandpur, a village near Varanasi, and the city of Varanasi itself. Most of the additional studies reported in chapters 10 to 15 have been carried out in these two locations. An additional village location, Panditpur, was chosen because we were told that the language used there was mainly egocentric, which provided an interesting contrast with Roopchandpur (see chapter 8).

Roopchandpur village

Roopchandpur is situated 35 km north-west of Varanasi in the eastern part of Uttar Pradesh along the highway that connects Varanasi to Azamgarh and Gorakhpur. The village has been in existence for the last 200 years with a dominant population of Hindus. The land around the village is flat with rectangular fields in which a variety of crops are grown all year round. There are clearly marked dry and rainy seasons. Agricultural activities are undertaken mainly during the rainy season (July–September) when paddy, millet, corn, and rice are grown, and during the winter season (October–January) when wheat, peas, chickpeas, potatoes, sweet potatoes (yams), lentils, and a variety of oilseeds are grown. The beginning of the harvest season is marked by the celebration of the great festivals of Dashehra (in October when big fairs are organized) and Deepawali (in November when thousands of lamps are lit in the houses as well as in the outlying fields). The end is observed by celebrating another great festival, Holi, when people sing, dance, throw colored water and talc on each other, cook a variety of sweets, and organize great feasts. This marks the first day of the New Year for Hindus (as per their lunar calendar).

Traditionally the people of this area were farmers pursuing crafts and other specializations as part-time activities, especially during the lean period when there were few agricultural activities to be carried out. In recent years, however, full-time occupational specialization has been possible at least for some village people. There are a few tractors in the village to do most of the agricultural cultivation, but farmers with small land holdings use a plough pulled by a pair of bullocks. Lift pumps are used for the irrigation of crops during the dry seasons. The production of staple foods is generally the responsibility of men,

although women help in most of these activities. The whole family may come forward when the work is very intensive (e.g. planting rice or harvesting).

There are two market places about 4 km from the village. Some permanent grocery stores, general stores, tea stalls, tailoring shops, bicycle repairing shops, and restaurants exist in the market. There are also some small shops in the village to fulfill the daily needs of people. Houses are generally built close to each other. However, a number of small hamlets represent particular communities in terms of occupational specialization (e.g. potters, blacksmiths). Most of the families have migrated to Roopchandpur from many different places. According to the 1998 census, the total population of the village was about 2,600, including about 900 unmarried boys and girls.

Human labor is of great importance in any agricultural society. The ability to command the labor of others was, and continues to be, an important symbol of high status in Indian villages. From a very early age, respect and obedience are instilled in and demanded of children. Children carry messages within the family and neighborhood, and run minor errands. No child is expected to refuse a request from an adult of the family or neighborhood. In extreme cases, the lack of compliance on the part of a child may result in the withdrawal of food. Respect for elders is marked not only by linguistic usage (e.g. polite words), but also by many behavioral courtesies. These include not speaking in their presence, leaving their place on a chair or cot, fetching water for them, giving them a bath, washing their clothes and spreading them to dry, and so on. These are considered as highly valued qualities in a child even today.

A number of changes have taken place in the village in recent years, as a result of education, urban contact and industrial exposure. The perceived value of education has encouraged many of the villagers to seek higher education, including professional and technical training. A primary school has existed in the village for the last hundred years. A new school has also been running since 1984. Centers of higher education located in Jaunpur (40 km away), and universities of Varanasi (35 km away) have been catering for the people's educational needs for the last several decades. However, the educational status of the village is not very high. According to the 1998 census, about 50 percent of the population remains illiterate. About 6 percent of the population holds a university degree, 20 percent has a secondary level of education and 26 percent has gone to primary school. The literate people largely belong to Brahmin families. Movement of people to cities in search of employment and education has exposed them to an urban industrial lifestyle. Thus, families are becoming nuclear, the older authority structure is being replaced by the authority of parents and immediate family members, community and fraternity bonds are weakening, families are becoming more self-centered, and lifestyle is becoming more materialistic, mechanical and monotonous. An urban kind of life has become a status symbol.

Spatial orientation and language The Hindi language contains a rich vocabulary of directional terms (see Appendix 2 for detailed examples). The villagers mostly use *uttar*, *dakshin*, *poorab*, and *paschim* (north, south, east, and west) in referring to objects and places in their environment. *Baayen*, *daayen*, *saamane*, and *peechhe* (left, right, front, and back) are used very rarely. Even inside a house, people refer to various rooms by using terms that indicate cardinal directions (e.g. "the table in the eastern room"). Thus, the geocentric terms are not only used in describing distant features of the surroundings, but also proximal features. LRFB terms are sometimes used to refer to the location of objects which are either part of one's body (e.g. "the glass is in the right hand"), or placed close to one's body (e.g. "the ball is just in front of you on the ground"). Children are socialized from early childhood to make a distinction between right and left hands. The use of the right (socially accepted) hand for purposes like eating, drinking and writing is greatly emphasized.

Geocentric (NSEW) terms have functional value for the society, because many activities are oriented to specific directions. For example, south is believed to be an inauspicious direction (the abode of the God of death, called *Yama*). Hence, facing south is avoided while eating food, engaging in religious activities, orienting a table or desk for study, during excretory behaviors, and sleeping with the legs oriented to south, and so on.

Verbal interactions in the community also involve the frequent use of conventional landmarks (e.g. towards the orchard, pond, road, temple, etc.), which are known to all people of the village and complement the geocentric system. Interaction with young children in restricted settings (e.g. in a room) may also involve reference to local environmental features (e.g. towards the door, wall, window, chair, etc.).

How did we come to work in this village? About a decade ago, one of the authors (Ramesh Mishra) had carried out a research project in which people from Roopchandpur and other villages were studied. He was fully familiar with the surroundings of these villages, and had maintained many acquaintances over these years. One of his doctoral students had collected some useful background information, including the language that was used in day-to-day communication about spatial location of objects both inside and outside the home.

Varanasi city

Situated in the northern part of India on the bank of the holy river Ganges, Varanasi represents one of the oldest living cities of the world. It has witnessed a continuous history of human population for the last 3,500 years. Often referred to as Benares, it has attracted students and scholars from all parts of

the country for the acquisition and dissemination of knowledge. According to Hindu scriptures, the city is situated on the "Trident" of Lord Shiva and is outside of the earth (even the non-Hindus hold that Varanasi is simply out of this world!). Lord Shiva and Goddess Parvati are said to have a permanent abode in this city, making it the ultimate spot of pilgrimage for Hindus for ages. It is also believed that the Ganges in Varanasi has the power of washing away all the sins accumulated in people's present and previous lives. Thus, everyone who is graced to die in Varanasi is granted salvation and freedom from the cycle of birth and re-birth. The belief is so strongly shared that even today several thousand people stay in the city waiting for their death.

Besides being a center of pilgrimage, Varanasi has also been regarded as a center of culture and civilization for more than 3,000 years. It has served as a center for the promotion of spiritualism, mysticism, yoga, music, dance, and other art forms for centuries. Hence, the city is called the "cultural capital of India."

According to the Census of India 2001, the population of Varanasi is 3.14 million of which 1.26 million live in the main city spread over an area of 120 square kilometers. A majority of the population (80 percent) consists of Hindus. Muslims represent about 16 percent of the total population, and the remaining 4 percent is represented by other groups (e.g. Christians). The literacy rate is a little above 66 percent, with male literacy rate (78 percent) higher than female literacy rate (55 percent). An average household consists of seven persons, and the sex ratio is 903 females per thousand males. During the period of 1991 to 2001, the population showed a growth of 25 percent, and approximately 30 percent of the population had migrated to the city, largely from the surrounding village areas, but also from other places.

In earlier times, Varanasi served as the center of Vedic education, philosophy and astrology (*jyotish*). Students and scholars from different parts of the country came to the holy city to learn and develop excellence in these fields of knowledge. A great tradition of Vedic astrology, called *jyotish shastra*, still continues in the city in a form called "*guru-shishya parampara*" (teacher-pupil tradition). This is evident not only in traditional schools situated in "*ashram*" or "*gurukul*" (teacher's family), but also in the modern universities, such as the Banaras Hindu University, in which these disciplines of knowledge form an integral part of the overall teaching program.

For centuries, Varanasi has been the center of Hindu religion and home to Indian philosophy, mysticism and spiritualism. Knowledge in these fields was developed and disseminated in commune-like organizations, called "*muth*" and "*ashram*." Different religious outfits have their own *muths* and *ashrams*, many of which have survived through centuries, and serve as centers of spiritualism and religious activities even today. Most of them also run a school in their premises where children from different parts of the country are admitted

at an early age for Sanskrit education. These schools have played a major role in preserving traditional Indian knowledge and culture even in the face of many challenges in the past as well as in modern times (Mishra & Vajpayee, 2008).

Yoga is a way of achieving balance and harmony of body, mind and emotions. Pursued through the practice of *asana* (physical exercise), *pranayama* (breathing exercise) and *mudra* (postures), it not only purifies the body and mind, but also prepares one for the practice of meditation and the experience of cosmic consciousness. A great tradition of yoga continues at Varanasi even today. While *ashrams* and *muths* serve as traditional centers of theoretical and practical knowledge, yoga also finds a place in the course curriculum of several modern institutions of learning (e.g. Banaras Hindu University).

Sanskrit is a classical language in which all traditional Indian knowledge is preserved. As such, it serves as an important symbol of Indian cultural tradition and thought. Through its "*guru-shishya parampara*" Varanasi has been able to preserve the Sanskrit language, which people in other parts of the world seem to consider a "dead" language. Varanasi has produced many great scholars of Sanskrit. A Sanskrit University was set up in this city to keep the traditional Sanskrit scholarship alive. Through cataloguing, translating and publishing ancient manuscripts, this university has contributed significantly to the development and growth of knowledge related to the Sanskrit language.

The long-standing tradition of education in Varanasi has given it the recognition of "*sarva vidya ki rajdhani*" (the capital of all knowledge). Since ancient times, people from different parts of the world have taken an interest in learning Sanskrit, philosophy, astrology, yoga, and many spiritual practices. To cater for the increasing educational needs of the people, several formal educational institutions were established in the city as early as the seventeenth century. At the present time, Varanasi has four universities for higher education; two of them are specialized in Sanskrit and Tibetan studies. One university of Arabic studies is waiting for its recognition from the state government. Some important traditions of education (e.g. oral tradition), which have suffered extinction in other parts of the country, are still preserved in Varanasi in their natural form, not only in Sanskrit schools, but also in Urdu schools where children commit the holy Quran to memory but also learn many other subjects.

Sanskrit schools The basic philosophy of Sanskrit education is simultaneous development of the physical, mental, psychic, and spiritual capacities of children. This can be achieved by knowledge not only about subjects like history, geography and mathematics, but also by physical and mental exercises, practice of rituals, meditation, and yoga. The aim of these institutions is to provide children with an ideal education of *Gurukul* (an ancient institution of education) that allows them to fulfill various responsibilities of family

life, living the life of a true Brahmin. The message is that the world is the best teacher, and one should not renounce the world in search of a supernatural life or the realization of the supreme God. On the other hand, if someone has a calling towards renunciation, s/he can opt for that life with the permission of teachers and parents. Thus, one can find in these schools students who study together, but live a life detached from worldly affairs. They learn Sanskrit to study Vedas, religious scriptures, and other books for self analysis and self correction. Observing *sadachara* (moral behavior), and self-imposed restrictions on physical, mental and verbal behaviors, they divert their energies to the attainment of an eternal state of bliss, called *sachchidanand*.

Most parents today want their children to attend modern kinds of schools. Those who cannot afford the cost of education in modern schools send their children to Sanskrit schools (see Mishra & Vajpayee, 2008). Thus, choosing Sanskrit schools may be linked to a variety of motivations other than the real attainment of knowledge.

Recent developments The processes of urbanization and industrialization going on in the country as a whole have not spared Varanasi. During the last few decades a number of changes have taken place in the city. A major change is witnessed in the composition of its population. The availability of wage employment, both in government and in the private sector, has attracted a large number of people from neighboring villages as well as from far-off places. The uncontrolled flow of people into the city has resulted in a kind of population explosion during the last three decades. Because of its religious and spiritual importance the central part of the city has been overpopulated for a long time. The new immigrants have found places for settlement largely towards the periphery of the city. This has resulted in the expansion of the city into areas that were characterized as villages in earlier decades. The new settlements have opened up some scope for local business, but the main economy of the city still remains in the control of people inhabiting the center of Varanasi. This attracts a huge population into the main city both for small-scale and whole-sale trades. The narrow streets of the city cannot accommodate the flow of the population. On festival days and ceremonial occasions movement into the city is almost impossible.

The interaction of immigrants with members of local populations has generated a kind of "hybrid" culture in the city. While life in the main city along the holy Ganges is still characterized by age-old tradition, other parts of the city have shown the signs of development witnessed in any other metropolitan city of India. Knowledge of the English language is now regarded as a chief indicator of the level of an individual's development and also of family status. Hence, a large number of private English schools (nursery, primary, secondary) and colleges have been established in all corners of the city. The

new English schools promise an education that, in the phase of globalization, can link a child to the new upcoming market economy. There are also many schools run by the state-level government that offer education patterned mainly on the Western model of education, but carried out through instruction in the Hindi language. Hence they are sometimes called Hindi-medium schools.

Spatial orientation and language in the city In traditional Sanskrit scriptures one can find evidence for the existence of both geocentric (NSEW) as well as egocentric (LRFB) spatial reference frames. All children are expected to master both these systems during the early years of their development. The egocentric reference frame is mainly used in situations when objects and locations are situated within easy reach of one's body. It is important in several day-to-day activities. For example, food has to be eaten with the right hand. Hence, children are deliberately taught to make a distinction between right and left hands quite early in life.

For Hindus this distinction is also important in several other activities, such as offering a glass of water or a cup of tea to a guest or to someone in the family (the right hand is to be used), or moving around an elderly person in the family, or deities in a temple. On the other hand, there are several activities (e.g. eating, sleeping, worshipping, reciting holy scriptures, orienting a table for study, etc.) in which south has to be clearly identified and strictly avoided. Children build up these knowledge systems quite early in life with active support from parents, peers and significant others in their family or neighborhood.

These distinctions are also important for Muslim children (Mishra & Jha, 2006). For example, west is considered to be the most auspicious direction by the Muslim society. Hence, the Muslims have a special respect for this direction. They orient themselves to the west not only for daily prayers (*namaz*), but also for a number of other purposes. There is a general preference for having the main door of the house facing the west, and people avoid having washrooms oriented in that direction within the house complex. Sleeping arrangements are generally made in such a manner that the head is oriented to the north and the face to the west. Many rituals are also organized in the community (e.g. marriage) in which cardinal directions have to be strictly observed. The weavers set up their looms oriented to the west. Thus, in the larger local usage in Varanasi, it is the geocentric system that is dominant over the egocentric orientation system.

As children start moving through the streets on their own, they begin to learn to use left and right for wider purposes. For example, while biking they learn to keep to the left, and to overtake on the right (as per traffic rules). When they make errors they are often corrected by older bystanders. The city is characterized by the existence of narrow lanes and a large number of alleys. These not only restrict one's visual field, but also do not provide access to the sun or any

clearly distinguishable landmarks (e.g. trees) for orienting oneself in space in a geocentric manner. Managing movement through such lanes with reference to left and right appears to be quite functional for day-to-day negotiation of life. Hence, children gradually acquire this spatial frame of reference as a convenient device to organize everyday movement.

This is also more or less true for those children whose families have migrated to the city from villages characterized by the dominant use of the geocentric system (see the description of Roopchandpur). When these children start moving into the city for various purposes, they seem to find the use of the geocentric system not only difficult, but also less useful in the local context. Orienting in an egocentric manner seems to bear greater functionality in the context of the city life than in the village. The acquisition of the egocentric system, however, does not replace their previously existing geocentric orientation system. Instead, both of them seem to coexist in the cognitive repertoire of the child, and are used in a selective manner depending on their suitability and functionality in different contexts.

While the main city dwellers can be characterized as having both geocentric and egocentric systems in their cognitive repertoire, the migrant children learn the latter over the years as they negotiate life in the city. Those who attend a Sanskrit school seem to have a strong base in the geocentric system from their village background. The great importance attached to the knowledge of cardinal directions in the learning environment and day-to-day life of Sanskrit schools reinforces the use of this system. Children in these schools are taught about ten cardinal directions along with their cultural significance. This orientation system is illustrated in Figure 3.3. In addition to the eight named cardinal directions, the Sanskrit orientation system also includes *urdhva* (up) and *adhar* (down) that are not shown in this drawing.

Sanskrit-school pupils are not only taught about the ten cardinal directions along with their cultural significance, they are made to use the geocentric orientation system in their day-to-day practice (e.g. in morning and evening prayers). The teachers or the senior peers of the school also teach them certain tricks through which errors in the judgment of cardinal directions can be guarded against. Skillful use of certain locally salient cues (e.g. the main gate of the school, the location of street, noises, etc.) is one of these. In new locations, attention to the orientation of temples, their deities and other markers can facilitate their directional understanding. For example, in a Shiva temple, the statue is oriented to the north, which is also underlined by the presence of another statue of a bull outside the main hall of the temple. Other temples are also characterized by specific spatial orientations not only of its deities, but also of other arrangements within and outside the temple premises. Certain kinds of trees planted around houses also carry highly accurate information about directions. While walking around with their teachers or classmates, Sanskrit-school

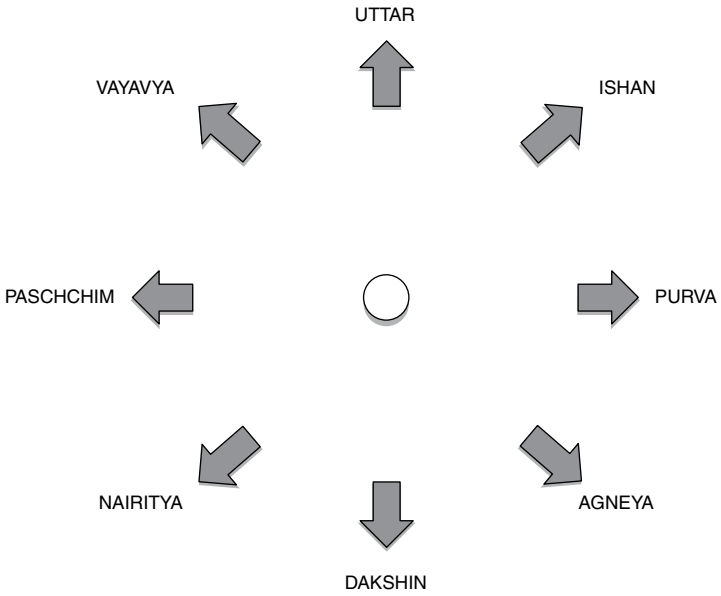


Figure 3.3 Sanskrit orientation system

children are taught the value of these environmental features, which they can use anywhere to know directions. Such reference points become a part of their cognitive structure that can differentiate among directions even in situations of limited cue availability.

Panditpur

Panditpur is a rural location in which we were told that egocentric language was the norm for spatial reference. The reasons for including this location are explained in chapter 8. It is a medium-size village located at a distance of 43 km from the district headquarters of Gorakhpur city, in the state of Uttar Pradesh. The total area of the village is approximately 707 acres, which also includes forests, orchards and ponds. The total population of the village is 5,700. Females constitute about 44 percent of the total population and children up to age 12 about 35 percent. The village has two primary schools (up to grade 5) and a junior high school (up to grade 8). There are also three private nursery schools that provide a kindergarten education, and admit children at the age of 4. Other schools admit children at the age of 6. A total of 766 children can be found in these schools.

The majority of the village population consists of Hindus, but there are also a few Muslim families. About 73 percent of the population is literate. People

usually speak "Bhojpuri" (a dialect of Hindi). The lifestyle of the village people is affected by urban contact. Motorbikes or scooters have brought a large number of people in daily contact with the city. Many people of the village have also migrated to cities for their earnings. The majority of the population lives from farming, growing sugarcane, wheat, gram, rice, potato, and peas as their main crops. The children and women also work in the fields. Children play a number of games that require some orientation to space. The older people use left, right and landmarks to refer to directions, but they also occasionally use standard cardinal directions.

Nepal

Nepal is a small country in the Himalayas, north of India, spread over an area of approximately 800 by 200 km, with clear divisions into mountain, hill and plain (*terai*) regions. The mountain region contains the highest mountains of the world (e.g. Mount Everest at 8,850 m). The hill region includes the mountains with altitudes between 1,000 and 4,000 m. Kathmandu Valley is a part of this region. Nepal had about 27 million inhabitants in 2004, with over sixty ethnic groups. Its official language is Nepali, spoken by about 11 million people.

Dolakha

In Nepal, the first study was carried out in the village of Bhimeshwor in Dolakha district, in the foothills of the Himalayas, chosen because the local orientation system was known to use the contrast "up" and "down," somewhat like in Bali but without the sea as a downstream reference, and without a named orthogonal axis for the transverse.

Dolakha is located about 135 km east of Kathmandu (the capital city of Nepal), to which it is connected by the Arniko highway leading to Tibet, and the Jiri (or Giri) road. Jiri, which is a major tourist destination of eastern Nepal, is about 55 km away from Dolakha, on the route to Mount Everest.

Bhimeshwor municipality

Bhimeshwor municipality gets its name from a famous temple, linked to Bhimsen, an important character of Mahabharat, the great epic of Hindu mythology. Bhimeshwor is set within a rocky landscape with small terraces. In clear weather, the great Rowaling Himalayan ranges can be seen.

A number of other small settlements also exist, which are scattered on the slopes with clusters of a few households, and can be approached only on foot through the trails running uphill and downhill. Bhimeshwor is a fairly old Newar

town characterized by a compact settlement. Most houses in Bhimeshwor municipality are constructed in traditional or semi-traditional style and generally have thatched roofs.

According to the Nepal census of 2001, the population of Bhimeshwor was 23,134. The population of children between 0 and 14 years was 5,347, consisting of 2,683 boys and 2,664 girls. Hindus accounted for 84 percent of the total population, followed by Buddhists. Bhimeshwor municipality is inhabited by a number of ethnic groups. The Chetry group constitutes about 36 percent of the total population, Newar 24 percent, Brahman 15 percent, and Tamang 11 percent. Several other groups are represented in the remaining population. About 74 percent of this population has Nepali as its mother tongue. Almost all Tamang and about half of the Newar have their own mother tongue (Tamang and Newari, respectively). However, Nepali as a language is fully understood (and also generally spoken well) by all who live in this area. Only in very remote areas can one find monolingual Newari or Tamang people. It may also be noted that the Newari language spoken in this area is a different dialect from the Newari language spoken in other parts of the country.

Nepali is an Indo-Iranian language, derived from Sanskrit like Hindi. Newari is a Tibeto-Burman language, although it has been influenced to a large extent by Nepali and Hindi. Both are written with the devanâgarî script.

Land and economy A remarkable feature of the land in Bhimeshwor is the difference between the lowest altitude (840 m above sea level) and the highest peaks (3,549 m). This has allowed a variety of lifestyles and types of flora and fauna to survive in the region. Agriculture constitutes the main economy of people (about 81 percent), followed by animal husbandry, small cottage industry, business, and government jobs. Bhimeshwor also has rich forest areas, which add significantly to its biodiversity and to the economic pursuits of the local people.

Education and health facilities With six high schools and a college established in the region, Bhimeshwor municipality can cater to the educational needs of children up to grade 12, but it lacks the facilities for higher and technical education. The college also faces severe constraints with respect to the number of teachers and teaching facilities. As a result, students have to move out of the area for higher studies, which is often not possible due to economic constraints. This is clearly reflected in the low percentage of students (3.6 percent) who go for higher education as against those who complete a high school level education (12.5 percent). About 11 percent represents the non-school-going population, characterized by approximately 65

percent of boys and 35 percent of girls. Very few children have highly educated parents; most of them have either a primary level of education or are illiterate.

Health facilities in this area are also limited. The municipality has a twelve-bed hospital, one health center, one health post, and two sub-health posts. There is also a separate hospital for patients suffering from epilepsy (established with Korean support).

Spatial language and orientation in Dolakha The mountainous terrain of Dolakha provides a landscape that can be clearly organized with reference to up and down. There is hardly anything that looks flat. The general view is either of the high-up mountains or the low-down valley between two mountains, with settlements of people at all levels. In the local language (Nepali), areas towards the mountains are referred to as "*unbho*" and those towards the valley are called "*undho*" (meaning uphill and downhill, respectively). Other expressions for the same landscape include "*matha pati*" (or "*matha tira*") and "*tala pati*" (or "*tala tira*"), literally meaning toward the head and toward the foot, respectively. The overall space is divided into these two broad domains, each covering a sector of 180°. Further divisions within this broad range are made by using local landmarks, which are commonly known to people.

From the beginning of life, children are exposed to this "up/down" spatial terminology in the home as well as outside. The "up/down" reference frame is used in the school setting as well, since the teachers are also versed in the same spatial terminology, and they find it easy to use when they refer to the location of objects in the surrounding environment. However, the school system also demands the learning of cardinal directions as an integral part of the curriculum. This learning is important for understanding the basic elements of geography, which are introduced at the level of grade 3 in the school. In later years, children are taught map-reading skills. Teachers spend a lot of time in schools providing children with this geocentric (NSEW) orientation. While it is easy for children to learn the names of cardinal directions, it is not so easy to apply them in dealing with the real space.

Our observations indicate that even teachers of the primary school had difficulty in pointing to actual cardinal directions. They seemed to have mastered the use of cardinal directions in the school setting particularly by linking each direction to some salient landmark(s) obviously visible from the school surroundings. Children were taught to use similar strategies to get to the cardinal directions. However, a little disorientation would bring them back to the spontaneous use of "up/down" which they had mastered from early childhood. Children seemed to use cardinal directions mainly when they considered the research situation as a "school test" in which the application of NSEW was necessary to achieve success. It was common to see children calculating the

cardinal directions on the basis of their initial "up/down" coding, which many times did not work out correctly.

Kathmandu city

Between the year 2000 and the beginning of our main study in 2002, the Dolakha region became a Maoist stronghold, and it would have been difficult to continue our field-work there. Our first intention was to find a location where the local population would be monolingual in a Tibeto-Burman language such as Sherpa, but this also proved to be too difficult. We therefore took advantage of the existence of English and Nepali schools in Kathmandu to carry out a study on bilingualism.

Kathmandu is the capital and largest city of Nepal, situated at 1,350 meters above sea level. According to the census of 2001, the total population of Kathmandu was approximately 700,000, with a male to female ratio of 114. The population of children between 5 and 14 years was 303,606. The population density was 2,739 persons per square kilometer. The majority of this population belongs to Newar, Brahmin and Kshetri groups, all of whom now speak the Nepali language, and follow either Hinduism or Buddhism. In the townships of Kathmandu, Patan and Bhaktapur, the Buddhist shrines (*stupas*) of Swayambhunath and Boudhanath, and the Hindu temples of Pashupatinath and Changu Narayan constitute the greatest attractions in the Kathmandu valley.

Kathmandu has been a place of attraction for foreign tourists over several decades mainly because of the magnificent view of several mountains of the great Himalayas and also the trekking opportunities it provides for visitors. For the local population, the value of the city from different points of view (economic, educational, health, general comforts) has attracted people from different parts of the country to settle there and engage in a variety of economic activities. The facilities of higher and technical education in the city have provided an additional attraction.

Schools in Kathmandu A large variety of schools, of different quality, exist in the city, such as Nepali and English schools, as well as some elementary Sanskrit schools. The value of English schools in terms of higher education and job opportunities has been recognized during the last few decades, and this has led to the establishment of several private English schools in the city. These schools are generally expensive and beyond the reach of common people; they attract children from relatively well-to-do families who can afford the cost of education in those schools. Children from ordinary families generally attend a Nepali school, which may be available within walking distance. Those in the English schools may be put on a school bus, or else the parents may transport them to the school on a motorbike or by car. Some

adolescent children may also be allowed to go on their own bicycle, but this is not a common practice.

In accordance with section 7(1) and (2) of the Education Act, 1971, "the language of instruction shall be Nepali in all schools, except that the subject of a particular language shall be taught in the same language." This provision is practically implemented in Nepali (government) schools, whereas private schools have been using mostly English as the language of instruction, except for the subject of Nepali language. English as a medium of instruction is seen as more prestigious, and more useful in terms of employment prospects. Hence it is preferred by the higher socio-economic status (SES) parents, who can afford it. In the city of Kathmandu, there are now more English than government schools.

The characteristics of the two streams are summarized in Table 3.1. This typology represents extremes, and there are, of course, schools that fall midline. All of the schools follow more or less the same basic curriculum, and all pupils are subjected to the same provincial exams in grades 5 and 8 and a national school leaving certificate in grade 10.

Spatial language and orientation in Kathmandu Kathmandu city is characterized by two distinct kinds of habitation. The older part of the city, which contains most of the markets, is heavily populated and has narrow lanes to walk through. The newer part is less populated, and has wide roads with many crossings organized in a grid pattern. In order to negotiate life through the city children are often told by parents about traffic rules that involve keeping track of left and right on the roads. On the other hand, they also learn to orient themselves with reference to cardinal directions (NSEW) in various culturally patterned and socially organized situations (e.g. visiting temples, participation in rituals). Children in high SES families have greater exposure to such situations than those from low socio-economic status families.

In view of the importance of cardinal directions in cultural and social life, and of left and right for day-to-day negotiation of life in the city environment, knowledge of both geocentric and egocentric orientations seems to be important for children in Kathmandu. This seems to be clearly attested by the inclusion of such lessons in children's school readers that aim to provide them with both frames of reference. For example, some lessons describe the route to a place by using LRFB, while others use NSEW. In both kinds of descriptions, there is also some use of landmarks. All basic readers starting from grade 2 in Nepali as well as English schools contain some lessons that aim at providing both geocentric and egocentric directional knowledge (see examples in Appendix 3).

Table 3.1. *Characteristics of English (private) and Nepali (government) schools*

Features	English (private schools)	Nepali (government schools)
Language used in school	Instruction is provided mostly in English, except in Nepali language class. Students are encouraged to speak English on school premises. Scolding or punishments are observed for those who use Nepali language.	Teaching is done through Nepali language, which is preferred even in English class. Students and teachers prefer Nepali language to communicate with each other.
Teachers	Convent-trained teachers are preferred. Teachers have good salaries.	Government-trained teachers are employed, and they are paid comparatively smaller salaries.
Curriculum and teaching methods	Attracts students and parents through different extra-curricular programs. Computer education, singing, dancing, sports, etc. are regular events.	Students engage only in basic instruction through lecture method. Events are organized only occasionally. Computer education is not yet available.
Class size	Classes have a maximum of 45 children.	Classes have no such boundaries. They may range up to 80 or 90 children.
Residential facilities	Most of the schools have residential facilities for their needy students.	There are no such facilities in any one of these schools.
Fees	Fees are based on internal rules and regulations. They are quite expensive.	School management committee decides the fee; usually very low.
Admission	Admission closes after a certain fixed time.	Admission depends upon the situation, and often remains open for the whole academic year.
Transportation	Usually schools have their own vehicle to bring students to schools.	No transport is available in any government school.
Management	Difficult to approach. Researchers are not welcomed easily. The system is scared of getting its internal affairs revealed.	Easily approachable. Researchers are welcome and teachers are willing to help. The system is flexible.
Publications and brochures	Attractive brochures. School publications are regular. Some even have a variety of magazines.	No brochures. Some have only an annual magazine, which is also not regular.
SES	The families have a higher level of SES. Parents take it as a matter of pride to have their children enrolled in these schools.	The families have a low level of SES. Parents have no choice of schools.

Geocentric reference in religious and cultural activities The presence of many temples and shrines in the Kathmandu valley creates a strong impression that its inhabitants are deeply influenced by different religious, spiritual and cultural traditions. They observe many rituals throughout the year by worshipping and offering prayers to hundreds of gods and goddesses. Some rituals are observed every day, while others are observed once a week, once a fortnight (*purnima*), once a month (*sankranti*), or once a year (e.g. on birthdays, or festivals like *Durgapuja, Deepawali*). There are still others that are observed occasionally (e.g. sacred thread ceremony, feeding ceremony, marriage ceremony). While daily rituals are quite personal, others are more of a social nature. In all these rituals, knowledge of cardinal directions occupies a prominent place.

For weekly prayers, there is a day fixed for a particular deity. For example, on Sundays the *God Sun* is worshipped. Monday is for *Lord Shiva*, Tuesday for *Ganesh* and *Hanuman*, Wednesday for *Kuldevata*, Thursday for *Bagalamukhi* and *Vishnu*, Friday for *Mahalakshmi, Santoshi Mata* and *Indrayani*, and Saturday for *Sani, Bhairav* and *Durga*. People visit the temples of these gods and goddesses, often with families, to offer prayers, especially on the days fixed for them. They also engage in regular prayers at home on a daily basis. All of these require orienting to a particular direction, which children informally learn from their parents.

The sun is granted a special place in the Nepalese culture. It is considered to be the God of intellect and wisdom. From a very young age, children are taught the directions of sunrise (east) and sunset (west). Therefore, east is identified as the most sacred direction. The morning prayer involves pouring some holy water (*jal*) on the ground while chanting holy verses (*mantra*) and facing the sun. Children are also asked to set their desks so that they face the east during study. It is believed that the east is the purest direction, and that facing east during study improves one's intellectual capacities and generates wisdom. Sleeping arrangements are made in a manner such that the children's heads are oriented to the east. Children are taught the religious and other values (e.g. health related benefits) of east from childhood, to fix this direction in their minds.

In the Nepalese cultural tradition, north is considered the homeland of many gods, but especially of Shiva. In all temples, big or small, at home or outside, the statue of Shiva (*lingam*) is oriented to the north. Children experience it on a daily basis when they visit the temples of Shiva with parents, or even moving around alone. Orientation to the north is also interpreted by asking them not to sleep with their head oriented to that direction. It is explained to them that non-observance of this rule brings great harm or even an end to life.

South is believed to be the direction of *Yama*, the God of death. Most religious families (especially Brahmin) never cook or eat facing the south. Only death-related rituals are performed facing the south. Children from a very young age are told about this direction, and they are never allowed to eat facing

the south, or sleep with legs oriented to the south (only dead bodies have legs oriented to the south).

Many other rituals are part of the Nepalese, and especially the Newari, culture. To celebrate the achievement of an individual in the family (e.g. passing an examination with good grades, returning home from a long trip), families observe a ritual called *sagun.* The ritual involves offering the concerned individual a cup of alcohol, a boiled egg, a small fish, and some other things to eat. The person who receives the *sagun* always faces the east, while the person offering the *sagun* faces the west.

Dashain (also known as *Durga puja*), is an important annual festival that involves a number of rituals in which directions matter. During this period, all families organize a special worship in honor of the Goddess *Durga* with the help of a priest. In this ritual, the priest always has to face the east. The ritual also involves visiting *Durga* temples located at different places in which the directions again have to be observed. On the tenth day of this festival (known as *dashami*), a ritual called *Tika* is observed in which each person pays respect to his or her senior relatives, who reciprocate by putting a colored mark (*tika*) on the forehead of the young relative. During the ceremony, the elders must face the west, while the younger ones face the east.

Deepavali or *Tihar* is another important festival (the festival of lights) in which families worship various deities, again facing east in every case. On the last day, women pay respect to their brothers by putting on a *tika* and offering some gifts (usually sweets). In this ritual, the brother always faces the east, while the sister faces the west.

There are several other occasions in which the knowledge of directions and their use seems to be essential. Listening to *puran* (ancient scriptures) is one in which a Brahmin priest recites the *puran* facing the west, and the audience face either the north or the east. South is always avoided in this event. Such experiences provide children with valuable knowledge about directions.

Nowadays an ancient art called *vastu* has regained popularity in economically well-off families. It requires orienting rooms and also one's position in those rooms in certain directions in order to maximize the effectiveness of the place for different purposes. Elders enjoy sharing this knowledge with children. As a popular program on TV, *vastu* is playing a vital role in enhancing the knowledge of cardinal directions among old as well as young people.

Our visit to several families in Kathmandu indicated that parents of low SES families had a difficult time coping with many pressing problems of everyday life. These families struggled hard to fulfill their basic necessities for survival. They usually lived in a single room, which was used for all purposes such as eating, sleeping and study. The parents generally worked on daily wages. The elders would leave the house early in the morning without performing the daily rituals, therefore the children did not have the opportunity to observe and learn

them. Parents of lower SES in general did not observe rituals on a daily basis and did not take note of directions so strongly in their lives, and they generally did not talk with their children about the salience of these directions in day-to-day life.

Geneva, Switzerland

The decision to repeat our study in Geneva was motivated by the absence of developmental data for Western children on the particular tasks we were using. When presenting our results from the 1994 study in Bali, and subsequently of the first study in India and Nepal, we often faced question: "What about European children? Are you sure they don't use a geocentric frame of reference?" Yes, in fact, we were quite sure, but had no data to prove it. One of us, having lived and raised children in Geneva, could be sure that he had never seen or heard anyone using geocentric references inside a building for table-top space. Of course, cardinal directions are used occasionally for driving, although not as much as in the United States, or possibly in the polders of Holland, and for map reading when trekking in the mountains. Several buildings of the University of Geneva are even organized according to geocentric labels: "The Jura wing," in reference to the mountains in the west, for example. "On the lake side" can also be heard. But these references are never used to describe the location of objects within a room.

To our knowledge, only Pascale Cottereau-Reiss (personal communication) had collected some data with preschool children in France, but the results were anecdotal and unpublished. Troadec (2007) carried out studies in France using encoding tasks such as Chips, but his instructions always guided answers towards either an egocentric or an allocentric frame (landmarks), and he did not collect data on individual spontaneous spatial language. So, a replication of our study in Geneva was certainly in order, even though the topic seemed rather esoteric to the school authorities who had to give us access to a school.

The school that was allocated to us for this study is situated in a part of Geneva with a large migrant population. Overall, in the Geneva area, 43 percent of the pupils have a language other than French as their so-called mother tongue. However, most of them were either born in Geneva or moved to Geneva early enough to have learned French. Teaching is exclusively in French, with the exception of some language awareness classes in which the children's attention is drawn to the existence of different languages and scripts (Hawkins, 1987; Perregaux, de Goumoëns, Jeannot, & de Pietro, 2003). German as a foreign language is taught starting in grade 4. There are also some extra-curricular language and culture classes organized by the migrant communities (or their embassies), for the exclusive use of their own children.

It so happened that the school where we did our study was in a part of town where migrants represented more than the average 43 percent, and it was in fact quite difficult to find enough monolingual French-speaking children so as to balance the design for age and gender.

Now that we have presented the methods in chapter 2 and the settings in this chapter, it is time to move on to the actual research. Details about sample characteristics will be presented in each case. Chapter 4 starts with presenting the research that was carried out some years ago. Even though most of the results have been published in separate articles, it is worthwhile bringing the major findings and conclusion together, since these are the basis for our main study, which is presented in chapters 5 to 9 with one chapter for each location.

Part II

Results

4 Pilot study in Bali and first study (India and Nepal, 1999–2000)

In this chapter, we present the results of the study carried out in Bali in 1994 (Wassmann & Dasen, 1996, 1998, 2006) and the subsequent research in India and Nepal in 1999–2000. Most of these results have already been published in various papers. Mishra, Dasen, and Niraula (2003) is an overview of the first study, with a focus on the ecological factor. The urban/rural comparison is presented in detail in Mishra and Dasen (2005) and the comparison of schooled and unschooled children in Dasen, Mishra, and Niraula (2004). Focusing on the study in Nepal is the paper by Niraula, Mishra, and Dasen (2004). Here we extract from these publications a summary of the results, with some comments showing links to the main study. For some of the computations, we take advantage of statistical procedures, such as Princals optimal scaling, that were not available to us in these first studies, but that we use for the main study. We also present a few aspects that have not been published earlier.

Bali, 1994

In Bali, Wassmann and Dasen discovered the existence of a geocentric FoR for the first time, so we spent a lot of time on ethnographic observations, for example on the way the Balinese orientation system (KKKK) is precisely used in various locations (see Figure 3.2). It will be recalled from chapter 3 that the Balinese system consists of two orthogonal axes, one being *kaja–kelod,* "to the mountain/upstream – to the sea/downstream," and the named transverse, *kangin–kauh* (the translation of which is controversial, as discussed in chapter 3). According to our observations, the system is truly used in an abstract, geocentric way.

The two researchers agreed on the principle that psychological research with "induced situations" should be carried out only after acquiring a good knowledge of what people say and what they do (and, quite often, of how what they do differs from what they say). Wassmann had done a lot of this ethnographic background research before Dasen joined him for field-work, including collecting spatial language through MPI space games with twelve pairs of children (7 to 15 years) and eleven pairs of adults in the remote rural location in

the north-east of Bali, and six pairs in the more urbanized south. The data on language use (Wassmann & Dasen, 1998, Table 1, p. 696) showed that in the rural location, spatial descriptions are either completely geocentric (KKKK) or a mix of intrinsic and geocentric. Only in a very few cases did some adults mix in a few egocentric words (like *kebot*, left), but these were never used in isolation. Children did not produce a single egocentric word; the 7–9 year olds used purely geocentric terms, the older group mixed in intrinsic descriptors (such as *disamping*, next to)[1] on half of the items. The few adults tested in a more urbanized area in south Bali mixed intrinsic with geocentric terms, and, in 36 percent of the items, also used egocentric terms.

In terms of language development, these observations indicated that in rural Bali, the geocentric FoR was the first one to be used. This was confirmed by a few additional very young children; even for an object held in the hand, they never used left and right, but always geocentric directions (e.g. "the stick in my upstream hand"). Intrinsic references appeared only later, and egocentric ones only with acculturation (in the more urban south, where there was more contact with the national language, Indonesian, and possibly with English). In sum, the sequence geocentric – intrinsic – egocentric in language gave a first hint that there might be a "reversal" of the "normal" (Western) stages.

We then turned to the two non-verbal encoding tasks, Animals and Steve's Maze. These tasks have been described in chapter 2. The sample characteristics are provided in Table 4.1.

The results are presented in Table 4.2 as average "R-A gradients," i.e. the proportion of items (out of 5) for which a geocentric encoding was used (multiplied by 100).

On the Animals task, the majority of subjects displayed systematically geocentric encoding, and none showed systematically egocentric reactions. In the case of the Maze test, only one quarter of the subjects reacted systematically in a geocentric style, while the majority mixed geocentric and egocentric choices. Another quarter of the subjects made systematically egocentric choices. This result gave a first indication of "task specificity," i.e. the fact that different testing situations can lead to quite different results. This is a very important point, because it shows that an individual does not use a particular encoding system systematically in whatever situation.

Children aged between 4 and 5 years gave systematically geocentric answers on the Animals task (Steve's Maze was too difficult for them to understand), which corresponded closely to the completely geocentric language they used. Some increase in egocentric answers with age was noticeable (a decrease in R-A gradient), an age trend which we over-interpreted at the time, thinking that it might represent a "reversal" between the geocentric/Euclidean and

[1] We assimilate such topological descriptors to intrinsic ones.

Table 4.1. *Sample characteristics of study in Bali, 1994*

Age groups	4–5	6–8	9–11	12–14 + adults	Total
N	9	8	7	14	38

Table 4.2. *R-A gradients on spatial encoding tasks in Bali by age group*

Age groups	N	Animals	Steve's Maze
4–5	9	96	—
6–8	8	80	58
9–11	7	73	58
12 –14 + adults	14	86	49
Total	38		

egocentric/projective spatial references. In fact, this age trend proves not to be statistically significant, but we did not calculate any inferential statistics at the time. We were also quite careful to say that this "reversal" would have to be confirmed by using different methods:

> It would thus be interesting to continue the research in this cultural context in order to determine if, by using tasks adapted from these theories of Western origin, we would really find a reversal of the developmental sequence described for Western children. Our research does not enable us to answer this question; indeed, the early utilization of an absolute system of directional axes does not necessarily mean that these young children could solve problems involving a system of Euclidean co-ordinates. (Wassmann & Dasen, 1998, p. 706)

The big difference in results between the two tasks led to a task analysis, for which we also used verbal introspections obtained on the fifth trial. The fact that a test is non-verbal does not necessarily mean that it does not function with linguistic coding. The Animals task certainly has a higher tendency to promote this form of coding, in the form of sentences of the type "they all look towards *kaja*." This linguistic strategy is much less applicable to Steve's Maze, where the configurations seem more likely to be encoded iconically. On this test, even the subjects who gave mainly geocentric answers claimed to have memorized the image of a route, sometimes describing its shape ("like the letter U," "like a belly whose curve faces *kauh*"). Those who gave egocentric answers talked of following the route, e.g. from right to left. An adult who made five egocentric choices stated "I remember the shape; the route goes from left to right; one cannot describe it with *kaja–kelod*." On the Animals test, however, he had provided five geocentric answers.

In conclusion, Balinese informants have the possibility of using two systems of coding, just as the Balinese language allows for a choice between egocentric and geocentric descriptors.[2] However, the preference for the geocentric system was evident, especially on Animals, for which a single word in the geocentric system is sufficient for coding the orientation of the display. An egocentric system of coding is chosen more often for Steve's Maze, which is more difficult to code verbally.

If one takes into account the two tests at the same time, only five subjects provided systematically geocentric answers. Consequently, it appears that in Bali all subjects, except possibly the younger ones, can indeed "choose," or be led by the task's demands or the experimenter's instructions, to use one FoR or the other.

Flexibility in spatial encoding

The layout of the tables for the non-verbal encoding tasks might have favored geocentric answers, since everything (the subject and the object) was ordered according to the main directions of the geocentric system. We therefore decided to introduce some changes in a second part of the experiment. After six or seven weeks, we repeated the experiment with twenty-seven of the same subjects, but with some modifications meant to induce the opposite type of encoding from the one the subjects had used spontaneously. For example, to influence egocentric encoding we used egocentric referents in the instructions ("all animals look to the right"; "the pathway moves away from you, and then turns right"). Also, the two tables were moved by 30° in relation to the *kaja–kelod* axis, and the object on the table was put on an angle of 30° in relation to the borders of the table.

Table 4.3 presents the number of subjects who changed, as well as those who did not change. To be considered a change, a difference in encoding had to occur on at least two items.

We observed that, for Animals, a third of the subjects changed the type of response, seven from geocentric to egocentric encoding, and two in the opposite direction. The young children stayed with geocentric answers in spite of changes in the instructions and display, while about half of the older children and adults changed their type of answer; this difference between age groups is statistically significant (Fisher-Yates, $p < .05$). The same age trend is visible on Steve's Maze, for which more than half of the subjects changed their type of response (about equally in both directions): the very young children displayed

[2] In retrospect, it is interesting to note that at the time, we did not think of linking the language and encoding data at the individual level (even though we had both sets for most of the subjects), but in fact the question did not arise, since there was no variation (no use of the egocentric FoR) in the children's language data.

Table 4.3. *Changes of answers between first and second session (N = 27)*

	Animals		Steve's Maze	
Age	Change (2 items or more)	No change	Change (2 items or more)	No change
6–8	0	8	2	6
9–11	4	4	4	4
12–14 + adults	5	6	9	2
Total	9	18	15	12

lack of flexibility, while half of the older children changed, as well as most adults; the difference is statistically significant between the younger group and the adults (Fisher-Yates, $p < .025$).

The fact that older children changed their encoding more in response to experimental prompting while younger ones stuck to geocentric answers reinforces the idea of a developmental change, not so much from geocentric to more egocentric, but a change towards more flexibility. However, as we will see shortly, this hypothesis will not be confirmed in the data collected in India and Nepal.

From this first pilot study, we could derive the following conclusions:

- in Bali, the geocentric FoR appears early (as early as 4 years) in both language and cognition;
- it is not a stable feature of individuals, who have the "choice" of using an egocentric FoR if prompted by non-verbal task demands (Steve's Maze vs. Animals);
- with increasing age, and/or schooling, and/or[3] contact with an egocentric language (schooling in Indonesian), the choice of frames may become more flexible (greater likelihood of using an egocentric FoR);
- there may be a rural/urban difference in the use of a geocentric FoR (tested in the pilot study for language only).

India and Nepal: first study (1999–2000)

In India, the research took place in the village of Roopchandpur near Varanasi, and in Varanasi itself, and in Nepal in the rural district of Dolakha. The locations are described in chapter 3, the sample characteristics are described in Table 4.4. In each of these locations, we were able to stratify the samples not

[3] The design of the pilot study did not allow us to untangle these confounded variables.

Table 4.4. *Design, and number of children in each sample in India and Nepal, first study (1999–2000)*

Age groups	India, village (Roopchandpur)				India, city (Varanasi)				Nepal (Dolakha)			
	No school		School		No school		School		No school		School	
	girls	boys	girls	boys	girls	boys	girls	boys	girls	boys	girls	boys
4–5	4	5	12	11	—	—	16	16	—	—	15	17
6–8	16	14	10	13	12	13	13	12	12	12	12	12
9–11	12	13	13	16	12	12	12	12	13	12	12	12
12–14	12	11	14	15	12	12	12	12	11	12	11	13
Total	44	43	49	55	36	37	53	52	36	36	50	54
				191				178				176

only to have an equal number of boys and girls, but also an equal number of schooled and completely unschooled children. We were keen to include unschooled children because of the confound we had witnessed in the Bali pilot study between chronological age and schooling, the latter bringing with it the learning of Indonesian. Note, however, that in India and Nepal, in the public school systems, teaching is done in the local national language (Hindi, Nepali), while in Bali the language of instruction was not Balinese but Indonesian.[4]

Generally speaking, chronological age and years of schooling are confounded in the vast majority of studies in developmental psychology, since in all of Europe and North America, and increasingly in most of the majority world, all normal children are schooled, and since they start school at the same age, there is no way to disentangle these two variables. It is therefore possible that many "developmental" effects attributed to ontogeny (and particularly to maturation) are in fact linked to schooling. In this respect, cross-cultural studies can serve as a "natural laboratory," in so-called quasi-experimental research, to unconfound such factors (see Segall *et al.*, 1999, pp. 51ff). This research strategy is "quasi-experimental" because subjects cannot be attributed to "conditions" on a random basis by the experimenter, as would be the rule for a controlled experiment. Because the groups are predetermined by the socio-economic and cultural conditions, there may be several concomitant variables that have to be taken into account. What are the reasons why some children are schooled and some are not? Is it a matter of wealth? – in which case we would have a confound with socio-economic status – or gender, family size, distance to school, or whatever? And if any differences are found, could they be explained by any of these extraneous variables?

Still another problem of testing the effects of schooling is the fact that the very testing situation – interacting with strange adults, who are asking questions for which they seem to know the answer; having to solve "problems" even though they are presented as "games," etc. – is very much like what happens normally at school. Therefore, schooled children may find the testing situation more familiar, be less estranged, and, hence, more able to apply their cognitive competence without any hindrance.

In discussions of the cognitive effects of schooling, Segall *et al.* (1999, pp. 119–120) and Mishra and Dasen (2004) proposed the following alternatives:

1. Schooling produces new cognitive processes.

2a. Schooling promotes the generalization of existing processes to a large array of contexts, including new and unfamiliar ones;

2b. Schooling promotes different cognitive styles (e.g. theoretic vs. empiric).

[4] This is why, in the main study, we will include a sample of Nepalese children taught in English.

3a. Schooling produces only superficial effects that result from positive test-taking attitudes and ease in test situations ("test sophistication effect" or "test acculturation effect," i.e. artefact);
3b. Schooling produces school-specific skills that are therefore likely to show up only in school-like experimental studies.

The methodological artefacts discussed above correspond to hypothesis 3a. Since we were quite aware of these various likely difficulties, we pre-tested all our tasks with unschooled children, making sure that they had no problem understanding the instructions. We always include a long training session for each of the tasks, we avoid any idea of timing, of having to work fast, and any indication that there might be right and wrong answers. As far as we could ascertain, at least in the rural areas, the decision to send a child to school or not is linked to a large number of conditions and events, of which a socio-economic differential is only a small part. Unschooled children are, of course, busier than their schooled peers with domestic, agricultural and herding tasks, and they spend more time with adult family members of the same sex (rather than one particular adult, the teacher). This provides them with a variety of daily experiences, some of which may be linked to developing spatial skills and learning the adult spatial orientation system. However, schooled children also get exposed to many such experiences, and furthermore, the orientation system of cardinal directions is taught explicitly in school (see Appendix 3).

We did not have any particular hypothesis linked to the effects of schooling. Among the hypotheses listed above, we favor the second one, either a) and/or b), and unlike several other researchers (see Mishra & Dasen, 2004), we do not think that schooling really produces new basic cognitive processes.

On the other hand, on the basis of the pilot study in Bali, and of the research by Pederson (1993) in south India, we were expecting a rural/urban difference, with more use of an egocentric FoR in the city. We think that a geocentric FoR is more functional in wide open spaces (such as desert areas, but also flat plains like those found in the Ganges valley near Varanasi), or when there is a clear slope to the land (like in Nepal, or the Tzeltal area in Chiapas, Mexico, studied by Brown and Levinson (1993), or steep islands like Bali). On the other hand, turning right and left is more common in city streets, where wider orientation cues, like the position of the sun, are often more difficult to ascertain.

This hypothesis goes counter to the analysis Majid *et al.* (2004) made of the data collected by the MPI group in twenty different languages. No relationship was found between the predominant linguistic FoR and ecological zone (alpine, desert, rainforest, savannah, etc.) or subsistence mode (hunting and gathering, shifting or stable agriculture, industrial). Majid *et al.* (2004, p. 112) conclude from their data that "None of the factors appears to determine the FoR, although there might be an association between urban-dwelling and use of an Egocentric FoR." We think that their data shows in fact quite a

Table 4.5. *Percentage of modal language use on combined tasks, by age group, in three locations*

	I	D	E	SL	CL	T*	U*	NSEW
India, village								
4–5	00	72	00	28	00	—	—	00
6–8	11	11	03	39	00	—	—	36
9–11	09	03	01	12	00	—	—	75
12–14	08	02	08	06	00	—	—	76
India, city								
	I	D	E	SL	CL	T*	U*	NSEW
4–5	03	82	01	14	00	—	—	00
6–8	14	14	18	29	00	—	—	25
9–11	10	06	28	16	00	—	—	40
12–14	06	05	55	04	00	—	—	30
Nepal, village								
	I	D	E	SL	CL	T*	U*	NSEW
4–5	03	82	01	14	00	00	00	00
6–8	05	11	04	18	14	08	32	08
9–11	02	06	02	09	09	11	39	22
12–14	01	04	04	04	09	12	39	27

* T and U are specific to Nepal.

convincing relationship! Among the twenty languages, there is only one case where an egocentric frame is the major one in a rural setting, and no single case where the geocentric frame is preferred in an urban one. It is difficult to calculate inferential statistics on so few cases, but we find the suggestion of a relationship rather striking. At least, it shows that the hypothesis is worth further testing.

Language development

In this study, we combined the data of the three language elicitation tasks by computing the proportions of spatial words in each category, compared to the total words recorded, and averaging these over the three tasks. The classification scheme for language use has been presented in chapter 2 (Table 2.1). The language category a child uses most frequently is called its modal language. The percentage of children in each modal language category is presented in Table 4.5 by age group for each location.

In all three samples, it is noticeable that the young children (4–5 years) use predominantly deictic (D), namely "this way" and "that way" usually

accompanied by a gesture of a finger or the whole hand. The status of this category is inherently indeterminate in terms of geocentric/egocentric encoding: it could be body related since a body movement is involved, and could mean "to the left/right," but the movement also points to a direction that is outside the display. The latter interpretation is reinforced by the fact that, in both samples in India, the very young children also use situational landmark (SL) references (i.e. outside the display, but within the room), a category that is still quite strong at age 6–8 but then disappears with age. So D could also be related to SL or to conventional landmarks (CL). In Nepal, some very young children already use "up/down" (U), which then increases with age, so it could even be geocentric. We examine the status of D more systematically in chapter 11.

The main difference in language use between the three samples occurs in the type of geocentric references used: in India, the children use NSEW as the main language category in the village, and to a large extent in the city. In Nepal, this is also used increasingly with age (mainly by schooled children), but less than the dominant "up/down" (for unschooled children the almost exclusive reference), and the lesser categories of landmarks (CL) and the Nepali word *terso* (T). This is a Nepali term that we found difficult to translate, used mainly by monolingual Nepali speakers in Dolakha to designate a direction along an uneven path going upwards; we place it in the geocentric group because it indicates a far direction and not a specific landmark.

This distinctive pattern of language use in these two locations makes sense in terms of the different ecologies. In the Ganges plain (India, village), the terrain is completely flat, there are no major features such as mountains or hills, and there are hardly any landmarks at all, except different fields or the occasional house or tree. In such ecological conditions, the use of NSEW based on the daily path of the sun (and reinforced by cultural and religious practices) is quite obviously adaptive. In the village in Nepal, on the other hand, the overwhelming reference is the slope: one constantly goes up or down! Because of the relief, landmarks (CL, such as prominent buildings like the temple or the hospital) are also more noticeable. Reference to landmarks allows one to give a more precise angle in a system where there are otherwise only two sectors of 180°. While CL occurs as a modal speech category only in Nepal, it does occur as a secondary spatial marker in India: when we re-tested outside (actually on the roof of a building) some of the children who had used predominantly SL inside a room systematically switched to CL.

In the city of Varanasi, what we get is a mixed pattern: it is the only location where "left/right" terms are current, and their use increases with age; in the older age group (12–14), egocentric is even slightly more frequent than geocentric language. This suggests a bimodal distribution, indicating that we might have two groups, with distinct preferences for the egocentric or geocentric frames of reference. The question arises as to which socio-demographic

factors might produce these two groups. For example, those using geocentric language might come from families that migrated to the city from a rural area, and continue to use geocentric references despite the change in environment. In this part of the study, we were not able to collect any background information that would enable us to test such a hypothesis.

In these three locations, children seem to learn the normative adult system and language progressively, and become competent in it by about the age of 9 years (i.e. later than what we had found in Bali). Before that (in the 6–8 year old group), they may attempt to use the adult system without being able to do it correctly (particularly in the case where cardinal directions have to be learned; in Nepal this learning is restricted to schooled children), or they use SL and, in Nepal (or for children in India, when testing is done outside), CL. Even younger children (4–5 years) tend to use D. To sum up, in these three locations in India and Nepal, the overall age trend in spatial language development seems to be from D at age 4–5, to SL and I at 6–8 (and CL, but in Nepal only); geocentric language starts at 6–8 and increases with age, except in the city, where E becomes more important.

It is difficult to compare these data to those of the pilot study in Bali, because there, systematic language data were collected starting only at 7 years, and no D, SL or CL were recorded. At this point of the research, we had only anecdotal evidence that geocentric language might start as early as age 4 in Bali, which is not the case in the locations of our study in India and Nepal, except that it might be masked by D.

It is also difficult to compare the data to those of Brown and Levinson (2008) on Tzeltal interactive games, since they do not use the same language categories as we do, and in particular they do not distinguish between SL and CL in their category of landmarks. For Tzeltal children, these two categories combined amount to 3 percent of the expressed language at age 5–7 up to 12 percent at age 14–16, altogether much less than we find for SL in each of our locations, and for CL in Nepal. Furthermore, they find a slight increase with age of landmarks, while we find that they are more frequent in younger than in older children (even though the age trend is not statistically significant). We therefore conclude, contrary to Brown and Levinson, that the use of SL (and CL where it occurs) is a stepping stone towards the geocentric FoR. However, we will see in Table 4.9 that SL tends to be negatively correlated with geocentric non-verbal encoding, more like E rather than G.

Non-verbal encoding

In this study, we systematically used three tasks, Animals, Chips and Steve's Maze, in the simple format (three animals, no 90° rotation, five items for each task); it was not possible to use Steve's Maze with the youngest age group. The

Table 4.6. *R-A gradients (and standard deviations) on spatial encoding tasks by age group in three locations*

	Age	Animals	Chips	Steve's Maze
India, village	4–5	73 (25)	50 (23)	—
	6–8	80 (19)	65 (21)	41 (19)
	9–11	90 (14)	70 (25)	51 (22)
	12–14	94 (13)	76 (25)	47 (22)
India, city	4–5	59 (25)	42 (26)	—
	6–8	68 (25)	46 (23)	39 (20)
	9–11	79 (26)	51 (30)	42 (23)
	12–14	75 (24)	53 (53)	40 (23)
Nepal, village	4–5	55 (25)	40 (29)	—
	6–8	75 (25)	57 (22)	47 (17)
	9–11	83 (18)	64 (24)	45 (17)
	12–14	88 (20)	71 (27)	43 (20)

results are computed in R-A gradients (proportion of geocentric items, counting distractors as .5); a gradient higher than .50 therefore indicates a preference for geocentric encoding, lower indicates that egocentric encoding is preferred. The results are presented in Table 4.6.

The three tasks differ consistently, with a similar pattern in the three samples. On the Animals tasks, most of the encoding is geocentric, even among the youngest children, and this proportion further increases over age. On the Chips task, a similar increase of geocentric encoding with age is noticeable, but at a slightly lower level. On Steve's Maze, there is almost no age trend, and there is a slight predominance of egocentric encoding.

In terms of our ecological hypothesis, we notice that there is overall a higher rate of geocentric encoding in the Indian village than in the city (despite the fact that the language, Hindi, is the same in these locations). We therefore consider that the ecological hypothesis is supported for both language production and non-verbal encoding.

In order to derive a single score for non-verbal encoding, a Princals optimal scaling procedure was performed,[5] using the R-A gradients for the three tasks. The results are displayed in Table 4.7. Object scores on dimension 1 can be used as a summary score. However, the Cronbach's alpha value is very low and only 42 percent of the variance is explained by this dimension. For most analyses, we will therefore treat the three tasks separately.

[5] This procedure has been described in chapter 2. We did not use this procedure at the time the first study was carried out and analyzed, and introduce it here because it will be used systematically in the main study. The component loadings on dimension 1 indicate how much each task contributes to the summary score. For all purposes we ignore dimension 2.

Table 4.7. *Princals results on three encoding tasks*

	Dimension 1	Dimension 2
Animals	.72	–.39
Chips	.78	–.07
Steve's Maze	.37	.91
Cronbach's alpha	.31	–.03
% Variance explained	42	33

The influence of schooling

Some of the differences between schooled and unschooled children have already been mentioned above; they concern mainly the village sample in Nepal, for which the details of the results are presented in Table 4.8. Remember that in rural Nepal, geocentric (G) language is represented by three categories, T (*terso*), U ("up/down") and NSEW (N).

The unschooled children tend to use U and CL more than the schooled children, while the latter use cardinal directions more often. This is due to the fact that cardinal directions are being taught at school in grade 2. For the schooled group, they tend to replace the more traditional "up/down" + landmarks system. In other words, the difference is in the kind of geocentric system that is used, and not in its overall importance compared to the egocentric FoR, which is basically absent in both groups.

In India, the only significant differences were found for the use of NSEW in the village (more frequent for schooled children; $p < .01$) and for E in the city (also used more in schooled children; $p < .05$).

For non-verbal encoding, the only significant difference was found for Chips in the rural sample in Nepal, where the schooled children produced more geocentric encoding.

All in all, we conclude that schooling has more impact on the choice of a FoR in language than for cognition, but overall the impact is not very important. For further research, it is a variable that can be left aside, especially since it is quite cumbersome to collect large samples of unschooled children (compared to the easy access provided by schools). On the other hand, it may be interesting to look at different kinds of schooling.[6]

However, while the age trends look quite systematic, they also fail to reach statistical significance on a multivariate ANOVA, except for NSEW language in the

[6] Mishra and Dasen (2004, p. 208) remark that "schooling is not a unitary process, but much depends on the amount, type and quality of schooling." And further: "The studies dealing with the quality or form of schooling emphasize the fact that schooling is a packaged variable that needs to be broken down into procedural components" (p. 218).

Table 4.8. *Categories of language used by schooled (S) and unschooled (NS) rural Nepalese children*

							Geocentric							
	E		SL		CL		T		U		NSEW		Other (D, I)	
Age groups	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S
6–8	01	06	15	17	15	09	05	10	39	21	02	13	23	24
9–11	02	02	09	07	10	07	12	09	46	28	08	35	13	12
12–14	01	05	02	04	12	03	16	05	44	30	16	33	09	20
p value					.03				.001		.000			

p values given for multivariate ANOVA.

Table 4.9. *Partial correlations between language and encoding (R-A gradients), controlling for age and years of schooling*

India, city					
	E	SL	Geocentric (N)	I	D
Animals	−.18*				
Chips	−.23**				−.20*
Steve's Maze	−.18*	.17*		.17*	
India, village					
	E	SL	Geocentric (N)	I	D
Animals		−.25**	.23**		
Chips		−.24**	.25**	−.19*	
Steve's Maze					
Nepal, village					
	E	SL & CL	Geocentric (N, U and T)	I	D
Animals					
Chips	−.25**		.31**		
Steve's Maze					
3 locations combined (N = 443)					
Encoding object score	−.35**	−.12**	.31**	−.11*	

Only statistically significant coefficients are reported: * $p < .05$; ** $p < .01$ (2-tailed).

two village samples and E in Varanasi, and for encoding on Animals and Chips in Nepal only. We therefore cannot claim that chronological age is more important than schooling as far as the choice of FoR is concerned; in fact, there is some impact of both of these variables, but not as massive as we might have thought.

Correlation between FoR in language and in cognition

In this study, we have language and non-verbal encoding data collected for the same subjects, and insofar as there is some variation in both, we can compute correlations between the two. Since age and years of schooling do have some effect on language and on encoding (and the use of the geocentric FoR tends to increase with both), we use partial correlations, controlling for these two variables. The results are presented in Table 4.9.

Generally speaking, the number of statistically significant correlation coefficients is surprisingly low. Those that do occur are, however, in the expected

Table 4.10. *Language used on encoding tasks. Geocentric and Egocentric encoding on items 4 and 5 of three tasks combined. Language categories as defined in chapter 2.*

		Language categories:								
		I	E	SL	CL	U	NSEW	D	Other	Total items
Encoding:										
Geocentric	N	139	140	307	70	185	726	14	101	1682
	%	5.4	5.5	12	2.7	7.2	28	0.5	3.9	
Egocentric	N	183	125	127	18	77	225	7	115	877
	%	7.1	4.9	4.9	0.7	3	8.8	0.3	4.5	
										2559

direction: negative correlations between E language and geocentric encoding, but positive correlations with G language. It is interesting to note that SL shows negative correlations with encoding on Animals and Chips in the village in India (and also with the summary measure if the three locations are combined); as discussed above, this is an indication that landmarks would be closer to E than to G (and hence, as expected in Piagetian theory, in the category of projective space).

From this we could conclude that the results are in favor of linguistic relativism, namely that there is a correspondence between language used and the encoding process. But things are not that simple. If we look at the data in more detail, we find several discrepancies.

For example, on the non-verbal encoding tasks, we asked the children to explain, on items 4 and 5 of each task, how they had remembered the display and recorded the language they used. Table 4.10 displays the correspondence between encoding and language used for these two items (all items and all Ss in the three locations combined).

Obviously, geocentric language (NSEW, U) tends to go with geocentric encoding, but it is also used in a number of cases (12 percent) to justify an egocentric encoding. In fact, an egocentric encoding is justified just as often using geocentric rather than egocentric language. Of course, this is not unexpected, since geocentric language is the dominant norm. Conversely, egocentric and intrinsic categories, although much less frequent, are used to justify both egocentric and geocentric encoding. In this case, SL and CL seem to go with geocentric encoding, which tempers the correlational finding described above.

It cannot be ruled out completely that some children, when they were asked to explain their non-verbal behavior ("how did you remember?"), took this question as an implicit criticism, and hence switched the FoR for their answer. This is why we asked this question on only the last two items of each task. It

Table 4.11. *Description on Perspectives task when moving around display by predominant spatial language used (6 to 14 year old children combined)*

	I	E	SL	CL	U	NSEW	D	Total
3 different descriptions	1 (0.2)	53 (12)	69 (15.5)	12 (2.7)	56 (12.7)	169 (38.3)	6 (1.4)	366
2 same descriptions	1 (0.2)	7 (1.6)	17 (3.9)		4 (0.9)	16 (3.6)	2 (0.5)	47
3 same descriptions			6 (1.4)		4 (0.9)	17 (3.9)	1 (0.2)	28
Total	2	60	92	12	64	202	9	441

is unlikely to have occurred often, first of all because the testing atmosphere was not one of school performance. Such a conscious switch of frame, if it did occur, would of course prove the point that the choice of frames is flexible.

Another discrepancy with the literature occurs on the Perspectives task. According to Levinson (2003), people who use geocentric spatial language should describe a figure/ground relationship using the same geocentric terms regardless of their position in relation to the display. In our study, we asked the children to move around the display of three objects of the Perspectives task, and to describe it from three different positions.

We compared the second and third descriptions to the first one. To be considered "the same," the descriptions had to be identical. A child could possibly use the same geocentric FoR of cardinal directions, but change the directions of reference (e.g. an object located north is now located west), in which case we count this as different. In other words, we are not looking at a change in overall FoR, but in the exact wording. The data are displayed in Table 4.11.

Only 6 percent (of 441 children for which these data are available) give the same description from all three positions, and another 11 percent for two of the positions. The majority of the children (83 percent) give three different descriptions for the three positions. Since the initial hypothesis is disconfirmed so strongly, it may be interesting to look at what the children say in more detail. First of all, is there a link between giving the same description and using geocentric spatial language? As we can see in the above table, those few children who do give three identical descriptions are using predominantly geocentric language (NSEW, U), but using such language does not imply giving the same descriptions. A more detailed analysis of this issue will be presented in chapter 12.

Looking at the data at the individual rather than at the group level, the relationship between language use and frame of encoding is certainly less than perfect. We have found that children may encode a situation with an egocentric frame, but when asked to explain how they did it, they use geocentric

language, which can easily be understood in terms of the dominant geocentric adult norm. But the reverse occurs also, i.e. the use of a geocentric mode of encoding explained with egocentric language, a more puzzling (but also less frequent) combination. That individuals say something but do something else, is of course a common problem in psychology when one deals with attitudes and values, but it seems also to be true in the cognitive domain.

Previous research (such as Wassmann & Dasen, 1998, and others by the MPI group) examined the relationship between language and spatial encoding only at the group level. A linguistic analysis shows that, in many of the societies that have been studied, a geocentric orientation system exists in the culture, is accompanied by a predominance of geocentric language, and goes with a strong trend towards geocentric encoding (hence, seemingly, a strong confirmation of linguistic relativism). In this study, we have been able to record the language used by each individual, and to relate: 1) the dominant language use for each individual to his or her encoding measured task by task; 2) the particular language used on particular items in relation to the encoding on the same items. With such an analysis at the individual level, the correspondence between language and encoding is much less impressive.

Another important question was whether the use of geocentric orientation systems and geocentric language would have an impact only on spatial encoding in situations (tasks) specifically geared to be sensitive to this feature, such as the tasks developed by the MPI group, or whether it would have an impact on spatial cognitive development at a more general level. To answer this question, we used a series of Piagetian tasks in the area of spatial concept development, which we present in the next section.

Spatial concept development

Piagetian tasks were used in age groups 6 to 14 in all three locations. The procedures and scoring of these tasks have been described in chapter 2.

Results The Piagetian tasks show, as could be expected, significant correlations with age (between .12 and .39, which is highly significant with an N of 449) and schooling (.14 to .39); the lowest of these correlations occur for the Perspectives and Route Memory complex path tasks, the highest with Rotation of Landscapes and Horizontality. In the following calculations, it is therefore important to partial out these two variables. Gender, on the other hand, showed no significant correlations with cognitive tasks (except .11* for Horizontality). The correlations among the cognitive tasks are presented in Table 4.12.

All correlations are highly significant, except with the Perspectives task, which shows no correlations with the other cognitive tasks (and no significant results in any of the analyses that were performed). While this task provided

Table 4.12. *Partial correlations among the Piagetian tasks, controlling for age and schooling*

	Perspectives	Rotation of Landscapes	Route Memory simple path	Route Memory complex path
Horizontality	−.04	.24***	.15***	.21***
Perspectives		.07	−.06	.03
Rotation			.22***	.26***
Route Memory Simple path				.53***

* p < .05, ** p < .01, *** p < .001.

an excellent setting for language production, the cognitive testing part involved fairly complex instructions and the selection of pictures. It was possibly inappropriate for most of our subjects, even though this was not obvious during testing. We therefore exclude this task from further computations. For Route Memory, the two forms of the task were combined into a single score, and proportional scores were derived for all the tasks.

In each of the locations, all three tasks show a significant increase with age, the strongest increase being found with Horizontality, the task most clearly linked to Euclidean space. Analysis of variance indicates a significant effect of age and schooling, and also a significant difference between locations for all tasks (except for village and city in India on Route Memory). The differences in mean scores follow the classical pattern of acculturation, the highest scores being found in the city sample.

Princals optimal scaling was performed with these scores, considered as ordinal scales. The model summary is displayed in Table 4.13. Dimension 1 explains 56 percent of the variance with a Cronbach's alpha of .61. Although this is not very high, it shows that the three Piagetian tasks do measure some common aspect of spatial concept development. Object scores on this first dimension are used as a summary measure in some of the following analyses.

Language and cognitive development

Is there a relationship between modal language use and cognitive performance? The results of correlations of the individual tasks with language are presented in Table 4.14.

The correlations between Piagetian concept development and language use show an interesting pattern that is quite coherent with the theory. First, despite the fact that age is controlled statistically, there are significant negative correlations with the categories of language that occur in the younger children: D

Table 4.13. *Princals analysis of Piagetian tasks*

	Dimension 1	Dimension 2
Rotation of landscapes	.81	−.18
Route Memory	.67	.73
Horizontality	.76	−.45
Cronbach's alpha	.61	−.46
% variance explained	56	26

Table 4.14. *Partial correlations, controlling for age and schooling, between the proportions of the different language categories and object scores on Piagetian cognitive tasks*

	India, city	India, village	Nepal, village	3 locations combined
I	−.21**			
E			.18*	.23**
SL	−.21**		−.32**	−.22**
CL				
U				
T				
NSEW		.29**	.23**	.13**
G (NSEW + U + T)		.23**		
D	−.27**		−.21**	−.17**
N	141	140	154	435

* $p < .05$, ** $p < .01$, only significant correlations are shown.

and SL (and I in Varanasi). On the other hand, the use of geocentric language (cardinal directions, NSEW) is correlated positively with the Piaget score, particularly in Nepal, where "up/down" (U) and *terso* (T) do not produce the same correlation. In Varanasi, this correlation does not reach the significance level, probably because the variance is shared with E, since both NSEW and E increase with age. This finding suggests a developmental pattern where children who are less advanced in spatial cognitive development (at any given age) also tend to use language typical of children younger than their age, and of course the opposite for children more advanced in conceptual development.

On the other hand, there seem to be virtually no relationships between the non-verbal encoding tasks and performance on cognitive tasks; the only significant positive correlations were found with the R-A gradient on Chips in the two villages but not in the city. So, contrary to the expectation that children

using geocentric encoding may have greater facility with the spatial cognitive developmental tasks, the link between encoding and spatial cognitive development is at best weak and inconsistent.

This finding is a further indication that language use and non-verbal encoding are different and separate processes. Although they may be strongly correlated when studied at the group level, at the individual level, the relationship is less stringent, and the two processes show different relationships to other aspects of cognitive development such as measured by Piagetian concrete operational tasks. Notably, the use of cardinal directions in language does seem to be related to overall spatial concept development, while geocentric encoding does not show any such relationship.

Flexibility in non-verbal encoding

In this study, we again re-tested the children with the Animals task, but using instructions that went against the frame they had chosen most often when they were first tested, and setting up the table alignment accordingly. The results are presented in Table 4.15 by age group and location. The same definition of "change" was used as previously, i.e. a change in two items or more.

Altogether, 24 percent of the children take the suggestion from the experimenter and change their frame of encoding, about half in each direction. The proportion of change is higher in the city (34 percent change) than in the villages, but no particular age trend is obvious. The hypothesis that children get more flexible with age is not confirmed in this study.

Background variables

As SES indicators, data on fathers' and mothers' education and fathers' occupation, as well as their contacts with media, were combined into an SES object score with a Princals optimal scaling data reduction procedure, giving the results presented in Table 4.16. Mothers' occupation and contact with the city for village children were also recorded, but showed too little variation to be useful.

The SES score presents a strong correlation to the children's schooling ($r = .56$ in India village, .50 in city, .45 in Nepal, all $p < .01$), which will be controlled statistically in the following analyses. If the samples of the three locations are combined ($N = 443$), SES is significantly correlated to Piagetian tasks (.13**), geocentric encoding (−.19**), geocentric language (−.22**), and egocentric language (.28**). If the samples are considered separately, the only significant correlations occur with G language in Nepal (−.27**) and geocentric encoding (−.30**) and E language (.17*) in the city of Varanasi.

Table 4.15. *Change in second administration of the Animals task, with induction*

Sample	Age groups	No change	To G	To E
India, village	**6–8**	44	1	8
	9–11	46	4	4
	12–14	44	6	2
	Total	134	11	14
India, city	**6–8**	32	6	12
	9–11	35	8	5
	12–14	30	11	7
	Total	97	25	24
Nepal, village	**6–8**	35	7	6
	9–11	41	4	4
	12–14	36	6	5
	Total	112	17	15
3 samples	**Total**	343	53	53

Table 4.16. *Princals analysis of SES score*

	Dimension 1	Dimension 2
Education father	.86	−.16
Education mother	.75	.14
Occupation father	.77	−.51
Media	.71	.59
Cronbach's alpha	.78	−.72
% variance explained	60	16

The data suggest that geocentric language and/or encoding may be less used in higher SES families, at least in some locations, while egocentric language is used more (at least in the city of Varanasi). Although they are not very systematic, these results indicate that SES should be considered as a variable worth investigating in future studies.

Summary of results

One of the assumptions in this study is that as cultural features of the groups, the spatial orientation system and the language that goes with it are adaptive to respective ecological settings. Thus, in the mountains of Nepal, where the obvious feature of the terrain is the slope, people refer to "up" and "down," and occasionally to local landmarks to describe objects in space. In the villages

in India, which are located in the flat plains of the Ganges, characterized by a complete absence of hills and very few obvious landmarks, the use of cardinal directions (NSEW) is the norm. In the city in India, which provides limited space and a highly congested setting with narrow lanes requiring left/right movements in walking, the use of egocentric (LRFB) terms predominates in language.

An analysis of the developmental trend reveals that children in these three locations learn the normative adult system and language progressively, and develop competence in it by the age of 9 years. Between 6 and 8 years, they may attempt to use the adult system without managing to employ it correctly (particularly in cases where cardinal directions have to be learnt; in rural Nepal this learning occurs mainly in school). They may also use what we have called "situational landmarks" (outside the display, but inside the room), or "conventional landmarks." Younger children tend to say "this way/ that way."

The analysis of the encoding of simple spatial arrays reveals that the children in the plains of India and mountains of Nepal generally do it in a geocentric rather than egocentric frame, which is congruent with the geocentric orientation systems that are prevalent in these locations. On the other hand, there is also evidence for "task specificity" in spatial encoding. More geocentric encoding is observed if the task can be easily coded in linguistic terms (e.g. Animals), whereas more egocentric encoding is evident if the task is more difficult to encode linguistically and easier to encode iconically (e.g. Steve's Maze). This result clearly shows that, in these populations, there is no overall linguistic determinant of a frame, but the two frames coexist in every individual, with the situation determining which frame is to be used preferentially. The overall relationship between language use and frame of encoding is found to be less than perfect.

Does a geocentric or an egocentric non-verbal encoding have any relationship with the cognitive performance of children? This question was addressed by analyzing the relationship of geocentric and egocentric encoding with performance on Piagetian tasks that assess spatial cognitive development at a more general level. The findings reveal no relationship between geocentric or egocentric spatial encoding and broader aspects of cognitive development. On the other hand, the data show some correlation between modal language use and some of the cognitive development tasks, even when the effects of age and schooling are partialed out. The overall developmental trend indicates slightly more egocentric encoding in young children, which is replaced by geocentric encoding in older children. This trend, however, is not reflected in the modal language use. Children almost never use egocentric language, except in the city, where it increases with age, while egocentric encoding decreases with age.

As a general conclusion, we still subscribe to what we wrote in 2003 (Mishra, Dasen, & Niraula, 2003, p. 379):

> It is not possible to distinguish language as a causal factor in relation to cognition, since it does not occur out of a more general cultural context, that is itself adaptive to the ecological context. An orientation system based on cardinal directions, such as it occurs in rural India, is completely congruent with the Hindu religion, and symbolism attached to it, as well as with daily routines and practices. The same, of course, was true of the previous research in Bali (Wassmann & Dasen, 1998). In other words, language comes as a package with other cultural features. …
>
> The results show that encoding is highly task specific, with more absolute encoding if the task can be easily coded in linguistic terms (e.g. Animals), and more relative encoding if the task is more difficult to encode linguistically and easier to encode iconically (Steve's Maze). This clearly shows that there is no overall linguistic determinant of a frame, but that the two frames coexist in every individual, with situational determinants as to which frame is used preferentially.

However, as we will see in the following chapters, we now have more data to substantiate the fact that both G language and encoding occur in a complex web of eco-cultural variables, and are variously linked to other cognitive processes.

Other developmental research carried out at the time or following our first study

While we were working on the project reported in this chapter, some other research was carried out using the MPI rotation paradigm with children. As part of a detailed linguistic study of Marquesan, Cablitz (2006) looked at language development and used the rotation paradigm, comparing the reactions of children in familiar and in unfamiliar surroundings. The Marquesan geocentric system is a typical Oceanic system with a sea–inland axis complemented by an undifferentiated orthogonal "across" axis. In familiar surroundings, children as young as 4 years of age used references to these geocentric axes in an adult fashion. In unfamiliar surroundings, on the other hand, they could not do so until the age of 8 or 9 years. To overcome the lack of dead reckoning when they move around unknown areas, their strategy was to rely on directly accessible environmental features such as landmarks or the actual slope of the hill. Some children below age 9 referred to the two axes as if they were overlapping (instead of orthogonal), which indicates that a Euclidean use of the system seems to start at about that age.

Following our research in Bali, Cottereau-Reiss (1999, 2001; Troadec, Martinot, & Cottereau-Reiss, 2002) carried out a study among the Kanak of New Caledonia. In the Paicî language group, on the east coast of the island, two main directional axes are used, both expressed as "up" and "down"; one axis refers to cardinal directions along the coast (north and south), the other to

the locally more contingent opposition land–sea. On a space game with a man and a tree, using toy objects, children (4 to 16 years; N = 80) did not use the complete orientation system, only the land–sea axis, and they did so correctly as early as age 4. They also used landmarks.[7] With increasing age, there was a decrease of these locally extrinsic features in favor of a slight increase in egocentric language (possibly due to schooling in French; adults never used egocentric language). Spatial encoding was found to be mainly geocentric on one of the non-verbal tasks (Animals) and egocentric on another (Steve's Maze). The age trend was an increase of geocentric encoding with age, from 65 percent geocentric encoding at age 4–6 to 90 percent in adults. If, on the Animals task, the children were asked to take the toy animals with them when moving to the second table, encoding became mainly egocentric (the display moves as part of the body, as it were). This research confirms that both language elicitation and spatial encoding are highly situation and task dependent.

Also inspired by our research in Bali, Troadec and Martinot (2001; Troadec, Martinot, & Cottereau-Reiss, 2002; summarized in Troadec, 2007) have used two of the non-verbal coding tasks in a study in Tahiti and France. Troadec first studied eighty-nine city children in Papeete, Tahiti, from age 5 to 13. These city children used mainly egocentric encoding on the Animals task; young children (5–6 years) did not change their encoding even when the researcher tried to encourage a geocentric encoding through the language used in the instructions, while older children (7–8 and 10–11) progressively switched to geocentric encoding when enticed to do so by the instructions.[8]

Troadec also used a task adapted from the MPI Chips on Moorea, a small rural island in French Polynesia, with ninety-six children from 5 to 11 years. Just as in Papeete, all children were tested in French and were attending schools based on the French system. More than 80 percent of the children used geocentric encoding, in all age groups, and whether real objects or pictorial material was used. Furthermore, even the older children resisted any induction in the instructions towards an egocentric frame. This is a strong indication that in French Polynesia, despite schooling in French, the geocentric system corresponds to a "real cultural preference" (Troadec, 2007, p. 143) in the rural areas but not in the city.

[7] Unfortunately, the author puts landmarks in the same category as the use of the land–sea axis. She remarks that it was often difficult to be sure about which reference system the children were really using, and some of the answers might even have been intrinsic ("up/down" on the display rather than in relation to the environment).

[8] This finding corresponds to what Wassmann and Dasen (1998) had found in Bali, namely a greater flexibility in older children to take a hint from the instructions to switch the frame they use (presumably to please the experimenter!). We tried to induce this change when testing the children a second time, while we always avoid any spatial language in our standard procedures; since Troadec always tried to induce one frame or the other in his instructions, his data are not really comparable to ours.

Troadec also included a sample of French children in a small town in France (N = 56, age 7 to 10). For what he calls geocentric instructions, he used the indication "towards the preschool" and "towards the courtyard," i.e. in fact landmarks. The younger children followed the encoding suggested by the experimenter's instructions, while older children gave systematically egocentric encoding, particularly girls. Hence, in this case, it seems that the younger children were more flexible than the older ones. The interesting result is that French children seem to learn the culturally preferred egocentric system relatively late. Troadec (2007, p. 153) concludes that the egocentric system "is not as 'natural' as theorists of development may have thought."

Two other French researchers, an anthropologist (Chamoux, 2001, 2004) and a psychologist (Tanon, 2001), have carried out a developmental study among Nahuatl Indians in Mexico. They found a tendency for children (N = 40, 5 to 14 years) to use mainly intrinsic spatial terms, while adults tended to use names of towns to indicate directions. Only very few egocentric ("left/right") references were produced, and this was only by older children, which could be due to the impact of schooling in Spanish. On the non-verbal MPI tasks, the authors found an increase with age of geocentric encoding on the Animals task, and a curvilinear relationship (an initial increase of geocentric encoding followed by a decrease) on Chips and Steve's Maze. This could also be due to the influence of schooling in Spanish. There was more egocentric encoding on Steve's Maze than on other tasks.

Also in Mexico but in the Yucatan peninsula (Quintana Roo), Le Guen (2006) presents a detailed study of language development and non-verbal encoding with three MPI tasks (Animals, Chips and Maze recognition) among forty-one children from 5 to 14 years and fifteen adults. He found that the language was mainly intrinsic, and encoding mainly geocentric. However, Le Guen (2009) shows convincingly that adults were really using a geocentric system in their gestures despite not using geocentric language.

In some of these studies, there is a possible confound between geocentric and intrinsic non-verbal answers: the subjects could have taken intrinsic references (such as the table edge) to produce what might look like geocentric answers. As we mentioned in chapter 2, this is why we have introduced some modifications to the Animals and Chips tasks, particularly using a 90° rotation in addition to the 180° rotation (cf. Levinson, 2003, p. 204).

Wassmann (2001) followed up on his earlier work on spatial concepts among the Yupno in Papua New Guinea (Wassmann, 1997) by using some non-verbal encoding tasks. Encoding on the Animals task was predominantly geocentric, while the language used on this task was often egocentric, which shows the importance of assessing language and encoding in the same situation. The use of Steve's Maze proved to be difficult with this population. Polit (2001) reports a study on Kai island in the Moluccan archipelago, and with Kai immigrants in the Netherlands. While they use a symbolic "up/down" system

on the island (somewhat similar to the one reported from New Caledonia and the Marquesas), the migrants in the Netherlands, even when interviewed in their own language, use a system of place names. Spatial orientation systems seem to be adaptable to the local ecology and hence change when a group moves to a new place where the traditional system no longer makes sense. In our main study, we will also look at the consequences of migrating to a city from rural areas.

A problem to which we will come back, but that can be mentioned here, is the status of "landmarks," as in the anecdotal sentence reported by Troadec (2007, p. 123) from Tahiti: "Brush your teeth left, towards the road." The teacher first used an egocentric reference, and then explained it with a direction towards some geographical landmark, an outside reference. But is it therefore geocentric? Troadec (personal communication) considers it at least as "environment centred." To be properly geocentric, reference has to be made to some wider, more abstract geographical direction, such as north, or at least "to the sea." A geocentric orientation system is one that has at least two orthogonal axes, such as cardinal directions, or the systems described in chapter 3 for rural Nepal and Bali.[9]

In our research, we have followed Pederson (1993) in his distinction between conventional landmarks (CL), which indicate some well-known location fairly far away, either within sight or even out of sight, and situational landmarks (SL), such as "towards the window," a direction inside the room but still outside the immediate table space. We consider these landmarks as intermediate between intrinsic/projective and geocentric, and hence deal with them as separate categories. Their precise status is still not clear.

In some of our previous publications (e.g. Mishra, Dasen, & Niraula, 2003; Niraula, Mishra, & Dasen, 2004), we have classified SL and CL as "projective" on the grounds that they indicate the use of a direction, a line of sight, which can be used with some angular precision. The problem is that this would put landmarks into the same Piagetian category as the egocentric frame, which is clearly not correct.

Brown and Levinson (2008) consider landmark-based directions as a special kind of intrinsic, and also treat them as a separate category, which they define very broadly. The listed examples (see Table 33.2, p. 458) include very near table-top locations ("towards where there's a nail in the table") that we have no problem in recognizing as intrinsic, "towards the edge of the bench" (SL), "towards the lime tree" (CL), and even "towards the mountain" (up or G). Indeed, they demonstrate with a figure (Fig. 33.3, p. 456) that "the boy is north of the tree" is truly geocentric, while "the boy is mountainwards of

[9] We argued there that the Balinese orientation system, even though it is locally adapted to particular landscape settings, is a truly abstract geocentric system, unlike what may be the case for some of the Oceanic systems.

the tree" could be intrinsic, because walking around the mountain would change the description, while one cannot walk around north. A geocentric description should indicate the cardinal direction (or equivalent) of the whole array.

While we understand the logic of this argument, we are convinced that most often, "mountainward" is equivalent to the 'uphill' that Brown and Levinson consider geocentric. In our research, this can occur in locations where the orientation system is not a cardinal direction system per se but an equivalent, e.g. in Bali and in rural Nepal.

However, Cablitz (personal communication, June 2008) raises another difficulty, which she found often with Marquesan children up to the age of 6 or 7, who said something like "the tree is seaward" or "the cow is facing seaward." Since there is no reference object (such as "the tree is seaward of the cow," which children use only after age 6 to 7), such references are not necessarily viewpoint independent, and have some projective properties just like landmarks.

Another difficulty with the scheme of three frames seems to occur for one of the researchers who, otherwise, has carried out research that comes closest to our own. Troadec (2007, pp. 124, 128) seems to misunderstand Piaget's process of decentration and the order of levels or stages; he attributes egocentric space (which he wrongly calls topological) to sensori-motor development in infancy, with intrinsic (and what he calls exocentric space) coming second (between 2 and 10 years), linked to concrete operations. This seems to be in reference to a French developmental psychology textbook (Bideaud, Houdé, & Pedinielli, 1993), which attributes the third level, that of Euclidean space, because it is based on abstract axes, to Piaget's formal operations. To our knowledge, Piaget has never suggested anything of that kind. This bizarre scheme is wrongly attributed by Troadec (2007, p. 124) to Mishra, Dasen, and Niraula (2003). If geocentric space really were linked to the stage of formal operations, it would be particularly odd to find its development starting in early childhood, possibly as early as age 4!

Perspectives for further research

The studies reviewed in the preceding pages indicate a significant advance in research on spatial orientation systems and spatial cognition with a variety of techniques of assessment. Compared to the research that came from the CARG group in Nijmegen, our own studies in India and Nepal add several features that were not evident earlier:

1) Developmental data is now systematically collected (whereas most previous research was carried out only with adults).

2) Data on several spatial encoding tasks are obtained with the same subjects, and various formats of task instructions are being tried out, showing that spatial encoding is highly task dependent.
3) Language production data is obtained with the same individuals as data on spatial encoding, so that the relationship between the two can be tested at the individual rather than only at the group level.
4) Only our study in India and Nepal includes other spatial concept development tasks, allowing us to study the generalization to the larger domain of spatial cognition.

Surprisingly, little developmental research had been carried out, to our knowledge, using the same tasks with children speaking a European language (or indeed even with adults, with the exception of some Dutch).

While all this work does provide answers to some of the questions researchers were facing in this field, it raises even more questions to be addressed in the future. For example, one puzzling question that still remains unanswered is: was the apparent inversion of cognitive stages in Bali reported by Wassmann and Dasen (1998) a true fact, or an artefact of a small sample and a small number of tasks? The finding that very young Balinese children would produce systematically geocentric encoding on the Animals task, and could not be enticed to change to the egocentric mode despite changing the task instructions, is difficult to attribute to problems of method alone. If a true fact, is it unique? Or can a similar reversal be found elsewhere, in India or Nepal where geocentric orientation systems exist, or possibly elsewhere in island locations, either in Bali itself in a larger replication study, or in locations that are similar to Bali?

Issues of research emerging from our first study

Our first research in Bali, India and Nepal raises several points that need to be clarified. We would like to point out a few of these issues to set the stage for the main study.

1) The main spatial language used by children aged 4 to 6, in all three samples in India and Nepal but not in Bali, is what we have categorized under D for deictic (and sometimes M for movement). The children would say “this way” or “that way” and point with their hand or finger in a direction, usually to the left or right. It is still not clear for us what these gestures actually indicate. Are they relative to the body because the child points to the right or left? Or are they indicative of a more distant direction, because the movement is towards the outside (e.g. wall or window in the room)? We need more data, using video recordings to carry out a more detailed analysis (e.g. hand positioning, verbalizations, etc.). Possibly what

we have considered as a single category could cover a variety of behaviors and meanings.

2) In the village in India and also in Nepal, the gradual use of cardinal directions is not immediately correct. While we noticed that by the age of 8 years children start using this geocentric orientation system and the language linked to it, we need to document further how precisely they get to master this language for appropriate description of objects or situations in their spatial surroundings.

3) In the city location, some children use predominantly egocentric language ("left/right") and some predominantly the NSEW geocentric system. Could it be that the latter tend to come from families that have recently immigrated from villages in which the use of cardinal direction is the norm? The study of children from families that have a long history of habitation in the city in comparison with those that have recently migrated there (within a decade or so) could give us an indication of why the orientation system is different in the city and the village. At the same time, we also need to examine ecological features of the city and the strategies that people adopt for day-to-day negotiation of life in it, in order to understand the mechanisms that enhance the use of egocentric spatial encoding.

4) Spatial language acquisition. Not much work has been done with respect to socialization in the use of spatial language in a developmental framework. For example, we do not know the spatial language that mothers use with children of different age levels to organize, direct and control their activities in a given spatial surrounding. We also do not know whether and how mothers teach their children the spatial language that they learn and master as a child and use as an adult. Similarly the process through which children acquire flexibility in switching from one kind of language use to another is also not understood. A detailed study of language acquisition and socialization is needed in order to understand the context of spatial language development and answer the questions raised above.

5) Neuropsychology of spatial cognition. What are the neuropsychological underpinnings of spatial reference systems? A number of techniques have been used to assess the lateralization of brain functions. At a very crude level, left- or right-handedness has been used as an indicator of right-or left-hemispheric dominance. Those with right-hemispheric dominance prefer to use the left hand to perform day-to-day tasks (e.g. combing hair, unscrewing a bottle), whereas those with left-hemispheric dominance generally prefer to use the right hand. Bryden (1982) has developed a laterality quotient to examine the functional asymmetry of the brain. However, the effect of social pressure, especially on the use of the right hand for many activities, has to be taken into account. For example, many left-handed people have been found to use the right hand for activities like eating and writing, especially in traditional cultures like India,

where the left hand is considered to be impure (Mandal, Pandey, Singh, & Asthana, 1992b). Based on such observations a cultural pressure/conformity theory has been advanced, which explains right-handedness as a function of environmental adaptation and teaching (Collins, 1975, cited in Coren & Porac, 1977).

Recent studies have generally used visual half-field techniques to assess hemispheric lateralization. In these studies, stimuli are presented in the right or left visual field of the subject. Reaction time and accuracy of judgment are recorded. Faster reaction time and greater recognition accuracy of stimuli presented in one rather than the other visual field is taken as an index of hemispheric lateralization. Better performance in the left visual field suggests right-hemisphere specialization. Children as young as 5 years have been found to show clear discrepancies in the judgment of stimuli presented in right and left visual fields. The results of such studies consistently support right-hemisphere superiority for dealing with spatial stimuli (Witelson & Swallow, 1988). What is not known is whether a geocentric language, which seems to be positively correlated with performance on spatial cognitive tasks, is also related to greater lateralization of the right hemisphere, knowing that language functions are predominantly localized in the left hemisphere. In other words, can we say that children who use predominantly or mainly a geocentric language would demonstrate more lateralization of the right hemisphere than those who use an egocentric language?

6) Bilingualism. There is a possibility of working with bilingual Nepali children who are fully educated in English. In Kathmandu, there are several schools (both residential and day schools) that have only English as the medium of instruction. Speaking English at home and getting children educated in English is now a status symbol in Nepal. Such families and children do speak Nepali at the marketplace or in several other local interaction contexts and they are therefore all bilingual. We expect children attending English schools in the city of Kathmandu to use an egocentric frame.

7) French-speaking city sample in Geneva. The predominant use of egocentric terms is characteristic of both Dutch- and French-speaking populations. Until recently, non-verbal encoding tasks had been used with adults only, and developmental data with a European language is still needed for our study. The techniques adapted in India, Nepal and Bali in our previous study need to be used in the same format for cross-cultural comparisons as well as for linking the study to mainstream developmental psychology.

Carrying out part of the project in Geneva therefore remains essential. In Geneva, it is easy to find monolingual French-speaking children as well as bilingual children (43 percent of the pupils in Geneva schools have a language other than French as their first language).

8) Village sample using egocentric language. The possibility seems to exist to find a rural sample characterized by the predominant use of egocentric

language. Such samples can apparently be found in the Gorakhpur district, north of Varanasi.

This is a summary of our initial findings in our 1999–2000 study. In carrying out what we now call the main study, in later years (starting in 2002), we attempt to answer all the questions raised here, starting with the need for a replication study with larger samples in Bali, which is the topic of chapter 5.

5 Returning to Bali: main study 2002–2007

The first thing one of us (P. Dasen) did in the main study was to return to Bali, together with J. Wassmann, in order to replicate our initial study there with larger samples. This would have been difficult in the remote village of Bunutan, but in the small city of Singaraja and the neighboring village of Sambangan we encountered excellent working conditions. The tasks we used are the standard ones described in chapter 2.

The Balinese orientation system, and its cultural importance, have been described in chapter 3. In summary, the Balinese use a geocentric system of two orthogonal named axes, one (*kaja–kelod*) designating upstream/to the mountain vs. downstream/to the sea, and the transverse axis named *kangin–kauh* (hence the abbreviation KKKK). This is the case only if the local Balinese language is used; in the official Bahasa Indonesian (the only language used in schools, for example), the standard cardinal directions (NSEW) are used, and egocentric references are usually preferred. A glossary of Balinese and Indonesian terms used in our instructions, and examples of language produced by the children, are provided in Appendix 2. The sample characteristics for this main study, carried out in 2002, are provided in Table 5.1.

A quick glance at the data computed during field-work showed that the results were partly different from those obtained in 1994. We therefore also returned to Bunutan, the remote village where we had worked in 1994 (see chapter 4), and tested thirty-three children from 4 to 8 years on a reduced number of tasks.

We had requested the teachers to select for our study only children who they knew to speak Balinese in their homes. However, later analysis of home background data showed that they had not completely followed our instructions. As shown in Table 5.2, out of 166 children for whom the information was available, 64 spoke at least some Indonesian at home, although it is the first or exclusive choice for only 18. Indonesian is used significantly more in the families of the city children.

We carried out all the testing in Balinese, but Indonesian is the language used at school, which no doubt motivated some children to answer in Indonesian

Table 5.1. *Sample characteristics of main study in Bali, 2002*

Age groups	4–5	6–8	9–11	12	Total
Singaraja (city)	15	24	28	5	72
Sambangan (village)	16	35	37	10	98
Bunutan (remote village)	15	18			33
Total	46	77	65	15	203

Table 5.2. *Balinese and Indonesian used at home*

	Language in home 4 groups				
	Only Indonesian	Mainly Indonesian	Mainly Balinese	Only Balinese	Total
Singaraja (city)	5	10	39	17	71
Sambangan (village)	3	0	7	85	95
Total	8	10	46	102	166

rather than Balinese. While this feature was not initially planned in our study, it proves to be extremely interesting, especially since we recorded the language the children spontaneously used on our tasks. In fact, this will allow us to analyze our data according to the spontaneous language preference of the children.

Table 5.3 shows the distribution of children in the two locations using systematically only Balinese or only Indonesian on the Road and Perspectives tasks, and those mixing the two languages on different items. In the village, 71 percent of the children use Balinese only, while this is the case for only 29 percent of the children in the city. It is interesting to note (see Table 5.4) that the children preferring Indonesian for the tests are not necessarily those who speak Indonesian at home (although the relationship is statistically significant (contingency coefficient = .38**).

In the analysis of the data, we will use these language groups to study the impact of bilingualism with a language (Bahasa Indonesian) that emphasized the egocentric rather than the geocentric FoR.

Table 5.3. *Balinese and Indonesian used on tests*

	Language used on tests			
	Indonesian	Mixed	Balinese	Total
Singaraja (city)	26	25	21	72
Sambangan (village)	5	23	70	98
Total	31	48	91	170

Table 5.4. *Cross-tabulation of language spoken in the home and preferred on tests*

	Language in home 4 groups				
Language used on tests	Only Indonesian	Mainly Indonesian	Mainly Balinese	Only Balinese	Total
Indonesian	2	2	18	9	31
Mixed	3	6	11	26	46
Balinese	3	2	17	67	89
Total	8	10	46	102	166

Results

Language development

Perspectives task Remember from chapter 2 that the Perspectives task consists of three objects, the location of which has to be described three times; the total number of descriptions for each child is therefore nine. If the child used two language categories on any item, only the first one is used in the analysis, but this was quite rare. The language categories are those given in Table 2.1. In this case, G refers to the use of the *kaja–kelod/kangin–kauh* (KKKK) traditional orientation system of Bali as applied in the north of the island. We sometimes distinguish between overall geocentric language use (G) and its correct use (G+). Similarly, egocentric (E) language is coded E+ when only correct usage is counted. The development with age of spontaneous language used on the Perspectives task is shown in Figure 5.1 (for the city and Sambangan village samples combined).

Starting with the youngest children, the dominant category is geocentric (G), and, quite remarkably, it is used correctly (G+) by a large proportion of the children starting at age 5. When children refer to the KKKK system, saying for example "The yellow box is *kaja*" (to the mountain), they really mean a wide-ranging geocentric reference. They often accompany their statement

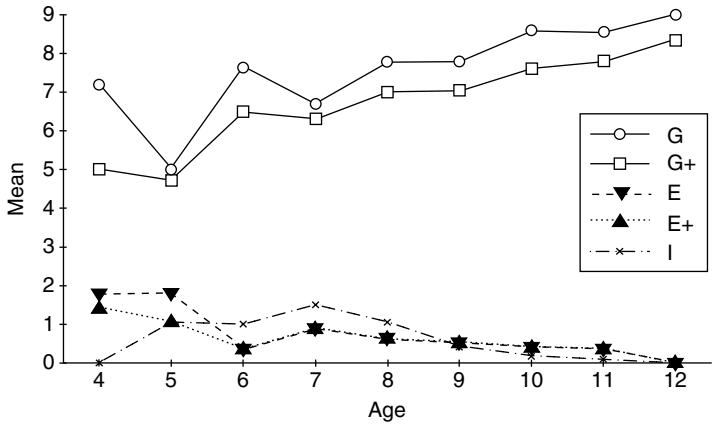


Figure 5.1 Spontaneous language on Perspectives by age

with a broad gesture, of the type illustrated in Figure 2.1. Of course, children, especially young ones, often do not make full sentences; they may also point to one of the objects and just say "*kaja*." We code this as G (or G+ if that object is really situated on the mountain side of the display), even though it may be considered as ambiguous in strict linguistic terms, since the ground object is hardly ever specified (*kaja* of the red box, or *kaja* of me?). And of course, prompting for complete sentences would have made the testing situation extremely tense and artificial.

The younger children also use some egocentric (E) references, on average two out of nine at age 4 and 5 (and, in the few cases in which it is used, it is used correctly starting at age 6), and some intrinsic (I) starting at age 5 with a peak at age 7. The former refer to references such as "The yellow one is left," and the latter "The yellow one is next to the red one." Other language categories that are found in other locations, deictic (D), situational landmarks (SL) and conventional landmarks (CL) are not used.

Figure 5.2 illustrates the impact of bilingualism with Indonesian. From this figure, it is obvious that the Balinese-speaking children use geocentric language exclusively and correctly throughout the age span we tested. The group that prefers Indonesian, on the other hand, use I and E in the two younger age groups (4 to 8 years), starts switching to G at age 9–10, and geocentric language becomes the norm only at age 11–12. The mixed language group shows some of these features, but is closer to the Balinese-speaking group.

Road task On the Road task in Bali, children had to guide one of the assistants along a path drawn on the floor, which had eight segments (see chapter 2). The developmental results are shown in Figure 5.3 by language group.

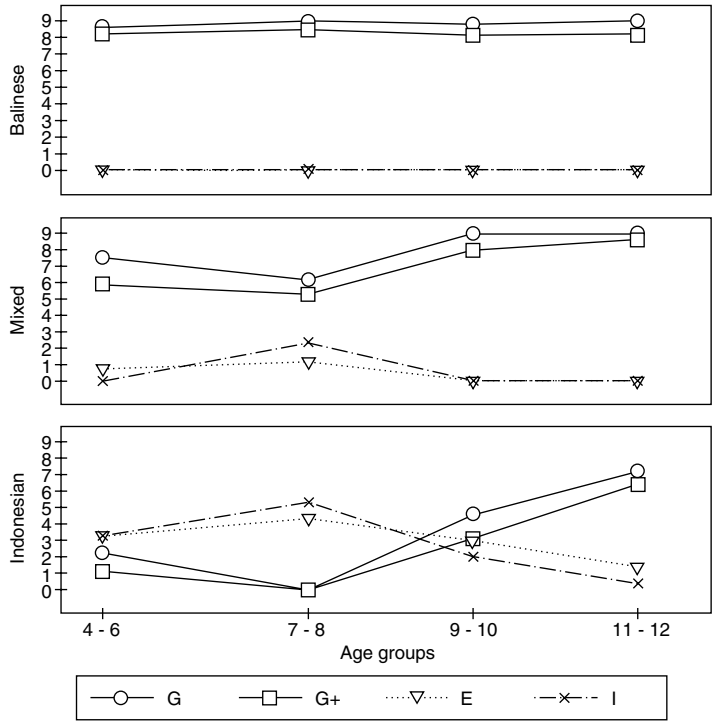


Figure 5.2 Spontaneous language on Perspectives task in three language groups

The results are very similar to those on Perspectives, except that no intrinsic (I) language is used. G (and G+) language again refers to the KKKK system; children say "Now, go *kelod* "(to the sea)" or "Turn *kangin*." The Balinese-speaking children do not use any E at any age, but only G, and this almost entirely in a correct way, even in the youngest age group (i.e. even as early as age 4). Egocentric language ("turn right or left") is used by those children who prefer Indonesian to Balinese, and they do this up to age 9–10 years, after which they switch to G. Those who mix the two languages present intermediate results, although they are closer to the Balinese-speaking group. They use predominantly G, but not always correctly, and some E (mostly correctly) in age groups 7–10.

Language on encoding tasks It will be remembered from chapter 2 that we asked children to explain their answer or choice on items 4 and 5 of each of the three non-verbal encoding tasks. Most of the children use geocentric language. In the Balinese-speaking group, this is almost exclusive, while in the Indonesian-speaking and mixed language groups, some egocentric language

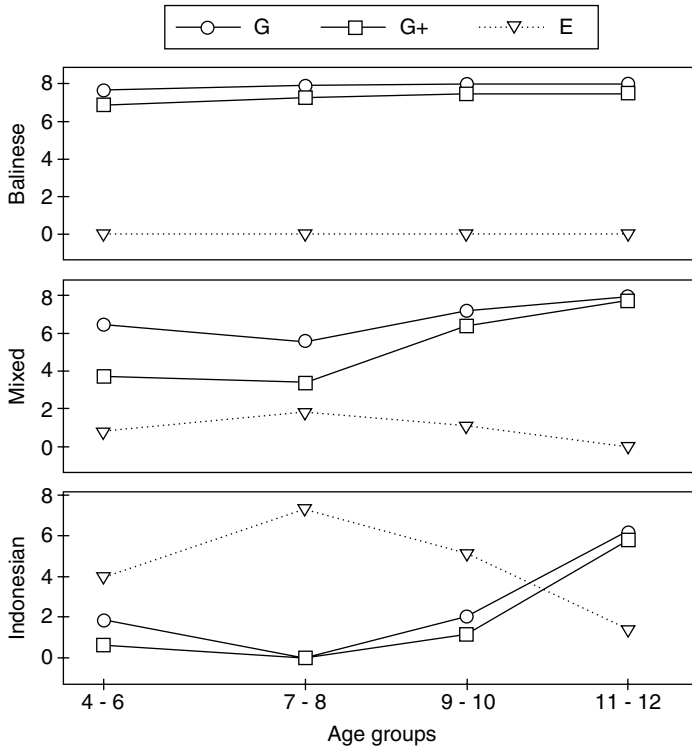


Figure 5.3 Spontaneous language on Road in three language groups

occurs up to the age group 9–11, as well as some intrinsic and deictic terms. On Steve's Maze, "shape"[1] is used by a third to half of the children in each group.

Summary measures for language To obtain a summary measure for geocentric language over the three language tasks, we computed a Princals factor score combining the G minus E language scores on the Road, Perspectives and encoding tasks. The outcome is presented in Table 5.5. Dimension 1, which represents 81 percent of the variance, is a good summary measure of the predominance of G language on the three tasks combined. Object scores, which are each individual's position on this dimension, will be used as the individual summary measure of G language.

In sum, the various language tasks complement each other to show a systematic difference between the Indonesian-speaking and the Balinese-speaking

[1] "Shape" is a language category that occurs on Steve's Maze only. The children refer to the path as a shape (e.g. "It looks like an S"). Some of them draw this shape in the air with a finger, and keep this movement going as a mnemonic device while they move to the second table.

Table 5.5. *Princals optimal scaling for 3 language tasks*

	Dimension 1	Dimension 2
G language Perspectives	.94	–.08
G language Road	.90	–.37
G language encoding	.87	.48
Cronbach's alpha	.89	–2.5
% variance explained	81	12

groups. In the former, the children start using mainly intrinsic and egocentric language and do this up to about age 10, after which they switch to G; in contrast, in the Balinese-speaking group, geocentric language is an almost exclusive usage from 4 to 12 years (with the exception of "shape" on Steve's Maze).

The developmental trend on the summary G language object score is shown in Figure 5.4, which clearly shows that G language increases strongly with age in the Indonesian-speaking group.

Rural/urban contrast on spontaneous language Another way to look at the same variable is presented in Figure 5.5, which shows the difference between the city and village groups. G language is consistently present in the village but increases with age in the city.

ANOVA shows a significant difference between the two locations ($F = 21.568$, $p < .001$), and a significant interaction between location and age ($F = 3.196$, $p < .01$), and similar results are obtained with the three language groups ($F = 24.147$, $p < .001$; interaction with age $F = 2.406$, $p < .01$). Language spoken in the home also divides our sample into two groups, with similar results, except that the age by group interaction effect is not statistically significant.

Knowledge of orientation system

As described in chapter 2, we also asked the children directly to point to the various directions of the Balinese orientation system (KKKK) and of the cardinal directions (NSEW) in Indonesian (*utara*, *selatan*, *timur*, *barat*). We first did this outside in the playground and later also inside a room. We recorded how many of these directions the children used accurately; the maximum score is therefore 4. For the knowledge of egocentric language, we asked them about left and right, front and back.

As can be seen in Figure 5.6, if the children prefer to speak Balinese during testing, they also know the Balinese orientation system. This is indeed the case even for the youngest children, while those who mix the two languages know the Balinese orientation system perfectly only by age 9 or 10, and those who speak Indonesian even less so.

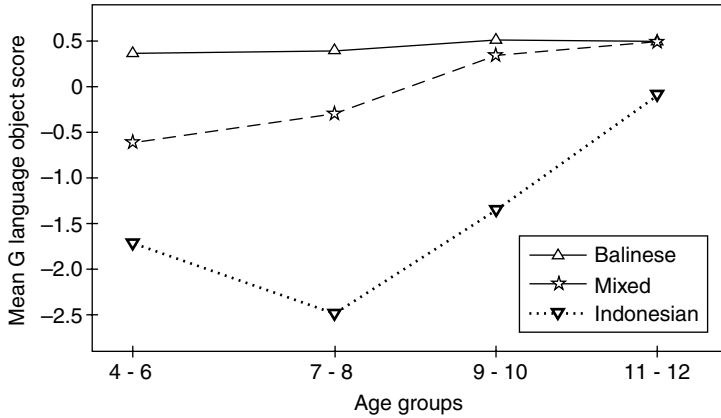


Figure 5.4 G language object score in three language groups

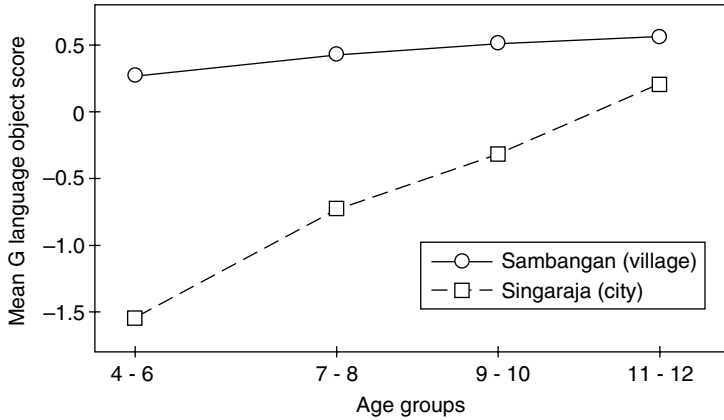


Figure 5.5 G language object score in rural and urban samples

More detailed analyses show that for the Balinese speakers, all but three of the children, if they know the *kaja–kelod* axis, also know the *kangin–kauh* axis, and if they know it outside, they also know it inside a room.

How do the children learn the Indonesian cardinal directions? Contrary to what might have been expected, as can be seen in Figure 5.7, it is not the Indonesian-speaking children who learn these first, but the Balinese-speaking children. This is no doubt because they are socialized early to use the Balinese orientation system, and therefore find it easy to transfer this knowledge to the Indonesian cardinal directions. Their performance, however, is far from perfect. The NSEW system is completely mastered by virtually all children only by the age of 12.

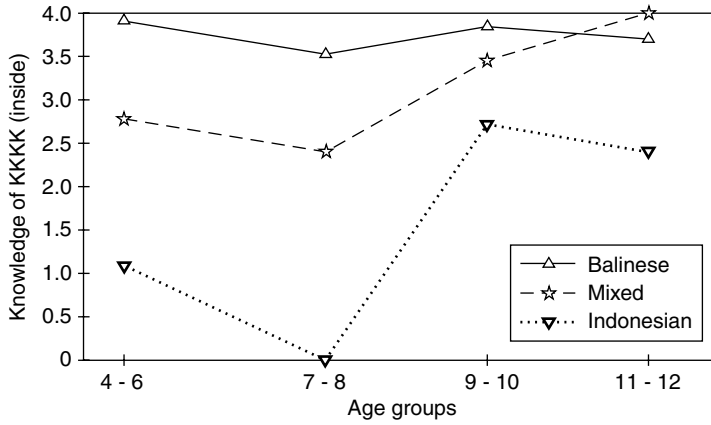


Figure 5.6 Knowledge of Balinese orientation system (KKKK), inside, in three language groups

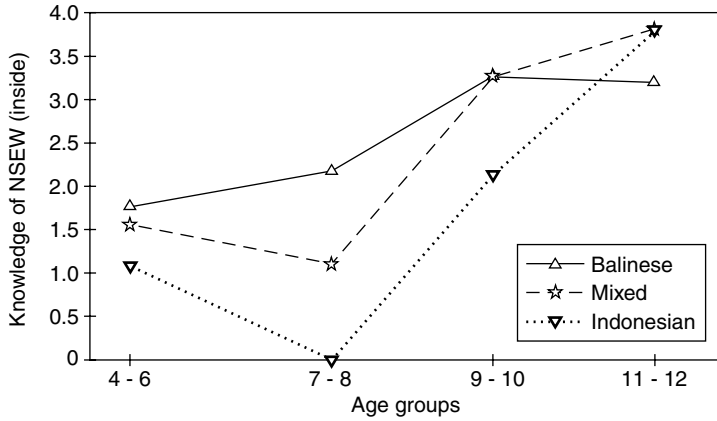


Figure 5.7 Knowledge of Indonesian orientation system (NSEW), inside, in three language groups

Again, further analyses show that if the children know the system outside, they can also use it inside. The correlation between performance outside and inside is .83 ($p < .01$), and this is the case even if age and language groups are controlled.

It is also interesting to compare the knowledge of the two geocentric orientation systems, the Balinese and the Indonesian one, in the two locations. This is shown in Figure 5.8.

In the village, the Balinese orientation system is acquired very early: four year olds know it perfectly, even inside a room. On the other hand, in the

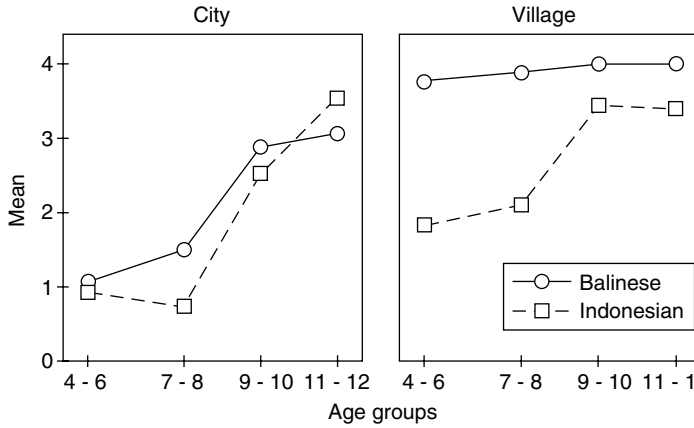


Figure 5.8 Knowledge of the two orientation systems (Balinese, KKKK and Indonesian, NSEW) in the city and in the village

city, the knowledge of the systems in the two languages takes longer to be mastered.

Balinese children are also taught very early on to distinguish their right and left hands, because the appropriate use of each has to be acquired. To test their knowledge of left, right, front, and back (LRFB), in Balinese (*kenawan*, *kebot*, *di malu*, *uri*) and in Indonesian (*kanan*, *kiri*, *di depan/muka*, *di belakang*), we simply asked children "Show me where is (your) left" (right, in front of you, back). We call these terms egocentric because they are body related, as is customary in Balinese, since they are not commonly used for objects that do not touch the body.

The results are illustrated in Figure 5.9. Indonesian-speaking children know these egocentric terms in Indonesian as early as age 4, but find it more difficult in Balinese. In the other two language groups, there are some lapses up to age 9. Left and right are found to be slightly easier than back and front in the younger age groups.

These results illustrate the fact that Balinese children learn both the egocentric (LRFB) system and the local geocentric one (KKKK) at home, while cardinal directions are expressed in Indonesian and learned in school, so that their knowledge is not complete before age 12.

Overall, these results on spontaneous language use confirm our 1994 findings, namely that G language is acquired very early in Bali (as early as age 4), at least in a rural setting, and by Balinese-speaking children. The distinct differences found with the children who prefer Indonesian also confirms our previous findings on the impact of acculturation.

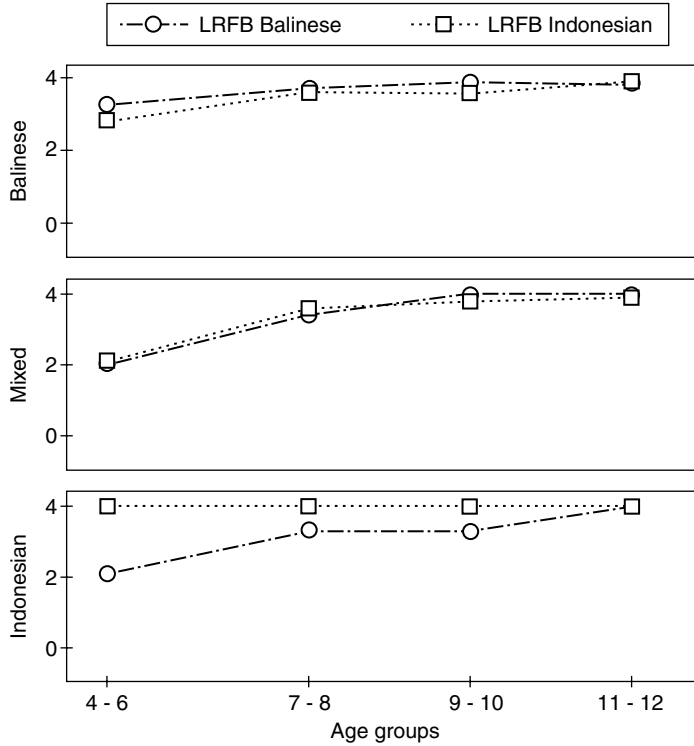


Figure 5.9 Development of knowledge of Balinese and Indonesian egocentric terms (LRFB) in three language groups

Spatial encoding

The three non-verbal encoding tasks, using the rotation paradigm, were described in chapter 2. We start with looking at the 1994–2002 replication, for which Animals and Steve's Maze were used on both occasions. Let us consider first the Animals task, and look at the results with three animals only, since that was the format used in previous studies. The results are presented in Table 5.6. We use the same classification as in previous reports by Levinson's group and by Wassmann and Dasen (1998), in which A represents four or five items coded in the geocentric frame, A- three out of five geocentric items, R- three out of five egocentric items, and R four or five egocentric items.[2]

We first look at the results, in the top half of Table 5.6, of the remote village location of Bunutan where, in 2002, we used only this single task and tested

[2] A stands for "absolute" and R for "relative," the terms Levinson (2003) prefers, which also occur in the "R-A gradient" we use in some calculations.

Table 5.6. *Encoding on Animals (3 animals only) in 3 locations in Bali, 1994 and 2002 (in %)*

		4–5	6–8	9–10	11–12	Total %	Total N
Bunutan	A	100	100		63		
1994	A-				12		
	R-				25		
	R				0		
N		10	8		8 (age 11–15)		26
Bunutan	A	53	61				
2002	A-	33	39				
	R-	7	0				
	R	7	0				
N		15	18				33
Sambangan	A	44	66	67	75	64	63
	A-	19	3	22	20	14	14
	R-	37	23	11	5	19	18
	R	0	8	0	0	3	3
N		16	35	27	20		98
Singaraja	A	27	42	50	60	44	32
	A-	13	17	22	13	17	12
	R-	47	25	22	7	25	18
	R	13	17	6	20	14	10
N		24	15	18	15		72

only children from age 4 to 8. Bunutan has the highest proportion of geocentric encoding compared to the two other locations, in 1994 and 2002. However, compared to the 1994 results, the age trend in the 2002 data is different: instead of a 100 percent geocentric encoding in the 4–10 year old group, followed by a slight increase of egocentric encoding, we now have in all three samples the same age trends we found in India and Nepal, namely a steady increase of geocentric encoding with age.

How can we interpret this "failure to replicate" the previous results? There are two aspects, to be considered separately, the age trend and the starting point. As to the age trend, we possibly made too much of the decline of geocentric encoding with age in our 1994 results. We hesitated between seeing this decline as a sort of "reversal" of stages (geocentric first, followed by egocentric) – clearly an over-statement – and the effect of increased schooling and/or exposure to Indonesian with age.

As to the starting point: in 1994 we found 100 percent geocentric encoding at ages 4 to 10. We now still find a predominance of geocentric encoding, but about one-third of the children are in the A- group. This means that there are many very young children who do use systematically geocentric encoding. The

difference with the 1994 results is that they do not represent the complete cohort. How could this be explained? Possibly, it could be due to sampling, since we are dealing with very small numbers, but it is also possible that social change in the eight years separating the two studies might have introduced more of the urban characteristics that seem to go with more egocentric encoding. Indeed, the Bunutan region has become an attractive site for tourists, with many lodges, dive-shops and even an internet café, while it was very isolated in 1994.

If we look at the other two locations, we also find a systematic geocentric group in the younger ages, representing approximately half of the children in the village and one-third in the city. So, the main conclusion from the 1994 study remains: there are Balinese children as young as age 4 to 5 who use the geocentric FoR exclusively for their language and their non-verbal cognitive encoding. Not only this, but they use the system correctly. In other words, there is a distinct precocity of the geocentric system in Bali.

But the geocentric FoR is not exclusive; some children also use egocentric encoding while producing geocentric language, and a few even use egocentric language. This allows us to look at which environmental and socio-cultural variables are linked to this "choice" of frame. We have already remarked that the choice of the geocentric frame is more common in the rural than in the urban group. Another variable is whether they choose to speak Balinese or Indonesian. Of the children speaking only Balinese, 65 percent are in the A group, if they mix the two languages it is 54 percent, and if they speak mainly Indonesian it is only 32 percent.

This pattern of results shows that we indeed have a socio-historical process going on, where the more traditional Balinese cognitive style (and developmental path) is being changed slowly through the processes of acculturation. If that is so, and since we have collected other background information on the children's families in the main two samples, there may be other social indicators that we could link to the two styles of encoding. However, we are getting ahead of our story. Before having a closer look at these links, there are other aspects of the results on encoding to be considered.

Assessment format So far, we have analyzed the results of this task in the same format as it was presented in previous research, but remember that we have now added a fourth animal placed at a right angle, and we have added two items with the child rotating by 90° instead of 180° (see chapter 2). In other words, we now have more stringent criteria for consistent geocentric or egocentric encoding.

A comparison of results with more and more stringent criteria appears in Figure 5.10, using R-A gradients[3] calculated for the Sambangan (village) sample because that is where all children were subjected to these new procedures.

[3] As described in chapter 2, this is the measure used by Levinson (2003), and represents the proportion of items with a geocentric encoding (distractors counting as .5), multiplied by 100.

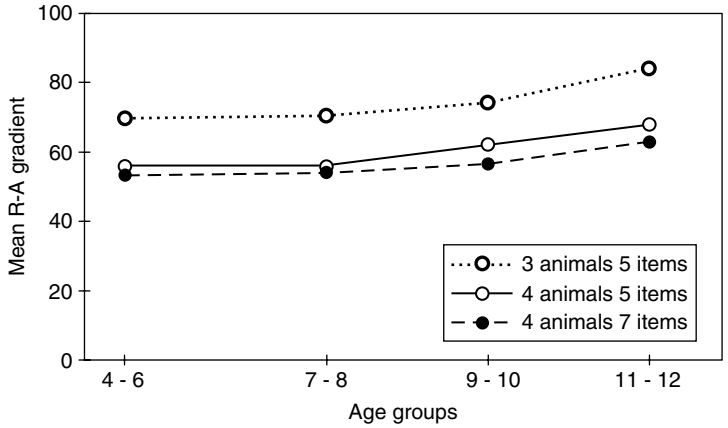


Figure 5.10 R-A gradient on Animals, three assessment formats (3 animals, 5 items; 4 animals, 5 items; 4 animals, 7 items including two at 90°)

Taking the fourth animal into account reduces the average R-A gradient from between 70 and 80 to about 60, and adding a 90° rotation reduces it further to about 55. Thus, it seems that using only three animals produced some overestimation of the degree of geocentric encoding. However, there is a fairly high partial correlation (controlling for age) between the simple measure and the more stringent ones (.77** between three and four animals, .76** with seven items) and a very high correlation between the latter (.94**).

We conducted a series of analyses using both the old and the new criteria. The overall picture of relationships does not change when using these more stringent criteria, which reassures us in the affirmation that even our previous measures with only three animals were sufficiently reliable.

Task specificity A comparison between the three encoding tasks is presented in Figure 5.11. We still use the R-A gradient on five items for each of the tasks, since that is the most comparable measure (the 90° rotation was used in Bali for Animals but not for Chips). For the Animals task, it takes into account four animals instead of three, i.e. to be counted as geocentric, both the line of three animals and the fourth one at right angles have to be in the geocentric position (coded GG).

In our first study in India and Nepal, Animals systematically produced a higher R-A gradient than Chips; the reverse is now the case in Bali. This is because we increased the task demands (or stringency of measurement) of Animals; the difference would appear even larger if computing the gradient with seven items on Animals. This shows that the value of an R-A gradient is highly dependent on the particular task format.

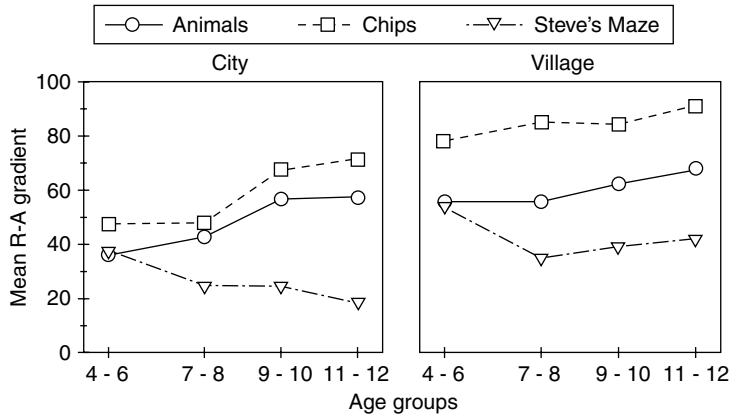


Figure 5.11 R-A gradients on three encoding tasks: Animals (4 animals), Chips and Steve's Maze, by location

Steve's Maze produces, as it did in all our previous research, a much lower R-A gradient than the other two tasks; in fact, there is on this task more egocentric than geocentric encoding in both locations. As we have hypothesized before (Wassmann & Dasen, 1998; Mishra *et al.*, 2003), this is no doubt due to the fact that it is easy to verbalize the Animals and Chips tasks in a geocentric form ("They all look *kangin*," "The red square is *kaja*"), while it takes several sentences to do this for the segment of path in Steve's Maze, and it is therefore easier to remember it as a shape. Such an iconic representation is inherently egocentric, since it is like an imprint on the retina, that moves with the individuals as they move; the same can be said of the mnemotechnic strategy used by some children of drawing the shape with a finger.

Another of our previous findings that is therefore strongly confirmed with these results is the task specificity of frames of reference used for encoding: individuals do not necessarily use the same frame under all conditions, but "choose" one frame over another, this choice being of course quite unconscious.

The difference between the two locations appears quite clearly in Figure 5.11: the R-A gradients are systematically higher in the village than in the city, for all three tasks, which again demonstrates the importance of the urban/rural ecological variable.

In order to produce a summary measure for encoding, we used Princals optimal scaling. To carry out this analysis, we subtracted items with egocentric encoding from items with geocentric encoding (and added a constant to avoid zeros in the scores). The component loadings are shown in Table 5.7. The results for Animals and Chips are similar, while Steve's Maze loads on a second

Table 5.7. *Princals optimal scaling for non-verbal encoding tasks*

	Dimension 1	Dimension 2
Animals	.97	–.48
Chips	.81	.08
Steve's Maze	.49	.82
Cronbach's alpha	.54	–.31
% variance explained	52	28

dimension. The factor score for dimension 1 (explaining 52 percent of the variance) is used as the summary measure of encoding for further analyses.

Using this combined measure, we look again at the differences between the two locations. An analysis of variance indicates that the difference between the means of the groups is statistically significant ($F = 50.874$, $p < .01$) and there is also a significant age effect ($F = 9.759$, $p < .01$). We also find a statistically significant difference ($F = 4.254$, $p < .025$) in encoding between the three language groups described earlier.

Language and encoding

In our first study in Bali, we had collected spatial language data, but did not relate each individual's language use to encoding on the Nijmegen tasks. When we did this in India and Nepal (see chapter 4), we found, surprisingly, that there was hardly any relationship between the two in terms of correlation coefficients. So we concluded that the hypothesis of linguistic relativism received support at the group level (when geocentric language is used as the adult group norm, encoding also tends to be geocentric) but not at the individual level. We can now explore this issue with the new Bali data.

The obvious way to answer this question is to compute the correlation coefficient between the two domains of interest, using the two summary measures for G language and G encoding. In the combined city and village sample ($N = 170$), the Pearson correlation is .46**, and the partial correlation controlling for age is .38**. If computed separately in each location, the coefficients are respectively .40** (partialed for age .28**) in the city, and .32** (partialed for age .22*) in the village.

This is indeed an interesting finding, since it contradicts the absence of relationships we found in previous research in India and Nepal, and will comfort adherents to the linguistic relativity theory. The relationship between language and encoding is not very strong, but nevertheless it is statistically significant even when the common background variable of age is controlled. However, we

Table 5.8. *Language and encoding on Nijmegen tasks (number of items and %)*

		Language		
		Geocentric	Egocentric	Other
Encoding	Geocentric	456 (53%)	28 (3%)	49 (6%)
	Egocentric	147 (17%)	59 (7%)	122 (14%)

will see that, if we take other socio-cultural variables into account, there is no structural link in the overall summary model.

On the encoding tasks, we can establish the correspondence between what the children do (geocentric or egocentric encoding) and how they explain what they did. The data in Table 5.8 is computed from items 4 and 5 on all three encoding tasks combined, giving a total of 861 items for the combined samples.

Items with geocentric encodings account for 62 percent of the items, and most of these are explained with a geocentric explanation, as could be expected. While items with egocentric encoding are less frequent (38 percent), what is striking is that they are explained most of the time not with egocentric language (that accounts for only 7 percent of the items), but with geocentric language[4] (or various other, such as intrinsic and shape). Altogether, 20 percent of the items are explained in the opposite FoR to that used for the encoding.

We found the same discrepancy in our research in India and Nepal. This shows, on the one hand, the dominance of the geocentric language in these communities, but on the other hand also that there is not a perfect match between what individuals say and what they do. This, of course, is not really a new discovery, but is the common lot of anthropologists and psychologists alike (a good example from another context is provided by Wassmann, 1993b).

Family background and other social indicators

Among the social background data collected with a questionnaire (usually with parents, in some cases with a teacher who knew the child well), we used Princals to compute an SES status score by combining the mother's and father's education and occupation. We also used a media score reporting the presence of newspapers, radio and television in the home; these national media

[4] To give an example: on Chips, on an item where the blue dot is to the right of the red one on table 1, the child points to the card with the blue dot on the right on table 2 (egocentric encoding), but says "There it was *kauh*, so here it is *kangin*" (G language).

Table 5.9. *Correlations between G language and G encoding and social indicators*

	Object score G language	Object score G encoding	Age	Location city vs. village
Object score G language	1	.46**	.37**	.54**
Object score G encoding	.46**	1	.32**	.37**
Media in home	−.37**	−.23**	−.05	−.60**
Contact with city	−.32**	−.28**	.11	−.69**
Object score SES	−.46**	−.37**	−.10	−.86**
Object score Balinese vs. Indonesian on tests and in home	.55**	.32**	.08	.67**

** $p < .01$ (2-tailed). N = 170 except for Media = 163, City contact = 141.

use Indonesian. We further obtained information on the family's history of migration from village to city or vice versa, whether they have family in the city (respectively village) and how often the child visits there. This information was first coded separately for village and city children, and then combined into a single "contact with city" score. We also asked about the language spoken in the home, which is combined with the language actually used on the tests into a Balinese language score. The Pearson correlations between G language and G encoding and these social background measures are presented in Table 5.9.

The correlations are all statistically significant beyond the .01 level, and in the expected direction: more geocentric language and encoding with less contact with the Indonesian media and the city, and with a lower SES index. These measures are, of course, strongly linked to the city vs. village contrast: the parents in the city have a higher level of education and professional employment, have more access to media, and – as we have seen earlier – use more Indonesian in the home. When location is statistically controlled, the correlations disappear. In the city, but not in the village, there is a significant correlation between G language and the use of Balinese in the home and on the tests.

All these findings join up to consolidate an acculturation or social change hypothesis. The more traditional segment of the population, living as farmers in the village, those with less contact with the city (through short trips to the city or visits of family members who live in the city) and less contact with the media, are more in touch with traditional Balinese culture, including its orientation system. And they transmit this to their children, among other things through the geocentric language they use.

Unfortunately, we did not ask questions about religious practices in the families, but as far as we can tell from participant observation, these practices are

upheld more in the village than in the city (to the contrary of what seems to be the case in Kathmandu, where the higher SES families spend more time on religious practices – see chapter 7).

It may also be unfortunate that we were not able to obtain social background data with the small Bunutan sample. However, it is likely that it would have been quite homogeneous, all families being Balinese-speaking farmers who have always lived in that village; the only variation might have been in the contact with the city through relatives or personal visits. Thus, even within such a homogeneous social setting, we now find some egocentric encoding (although never systematically), so we do not claim that these social indicators are sufficient to explain all the results.

Summary model

The variables discussed above were introduced into an Amos structural equation model. The results using the complete sample are presented in Figure 5.12.

The model for Bali has excellent fit statistics. It is relatively simple, because in this location we did not use an extensive interview schedule with children or parents, or additional cognitive tests, so there are fewer variables to be included than for Varanasi or Kathmandu (see chapters 6 and 7).

The main feature of the model is a virtual variable[5] "traditional culture" that is assessed through the index of speaking Balinese (at home and spontaneously on our tasks) instead of Indonesian, and the knowledge of the Balinese orientation system inside a room.

Traditional culture is linked to ecology, i.e. to location: the tradition, be it of speaking Balinese or of knowing the local orientation system, is kept much more strongly in the village than in the city. In other words, this variable can be seen as the opposite of acculturation (contact with the outside world, the national language, etc.). Introducing the separate variables of media and city contact does not improve the fit; they are covered by the location variable.

In Bali, we do not have a very strong base for assessing SES, but this measure is linked negatively with traditional culture, which makes sense in this context, higher SES status being linked to higher acculturation.

Age influences the development of G language, knowledge of the orientation system and G encoding, in that order of importance.

A striking feature of the model is that no link is needed between language and encoding: introducing such a link (in either direction) shows a very low

[5] A virtual variable is one that is not measured directly in the research, but is derived statistically from other measures, the introduction of which increases the fit of the model. Its meaning and relevance is of course open to discussion.

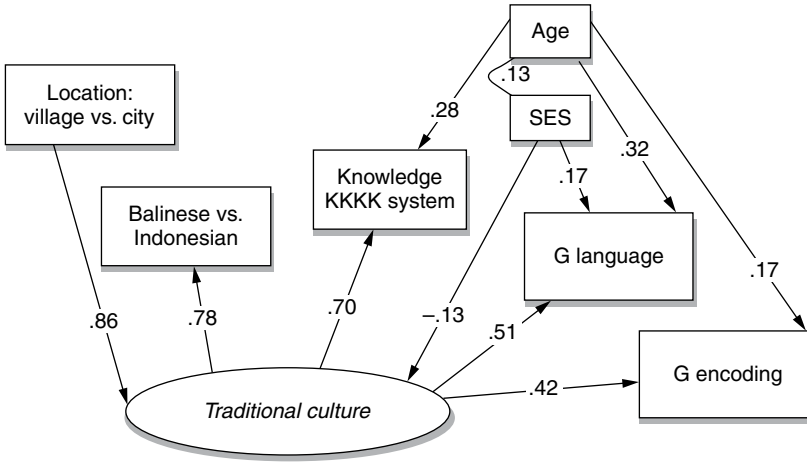


Figure 5.12 Amos summary model for Bali
Fit statistics:
CMIN = 6.114 df = 10 p = .806
RMSEA = 0 GFI = .99 CFI = 1 TLI = 1.025

Knowledge = Knowledge of Balinese orientation system inside;
Balinese vs. Indonesian = Language spoken at home and on our tests;
G language and G encoding = Princals summary object scores as discussed in text.

beta weight, and decreases the fit of the model. So it seems that both G language and G encoding are influenced separately, but in similar ways, by traditional culture, language somewhat more than encoding.

All these relationships are coherent with the detailed analyses we have carried out, which showed the important impact of ecology, and also of bilingualism between Balinese and Indonesian.

Models were also calculated for three age groups separately. The structure of the models remains much the same, with some minor variants, notably about the role of age in these more homogeneous groups. For the younger children, age is linked to both G language and G encoding, but the link is stronger with the latter. This is probably due to the fact that G language is already well established in Bali even in the youngest age group, while G encoding has more scope for developmental change. The effect of age then virtually disappears in the other two age groups. In the middle age group, the link of traditional culture with G encoding is about equal to that with G language, while in the overall sample and the two other age groups taken separately, it

is stronger with G language. The three models for each age group are sufficiently similar to justify using only the overall model.

Discussion and conclusion

In cross-cultural developmental psychology, it is not often that we find attempts at a replication of field studies. In this case, pursuing research first in India and Nepal was, in a way, a first attempt at replication, since in these locations, the people use geocentric orientation systems. They also have at their disposal, as do the Balinese, two systems of reference to describe and encode small-scale space, the geocentric and the egocentric one (discounting the intrinsic which is universal), so that we can study when and how they give preference to one or to the other. We are therefore in a situation somewhat different from the two populations on which Levinson (2003) concentrates most of his discussion, the Tzeltal speakers of Tenejapa in Mexico, and the Guugu Yimithirr Australian Aborigines, who use only the geocentric system. That some egocentric encoding occurs in these two populations is therefore more surprising than if it occurs in all of the samples we have been studying, including Bali.

The first study in India and Nepal (chapter 4) allowed us to show that the proportion of geocentric and egocentric encoding, and the development of geocentric and egocentric language, is to a large extent linked to the eco-cultural context, combining the appropriateness of the orientation system to the local topography, and symbolic and religious aspects as well as language. The latter is, as we see it, a part of the overall culture and not a single determinant of cognition in itself. The fact that the choice of a frame of reference for encoding is also task specific had been borne out by our first research in Bali, and was confirmed in our first larger study as well as again in this main study. On the other hand, the developmental trend of an early geocentric encoding on the Animals task, that then changes to some extent to egocentric with age, was not confirmed in any of the locations in India and Nepal, and it therefore seemed imperative to replicate the study also in Bali itself.

While this particular age trend was not found again in this renewed study, not even in the same area of Bali (although Bunutan itself, as we have mentioned, has changed in the meantime), we now have what appears to be a very coherent body of results, all of which make good sense. Working in several locations with relatively large samples provides a chance to study several variables beyond age, such as urban and rural contexts, the use of Balinese vs. Indonesian and other social indicators.

When Levinson (2003) concluded his review of the available data by writing that "all further tests provide no evidence for the effect of cultural change" (p. 197), he also realized that some of the measures of social variables (and

even age) in these studies were rather crude and the sample sizes quite small, so that he also cautioned: "there remains a good chance that a positive effect might be found with better data" (p. 196).

We believe that we now have the better data Levinson asks for, and contrary to his affirmation, we think that cultural change is one of the main variables to explain our results, of both 1994 and 2002. Already in the first field-work, Wassmann had noted that there was somewhat more use of egocentric language in the (more urban) south of Bali than in our remote location on the north coast. We also considered the possibility that the developmental trend from more geocentric to more egocentric encoding could have been produced by acculturative factors such as schooling, and the Indonesian language that is linked to it. All of the present results point to the importance of social change or acculturation.[6] The latter of course comes with a change in language use, i.e. the impact of Indonesian.

The Balinese orientation system, and the Balinese language (in particular in its complex form with several levels of address depending on social position), together with their religious and symbolic connotations, are all part of the traditional Balinese culture, and so is the geocentric frame of reference and the process of geocentric spatial encoding. We therefore find more geocentric language and encoding in rural locations than in the city (and even more in a more remote rural location such as Bunutan), more in Balinese speakers than in those who prefer to use Indonesian, more in traditional, farmer families with little contact with the city and limited access to the media than in families where parents have a higher level of education, paid employment and access to media, in particular to newspapers.

In all three samples, the age trends on the language elicitation tasks are an increase of geocentric language with age, and an increase of geocentric encoding on two of the Nijmegen tasks (the exception being Steve's Maze). It seems that the influence of acculturation does not increase with age, as one might have expected (with the number of years of schooling, greater proficiency in Indonesian, possibly wider geographical mobility with age), but the children seem, on the contrary, to be socialized progressively into the Balinese cultural norm irrespective of their various social and linguistic backgrounds. In other words, Balinese traditional culture shows its strength.

[6] The concept of social change is used when a society changes by itself, acculturation when it changes through contact with another society. In this case, we have a mixture of the two. Bali changes under the impact of globalization, Westernization brought in particular by tourism, and also the influence of the rest of Indonesia and Bahasa Indonesian, through school, television and government institutions. Even though this occurs within the same country, we can still consider this to be a process of acculturation.

6 Varanasi

Varanasi represents in many ways our main research location, where our procedures were pre-tested, and decisions were made. It is hence also the site for which our research has the largest range of components, in particular the study of neurophysiological correlates and of brain-damaged patients presented in chapter 13 and a study of dead reckoning in chapter 14. In this chapter, we present the main results, those that are comparable to the other locations.

It will be remembered from chapter 3, that the language spoken in Varanasi is Hindi and the geocentric orientation system uses cardinal directions (NSEW), although the results of our first study (chapter 4) have shown that egocentric references are also used, particularly by older children (11 to 15 years), which is why we chose to work with this age group in the main study. The sample characteristics are presented in Table 6.1.

From the total sample of 376 children, we initially tried to select 80 children who would fall most clearly into geocentric (G) and egocentric (E) sub-groups. However, we found relatively little overlap between a selection based on G and E language, and one based on G and E encoding, and it proved difficult to select homogeneous sub-groups. Therefore, instead of contrasting two sub-groups, we prefer to work with the whole range of variation. There remains one trace of this initial design, which is that background data through child interviews were collected only with the selected 80 children and family interviews with 66 of these.

In the analysis of the results, we will focus on the contrast between Sanskrit and Hindi schools. The characteristics of these school systems have been described in chapter 3, while a description of the particular schools used for this study appears below (see also Broyon, 2008). Our main hypothesis is that while the geocentric frame is fostered by the Hindi language, which is spoken in both groups, it is emphasized even more in the Sanskrit-school group, because these children learn Hindu religious practices that involve geocentric spatial orientation, and they learn a cardinal orientation system that has eight named directions (even ten, counting up and down, see Figure 3.3).

Table 6.1. *Sample characteristics, Varanasi main study*

		Gender			
	Age	Boys	Girls	Total	
Hindi schools	11	9	30	39	
	12	26	59	85	
	13	9	46	55	
	14	5	31	36	
	15	0	6	6	
	Total	49	172	221	
Sanskrit schools	10	2	0	2	
	11	6	3	9	
	12	35	5	40	
	13	49	6	55	
	14	30	7	37	
	15	3	9	12	
	Total	125	30	155	376

The Sanskrit-school children who participated in our study attended the following schools:

1. **Mumukshu Bhawan:** This school for boys was established in 1920. Spread over five acres of land, it comprises a section for higher level education as well as a primary school for younger boys and a residence for aged holy people. The school premise also houses charitable Ayurvedic and homeopathic dispensaries, a guesthouse and some temples. The primary school enrolls fifty boys as students whose board and lodging is fully taken care of by the trust. The boys live in a hostel in care of the family of a school teacher. The students largely come from lower middle class Brahmin families living in rural areas near Varanasi. The school imparts education in subjects like history, geography, literature, philosophy, religion (including a variety of rituals), meditation and yoga.
2. **Nand Lal Bajoria Sanskrit Mahavidyalaya:** This school for boys was established by a lady in memory of her late husband and is operated by a trust. The trust includes a Sanskrit school, a school for the blind, a hospital for the poor, and some houses for teachers. The trust fully supports the board and lodging of eighty Brahmin children for learning Sanskrit for two years. Children mostly come from village areas of eastern Uttar Pradesh and Bihar. The school teaches not only Sanskrit language and a variety of rituals and religious practices, but also subjects like history,

geography and literature. In comparison to Mumukshu Bhawan, children of this school live in physically and economically less privileged conditions.

3. **Panini Kanya Mahavidyalaya:** This school is meant exclusively for the education of girls. It is different from the boys' schools mainly with respect to the degree of freedom allowed to students for outside movement. This school was founded as a small school, which has expanded during the last three decades. The school campus includes school buildings, a library, a hostel, residence for teachers, a guesthouse, a *Yagyashala* (place for worship), an armory, a cow yard, some land for the cultivation of plants for Ayurvedic medicine, and a kitchen garden. The school admits students from all parts of India regardless of caste, class or social background. The students are adopted as a child of a Gurukul family, and are hence renamed there. The school comprises seventy students and five full-time teachers. Education in this school places great emphasis on learning of Sanskrit grammar, developed by an ancient scholar, Panini, and which includes 4,000 formulae. Besides Sanskrit language and grammar, the curriculum includes the study of Vedas, Ayurveda, history, geography, English, martial arts, physical education, yoga, classical music and dance, cooking, animal husbandry, agriculture along with the rituals of different ceremonies of life (e.g. birth ceremony, sacred thread ceremony, etc.). The primary aim of this school is to preserve the cultural heritage of Sanskrit language and self-development of women. While the school combines job-oriented with self-oriented education, the ultimate aim is to help a student to discover her inner spirit and strength.

The Hindi-school children attended the following semi-private school:

Malviya Shiksha Niketan: This is a co-educational school that imparts education through the medium of Hindi language, although English is taught as a second language. It teaches girls and boys, but at different times of the day. Established some fifteen years ago, the school provides education to about 2,000 day scholars. Since the school is a profit-making organization, the students pay a good amount of money as a fee. Syllabi of the school are adapted according to the norms prescribed by the state government, which provides a subsidy. Hence, all subjects including science are taught in the school, and the school has no choice in this respect. The philosophy of education is to make students independent members of society so that as adults they are able to manage life on their own. The focus is on the overall personality development of children to ensure their success in life.

Results

Knowledge of NSEW and LRFB

The scores obtained by Hindi- and Sanskrit-school children for knowledge of cardinal directions (NSEW), inside and outside of the school building, and of left, right, front, and back (LRFB), are illustrated in Figure 6.1.

In the Sanskrit-school children, the performance on these tasks is almost perfect throughout all age groups, and better than in the Hindi school, even in their knowledge of LRFB ($F = 92.200$, $p < .001$ for NSEW and $F = 19.97$, $p < .001$ for LRFB). In the Hindi-school group, while the knowledge of LRFB is fairly accurate, the knowledge of cardinal directions is far from perfect, but increases with age. There is no difference, on the other hand, between performance inside and outside the building in either school group.

Language

Perspectives task Table 6.2 presents the mean scores of the two school groups on the various language categories (see Table 2.1) on the Perspectives task. The maximum score is 9.

Geocentric (G) language is used most frequently and systematically in both groups, although significantly more in the Sanskrit-school group. While we notice a very small gap between the use of G and its correct use (G+) in the Sanskrit school, there is quite a big gap in the Hindi school. This indicates that while children in the Hindi school also tend to use the normative G language more than E, they are less perfect in getting the directions right than the Sanskrit-school children. Nevertheless they use more E language (often correctly) than the Sanskrit-school children. Other categories such as deictic (D), situational landmarks (SL) and conventional landmarks (CL) are not used; even the values for intrinsic (I) are very low.

Road task The mean scores with respect to language use on this task are given in Table 6.3 for Hindi- and Sanskrit school children. The maximum score is 8.

This task, being close to the practice of moving about in city streets, is expected to elicit more egocentric descriptions. A clear difference between the two school groups is apparent: in the Sanskrit school, G language is almost exclusive, and it is generally also correct. E language is almost absent, but if used, is usually correct. In the Hindi school, E and G descriptions occur almost equally, but their use is not always correct. The other language categories (D, I, SL, CL) are negligible. This analysis suggests a dominant use of G language by the Sanskrit-school group, but of G and E almost equally by the Hindi-school group.

Table 6.2. *Spontaneous language use on Perspectives by school type*

Hindi vs. Sanskrit schools		G	G+	SL	CL	I	E	E+	D
Hindi	Mean	6.38	3.54	.08	.00	.24	2.06	1.34	.05
N = 221	SD	3.99	3.73	.81	.00	1.23	3.52	2.58	.47
Sanskrit	Mean	8.71	7.94	.00	.00	.03	.26	.22	.00
N = 155	SD	1.60	2.49	.000	.000	.40	1.46	1.26	.00
	F	47.50	164.62	1.56		3.91	36.11	25.22	2.04
	p	.000	.000	.212		.05	.000	.000	.154

The G+ and E+ scores reflect the correct use of these terms. F and p values for ANOVA.

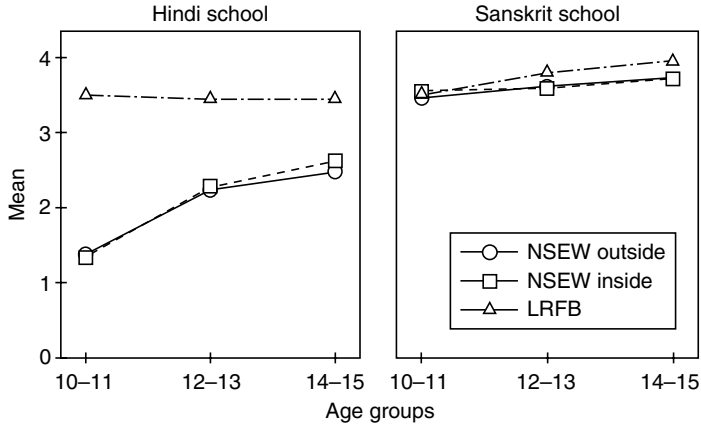


Figure 6.1 Knowledge of NSEW and LRFB by age and school type

Language on encoding tasks The language used on items 4 and 5 of the encoding tasks (Animals, Chips and Steve's Maze) is also geocentric, to a large extent, in both groups. Some E language is used in the Hindi-school group but never in the Sanskrit group.

In summary, our analysis indicates that, on the three language elicitation tasks, Sanskrit-school children spontaneously use G language almost exclusively. On the other hand, on the Road task, more than half of the Hindi-school pupils do not use G language at all, but use E, as expected from our previous results in Varanasi city (see chapter 4). On the Perspectives display, which is much more static, and on the six items of the encoding tasks for which language was recorded, all Sanskrit pupils (except five) use G language systematically. It is also more common with

Table 6.3. *Spontaneous language use on Road by school type*

Hindi vs. Sanskrit schools		G	G+	SL	CL	I	E	E+	D
Hindi	Mean	2.90	1.40	.03	.00	.00	3.90	2.20	.03
N = 221	SD	3.35	2.50	.47	.00	.00	3.34	2.21	.47
Sanskrit	Mean	6.10	5.50	.00	.00	.00	.86	.72	.00
N = 155	SD	2.30	2.60	.00	.00	.00	2.23	1.91	.00
	F	111.53	234.45	.70			100.61	45.00	.70
	p	.00	.00	.40			.00	.00	.40

Table 6.4. *Princals factor loadings for language elicitation tasks*

	Dimension 1	Dimension 2
Perspectives	.89	−.25
Road	.80	.60
Encoding	.88	−.29
Cronbach's alpha	.82	−1.4
% Variance explained	74	17

the Hindi-school children; nevertheless sixty-six of them use E language at least occasionally. It may be noted that on these tasks, virtually no other spatial references (such as intrinsic or landmarks) are used by either group.

Geocentric language factor score For each of the language elicitation tasks, a summary score was computed by subtracting E language from G, and these scores, treated as ordinal, were submitted to a Princals optimal scaling procedure. The results are given in Table 6.4. The object scores obtained on dimension 1, explaining 74 percent of the variance, will be used as the summary measure for the language variable.

Encoding

It may be recalled that in our previous study (chapter 4) we used only three animals and gave five trials to children on all tasks. The performance was evaluated in terms of the R-A gradient described earlier. The findings provided evidence for a relatively higher G encoding on the Animals task as compared to Chips or Steve's Maze.

In order to compare the present findings with the previous ones, we have calculated R-A gradients for the three tasks separately, counting only five items (and only three animals for the Animals task). From the first study, we only take the older age group, and from the main study the Hindi-school group. The results are provided in Table 6.5.

We again notice the usual difference between Steve's Maze, for which a majority of items are encoded in an egocentric mode, and the two other tasks, which produce more geocentric encoding. The difference between Animals and Chips task is marginal compared to the previous study.

Effect of task modification The Animals task is scored in two ways: 1) considering the three animals only, as in our first study; 2) using the more stringent measures (four animals, seven items) including two items with a rotation of the table at 90°. Similarly, for the Chips task, we can compare the

Table 6.5. *Comparison of R-A gradients in 1*st *study and in main study*

	Animals	Chips	Steve's Maze
1st study, age 12–14	75	53	40
Main study (Hindi school)	74	69	40

Table 6.6. *Princals component loadings for encoding tasks*

	Dimension 1	Dimension 2
Animals	.83	–.29
Chips	.83	–.25
Steve's Maze	.53	.85
Cronbach's alpha	.59	–.23
% variance explained	55	29

results with five items, and with seven (adding two items with a 90° rotation). There is a reduction in G encoding on the Animals task with the new criteria (from an average R-A gradient of 75 to 53), while this is hardly the case with Chips. The addition of the fourth animal raises the memory load, but allows us to eliminate items on which the children use an intrinsic FoR that could be mistaken for a geocentric one; this is also the case for the two additional items with a 90° rotation. The more stringent criteria no doubt give us a purer measure of geocentric encoding.

Summary measure on encoding In order to produce a summary measure for the three tasks (Animal, Chips and Steve's Maze), we used the Princals procedure. These results are summarized in Table 6.6. Animals and Chips load consistently on dimension 1, while Steve's Maze shows a different configuration. Dimension 1 explains 55 percent of the variance; object scores on this dimension will be used as a summary measure.

Comparison of Sanskrit and Hindi schools Table 6.7 shows a comparison of the mean object scores for language and for encoding in the two school types. These scores are much higher in the Sanskrit than the Hindi-school group. This is confirmed by the significant results of the analysis of variance (G language $F = 188.26$, $df = 1;374$, $p < .000$; G encoding $F = 72.12$, $df = 1;374$, $p < .000$).

Gender It may be noted in Table 6.1 that although we were able to include girls and boys in both types of schools, there is a gender bias in

Table 6.7. *Mean object scores on G language and G encoding by school type*

		N	Mean	SD
Object scores G encoding	Hindi schools	221	−.34	.97
	Sanskrit schools	155	.48	.83
	Total	376		
Object scores G language	Hindi schools	221	−.48	.87
	Sanskrit schools	155	.69	.73
	Total	376		

Table 6.8. *Pearson correlation coefficients between school type, gender, age, language, and encoding*

	Gender	Age	G language	G encoding
Hindi vs. Sanskrit schools	−.58**	.23**	.57**	.35**
Gender		.01	−.28**	−.23**
Age			.17**	.17**
G language				.39**
N = 376				

** Correlation is significant at the 0.01 level (2-tailed).
School type is scored 1 for Hindi and 2 for Sanskrit school; gender: boys 1, girls 2.

sampling in the two schools (more girls in the Hindi school, and more boys in the Sanskrit school). This requires the analyses to be carried out separately for each school type, or to control for school type statistically, for example through partial correlations.

Pearson correlation coefficients between school type, gender, age, G language, and G encoding are shown in Table 6.8. The strongest correlations occur with school type, the sampling bias being indicated by the −.58** correlation with gender. The partial correlation coefficients, controlling for school type, are shown in Table 6.9.

As we can see in Table 6.9, the correlations with gender disappear when school type is controlled. This in fact confirms the absence of any gender effect. We had found no gender effect in the first research with children aged 4 to 12 years, in the village and in the city. In this study, when we control for school type, there is also no significant effect of age, which is what we expected from the selection of older children only.

In a previous publication (Vajpayee, Dasen, & Mishra, 2008), we took the gender effect at face value, and tried to explain it. We looked into the background of boys and girls in Sanskrit schools, and found that although the

Table 6.9. *Partial correlation coefficients between gender, age, language, and encoding, controlling for school type*

Control variable: Hindi vs. Sanskrit schools	Age	G language	G encoding
Gender	.17**	.06	−.04
Age		.06	.10
G language			.25**
N = 376			

** Correlation is significant at the 0.01 level (2-tailed).

curriculum for both was the same, the boys' experience of the outside world was quite different. Most of them came from rural areas, and had attended regular government schools, while the girls had joined their residential Sanskrit school at an early age, and were then separated from their families. The girls were also not allowed to leave the school compound, while the boys moved about relatively more freely for various purposes. While this experiential difference is genuine, and may well produce gender differences, we do not in fact need to invoke it to explain our data.

Language and encoding

In our previous study in the city of Varanasi, we had found no correlation between G language and G encoding, but a negative one with E language (−.18* to −.23**). In the village sample, on the other hand, we had found a significantly positive correlation between G language and R-A gradient on the Animals and Chips tasks (.23** and .25**), but not on the Steve's Maze (cf. Table 4.9).

In this study, the Pearson correlation between G language and G encoding is .39** (see Table 6.8). However, both of these variables are also significantly correlated with age (to the order of .17**) and to gender (−.28** and −.23**). Therefore, a control for these variables is essential, which we achieve by working out partial correlations. Controlling for age and gender, the partial correlation is .33** and controlling for school type (see Table 6.9) reduces the coefficient to .25**. Controlling for grade or years of schooling does not change the value of this correlation further. This confirms that we find a stronger relationship between language and encoding than in the previous study in Varanasi. This could be due to the fact that this relationship is constructed gradually during children's development, so it is more stable in such a homogeneous group of older children than when the whole age range from 4 to 12 is considered. However, the correlation may possibly not be structural,

but mediated through other variables, as we will see with the Amos summary model presented at the end of the chapter.

G language, encoding and psychological differentiation

The SPEFT and BDT have been widely used to assess children's spatial cognitive development. We use them here to test whether G language or G encoding is linked to other spatial cognitive processes. From previous research in India and Nepal, we expect that the scores on these spatial tests would be positively correlated with a child's geocentric orientation. The outcomes of correlational analyses are given in Table 6.10. It may be noted that both SPEFT and BDT scores correlate significantly and positively with G language and G encoding. The significantly positive correlation between SPEFT and BDT scores (.35**) suggests that they measure largely the same process, called psychological differentiation. However, the analysis also reveals that age and school type are significant correlates of SPEFT and BDT, and so is gender for SPEFT. Controlling for age, school type and gender, we find significant partial correlations of G encoding with BDT (.11*) and SPEFT (.12*). Although the values of the correlations are low, they are statistically significant, and in the predicted direction. On the other hand, the correlations with G language disappear completely when partialed.

These findings indicate that a geocentric understanding of space is a relatively pervasive cognitive activity. It is significantly linked to fundamental spatial cognitive ability as measured by SPEFT and BDT. While part of this relationship is mediated by age, school type, and, to some extent, by gender, the ability as such does not rely on these factors for its structural organization.

On the other hand, the stronger expression of G language and G encoding in Sanskrit-school than in Hindi-school children suggests that the use of the ability can be sharpened by its practice and actualization in day-to-day life. We have noted that Sanskrit-school children receive an organized set of experiences and training to deal with space largely in a geocentric manner. This makes them highly sensitive to the geocentric spatial cues, and helps them in orienting themselves in the environment. In fact, most of the daily activities of Sanskrit-school children link them to their physical, social, religious, and spiritual worlds in a geocentric manner. Their previous learning of geocentric references in the village environment gets reinforced in the city with Sanskrit schooling to the extent that a geocentric orientation to space becomes almost an unconscious activity. Although a geocentric orientation also exists in the environment of Hindi-school children, it is not so strongly emphasized in their daily routines, except in the matters of eating, sleeping and a few other activities.

Table 6.10. *Pearson correlation coefficients with BDT and SPEFT*

	G language	G encoding	BDT	SPEFT	Gender
G language	1	.39**	.14**	.19**	−.28**
G encoding	.39**	1	.16**	.22**	−.23**
BDT	.14**	.16**	1	.35**	.04
SPEFT	.19**	.22**	.35**	1	−.21**
Age	.17**	.17**	.21**	.14**	.01
Hindi vs. Sanskrit schools	.57**	.35**	.13*	.28**	−.58**
N = 376					

* $p < 0.05$, ** $p < 0.01$.

Correlates of geocentric spatial orientation

In the comparison of Sanskrit- and Hindi-school children, we have noted the predominance of geocentric references among the former. Our observations in the schools have allowed us to hypothesize that regular opportunities for teaching, learning and practice of the geocentric reference system in Sanskrit schools are mainly responsible for the development of a strong geocentric orientation among Sanskrit-school children. In this section we try to describe the role of some other factors, particularly in the home setting, which might be linked in important ways to the development of the geocentric frame of reference.

Background data from child and home questionnaires

We developed questionnaires for interviewing children as well as their parents on a number of aspects of their life (reproduced in full in Appendix 1). In the child questionnaire, we focus on the child's own mobility (e.g. riding a bicycle or a motor bike), the distance from home to school, means of transport, visits downtown, the mobility of the family, the child's participation in activities outside the school (e.g. tutoring, sports, religious activities, artistic activities, chores), the child's contact with a village, and the languages spoken in the home.

With the home questionnaire, we examine the family's and child's migration history from village to city, the parents' educational practices, their level of education and occupation, presence of media (newspaper, books, radio, TV, etc.), languages spoken in the home, and the affluence and SES of the family. We also recorded the mother's and father's use of spatial language by using the

Perspectives task (three items only), and by asking them to describe a route to a well-known location.

Child questionnaires were used with eighty children and home interviews with sixty-six, of which fifty came from the Hindi school because it was rather difficult to obtain home interviews for the Sanskrit-school children, who lived in boarding schools away from their families.

Since most of our data on the questionnaires are of a categorical nature, and are fairly exhaustive, we use the Princals data reduction procedure applicable to categorical data to produce "object scores" representing broader dimensions of social-demographic variables.

Children's activities

In the child questionnaire we collected information on a number of activities that might take the child away from home. Some of our previous research in other locations (Dasen, 1984; Mishra, 1996) had demonstrated that children who move away from home to different locations develop spatial cognitive abilities more than those whose movements are more restricted. Guided by this hypothesis, we collected information about children's spatial mobility.

These variables were used for a Princals analysis, the results of which are presented in Table 6.11 and Figure 6.2. Note that most variables represent not the frequency but the distance at which the respective activities are carried out.

Dimension 1 represents mainly the variables that involve the children's mobility on their own (cycling, going downtown, sports, and play) vs. activities with the family (family outings, religious activities). We therefore label it *independent mobility*. Dimension 2 reflects the distance from home to school vs. living close enough to school to walk there. In a similar analysis in the Kathmandu sample (see chapter 7), where we find much the same configuration, being taken to school by car also loads on this dimension, but in Varanasi this does not apply. We can still give this dimension the same meaning as in Kathmandu, namely that of *passive mobility*. Object scores on these two dimensions will be used as summary measures for independent and passive mobility.

Village contact

In the child questionnaire we included a number of items to seek information about a child's contact with the rural area. Our previous study had indicated that village children were using mainly a geocentric FoR in language and encoding. We focused on whether the family has relatives in the village, how often the family goes there for a visit, how often the child goes there and stays for more than a week, and how often a person from the village comes for a visit to the family. The outcome of a Princals analysis of these variables is presented in Table 6.12.

Table 6.11. *Component loadings on Princals analyses of mobility measures*

	Dimension 1	Dimension 2
Owning a bicycle	.52	.43
Distance to school	.25	.75
Walking to school	−.11	−.65
Frequency of visits downtown	.68	−.09
Distance tutoring	−.17	−.06
Distance sports and play	.71	.10
Distance artistic activities	−.11	.28
Distance shopping	−.11	.64
Distance chores	.27	−.24
Distance playing with peers	.52	.05
Distance family outings	−.71	.13
Distance religious activities	−.51	.05
Distance other activities	.55	−.45
Cronbach's alpha	.69	.53
% variance explained	58	42

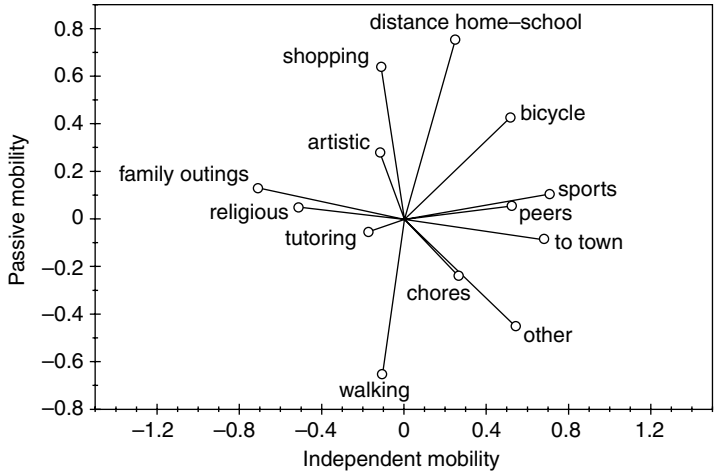


Figure 6.2 Graphic representation of Princals derived two dimensions of mobility

All variables turn out to be clearly placed on dimension 1, which accounts for 81 percent of variance, except for "week in a village," which also has a leaning to dimension 2. There is a high degree of consistency among these variables (Cronbach's alpha = .94), indicating that object scores on the first dimension may be treated as a good summary measure of "village contact."

Table 6.12. *Princals component loadings for village contact*

	Dimension 1	Dimension 2
Relatives in village	.97	−.20
Family's visit to village	.97	−.19
Child's visit to village	.91	.19
Spending a week in the village	.71	.68
Visits from the village	.91	−.30
Cronbach's alpha	.94	−.65
% variance explained	81	13

Table 6.13. *Princals analysis of SES status variables*

	Dimension 1	Dimension 2
Father's education	.67	.45
Mother's education	.71	.41
Father's occupation	.61	.61
Level of affluence	.91	−.34
Number of rooms	.77	−.44
Quality of residence	.91	−.34
Cronbach's alpha	.87	.18
% variance explained	60	20

SES

The variables related to SES were contained in the home questionnaire, which was used with parents. The items probed into the level of education of both parents (father and mother) and also their occupation. During the home visit, the assistants evaluated the residence in terms of the number of rooms and its overall quality on a five-point scale. They also evaluated the general level of affluence of the family based on their overall impression formed during the home visit. The Princals outcomes are provided in Table 6.13.

Dimension 1, which explains 60 percent of variance, provides a reasonable summary measure for SES. Dimension 2 opposes the father's and mother's education, and the father's occupation to the variables of wealth. The mother's occupation could not be included in this analysis, because there were only two mothers out of a group of sixty-six who had an occupation; others were "homemakers."

Media

During home visits, the availability of different media was assessed. The presence or absence of newspapers, books, radio, TV, and video games in the

Table 6.14. *Princals component loadings of media variables*

	Dimension 1	Dimension 2
Newspapers	.84	–.14
Books	.70	–.35
Video games	.69	–.35
TV	.68	.40
Radio	.42	.77
Cronbach's alpha	.71	.03
% variance explained	46	21

families was recorded. These media are usually in Hindi, although some TV channels in English are progressively available. The Princals analysis is presented in Table 6.14. Dimension 1 provides a summary measure explaining 46 percent of the variance.

Migration history

In the home questionnaire, we asked a number of questions related to the family's migration from villages to the city. Data were available for fifty families of the Hindi-school group (H), and sixteen from the Sanskrit-school group (S). Additional information regarding the family's migration history was obtained from fourteen Sanskrit-school children. Thus, for some variables, we have data for sixty-six cases only, while for others, data for all eighty cases are available.

The analysis reveals a clear difference between the Sanskrit- and Hindi-school groups with respect to their migration history. In the H group, 22 percent of the children were born in a village rather than in Varanasi (or in another city), whereas in the S group 81 percent of the children were born in a village. In the S group, children had moved to Varanasi more recently, between four and six years ago (probably when they joined the Sanskrit school), while in the H group, most children had been in Varanasi much longer (mean 9.6 years, SD 4.7).

We created three broad categories based on whether the child's and parents' background was more from a village, or more from the city, or from the city only. Table 6.15 presents the distribution of Sanskrit- and Hindi-school children with respect to their city or village background. A clear contrast between Hindi- and Sanskrit-school children can be noted. While 82 percent of the Hindi-school children have spent all their time in the city, approximately the same percentage of Sanskrit-school children have spent most of their time in a village.

As to the parents, 56 percent of the fathers and 42 percent of the mothers in the Hindi-school group were born and had spent all their lives in a city, and

Table 6.15. *Frequencies and percentages of children with village or city background by school type*

Child in city category	Hindi schools	Sanskrit schools	Total
More village	7 (14%)	25 (83%)	32 (40%)
More city	2 (4%)	2 (7%)	4 (5%)
City only	41 (82%)	3 (10%)	44 (55%)
Total	50	30	80

Table 6.16. *Princals component loadings for migration history*

	Dimension 1	Dimension 2
City stay father	.97	−.11
City stay mother	.94	−.36
City stay child	.85	.53
Cronbach's alpha	.91	-2.05
% variance explained	86	14

only one mother had a fully rural background. In the Sanskrit-school group only 7 percent of the fathers and none of the mothers were born in a city and had lived there all their lives, while 60 percent of the fathers and 73 percent of the mothers had a fully rural background.

The outcome of a Princals analysis on these variables is presented in Table 6.16.

Dimension 1, which explains 86 percent of the variance, is a summary measure of the family's degree of contact with the city, i.e. in fact the opposite of migration. In later analyses we reverse the sign of this dimension to represent migration from the rural area.

The child's city stay, while still loading on dimension 1, is opposed to the parents' measures on dimension 2. This indicates that the length of a child's stay in the city is not always linked to the length of their parents' stay there. While parents may stay in the city, children may stay in the village with the larger family and join their parents later, or when they need to be put in schools in the city for a better education.

Correlations among background variables

Table 6.17 shows the Pearson correlation coefficients between the various summary scores for the background variables.

Table 6.17. *Pearson correlation coefficients between the various summary scores for the background variables and school type.*

	Village contact	SES level	Media	Migration (city stay reversed)	Hindi vs. Sanskrit schools
Independent mobility	.31**	.05	−.42**	.36**	.55**
Passive mobility	−.17	.13	.03	.00	−.06
Village contact		.19	−.24*	.37**	.40**
SES level (dim. 1)			.57**	.25*	.19
SES education vs. affluence (dim. 2)			.16	−.23*	−.40**
Media				−.09	−.48**
Migration					.89**
N	80	66	80	66	66/80

* $p < .05$, ** $p < .01$.

The Sanskrit-school group shows more independent mobility, more contact with the village, a lower educational and occupational level of parents, less contact with media, and a higher rate of migration from the rural area. On the other hand, there is no correlation with the overall SES level, nor with passive mobility. The correlation with dimension 2 of the SES indicators suggests that the parents of Hindi-school children are not only more educated, but their fathers are also in relatively higher-level occupations (e.g. government employment or managerial) than those of the Sanskrit-school children.

These correlations show a coherent pattern. Independent mobility is also higher in families who have more contact with the village and who have migrated, and who have less media contact with the outside world. Note that passive mobility does not correlate with anything in this sample, probably because the children in our sample live either near the school or in boarding schools, and therefore don't have to be taken there.

Correlations of language and encoding with background variables

It was expected that a child's background variables would be linked in significant ways with the use of spatial language and encoding. In order to examine these relationships, correlations between the object scores for background variables derived from the Princals and knowledge of cardinal directions, G language and G encoding were computed. These correlations are given in Table 6.18. We also included the two spatial ability tests, BDT and SPEFT, but no correlations were found for these.

The three variables that produce consistent correlations with the geocentric FoR are contact with the village, migration from the rural area and a negative correlation with media contact. Independent mobility is linked significantly only to G language. Passive mobility and SES show no significant correlations.

Since, in the Sanskrit-school group, we have pupils whose families continue to live in rural areas, these variables are in fact more relevant to the Hindi-school group. Hence, we computed these correlations separately for each group. This analysis confirmed the importance of migration history for the Hindi-school group, while none of the correlations are significant in the Sanskrit-school group (but it has to be remembered that N is quite small in this sub-sample). These findings confirm the hypothesis we formulated earlier, namely that the city dwellers who tend to use a geocentric FoR are mainly those who have migrated from the rural areas.

The negative relationship of the geocentric FoR with media contact is not linked to SES, which shows no significant correlations. Media contact may be a proxy measure of "acculturation," i.e. contact with the outside, wider world. Many middle class families now have cable connections through which they have access to a large number of channels, including some Western ones, and children often watch cartoon programs in English. It therefore makes sense that media contact fosters an egocentric FoR rather than a geocentric one.

Summary model

Amos modeling was used to derive a summary model showing the relationships among the variables of the study. The modeling was carried out with the sub-sample of eighty children, since several of the background variables were available only for this group.

The summary model is illustrated in Figure 6.3. Fit statistics are quite satisfactory. We of course tried several alternatives, which did not produce such a good fit. To increase legibility, the graph does not include so-called "error terms" which represent individual variation on each variable.

In Varanasi, the socio-cultural variables such as language spoken in the home (Hindi or Bhojpuri, the local dialect of Hindi) or SES are relatively unimportant, and do not congregate to form a virtual "traditional culture" variable as they do in Bali and Kathmandu. The age range of the sample is more reduced (11–15) than in Bali (chapter 5) and Kathmandu (chapter 7), so that age does not come into the model as a significant variable.

The main variable that figures at the top is school type, Sanskrit vs. Hindi. The importance of this variable was brought out by all of the separate data analyses. It should be mentioned, however, that this variable covers by itself a large array of socio-cultural aspects, namely variables that were so closely

Table 6.18. *Correlations between background variables and measures of geocentric knowledge, language and encoding*

	Knowledge of NSEW	G language	G encoding
Independent mobility	.19	.28*	.19
Passive mobility	.04	.04	.09
Village contact	.26*	.39**	.31**
Migration	.44**	.52**	.39**
SES level	.19	.05	.00
SES educ vs. affluence	–.18	–.13	–.09
Media	–.23*	–.28*	–.25*
Hindi vs. Sanskrit schools	.43**	.35**	.35**

* p < .05, ** p < .01.

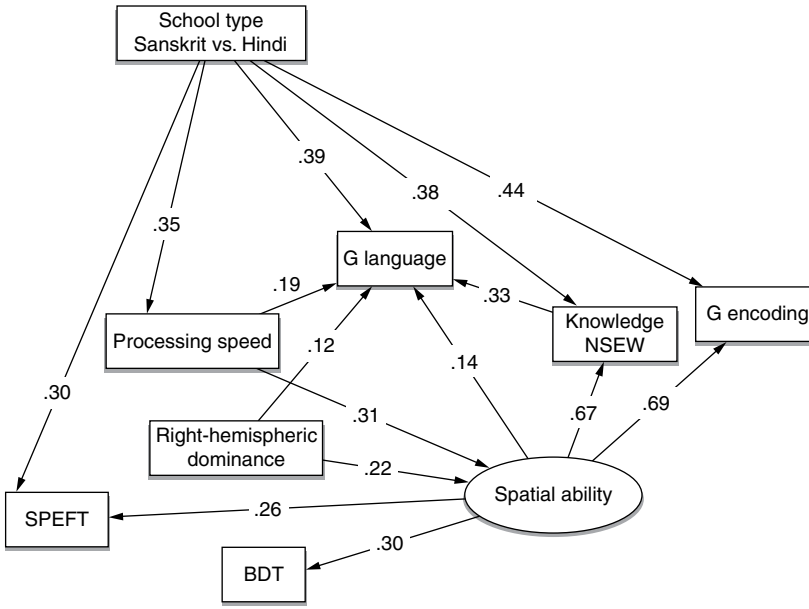


Figure 6.3 Amos summary model for Varanasi
CMIN = 7.300 df = 12 p = .837
RMSEA = 0 GFI = .978 CFI = 1 TLI = 1.058

linked to school type that they could not be introduced separately into the model. This is the case, for example, for migration history and contact with the village, two aspects that were linked to using G language in separate analyses.

Instead of the socio-cultural aspects, which are better brought out in Bali or Kathmandu, in Varanasi the interesting aspect of the model is the contribution of a virtual variable, "spatial ability," which is quite strongly linked to knowledge of the NSEW orientation system, and G encoding, and weakly to G language. This variable is assessed through SPEFT and BDT, the two measures of psychological differentiation. Performance on SPEFT is itself linked to school type, indicating that Sanskrit-school pupils seem to have overall better spatial skills.

Spatial ability is also influenced by other cognitive process measures, notably overall processing speed (mean reaction time on the lateralization task), and right-hemispheric dominance (on the same test). These measures are described in chapter 13 on the neurophysiological correlates of the geocentric FoR. They also show a direct link to G language, which could indicate that those who have a faster processing capacity, especially in the right hemisphere, are better able to deal with the complex aspects of geocentric language, independently of, or in addition to, the link through spatial ability, which is itself more strongly linked to knowledge of the orientation system and encoding than to language.

A striking feature of the model is the absence of a direct relationship between spatial language and encoding; introducing a link, in either direction, reduces the fit statistics. On the other hand, the model shows that geocentric language itself is part of a pattern that includes socio-cultural variables subsumed under school type, and other psychological and neurophysiological characteristics of children.

Thus, the study at Varanasi brings out not only the complexity of experiences embedded in the eco-cultural system, but also the role of different elements of this system in the organization of spatial language and cognition. The message is clear: spatial cognitive processes cannot be attributed to a single cultural variable called language; a number of other variables that constitute the textured context of children's development need to be considered in order to understand the relationship between language and cognition.

7 Kathmandu

Our main reason for conducting this part of the research in Kathmandu was to study a group of children who are bilingual between a language that has a preference for the geocentric FoR (Nepali) and one that usually favors the egocentric frame (English – at least in the way it is used in the UK and USA). From chapter 5, it will be remembered that such a comparison occurred without our prior planning in Bali between monolingual Balinese speakers and those who preferred to speak Indonesian (a language which also favors an egocentric FoR), or spoke it to some extent at home. The results in Bali were quite striking, so we can expect to find a similarly strong effect of English.

Since the Nepali vs. English school contrast is the basic design of the project in Kathmandu, some details about these schools, and the socio-cultural background in which they occur have been provided in chapter 3 in addition to the general background description for this location. It will be recalled that in the city of Kathmandu, the geocentric orientation system that is current is the use of cardinal directions (NSEW). Even though mountains are visible on the northern horizon, the "up/down" reference we found in Dolakha (see chapter 4) is not used.

Since English is the compulsory language in English schools, our testing was also performed in English, except that Nepali was used for additional explanations if that seemed necessary, or if the pupils themselves preferred Nepali. In Nepali schools, testing was carried out in Nepali. Because of several organizational constraints, sampling had to be spread out over ten different schools. The sample characteristics are provided in Table 7.1.

Results

Knowledge of NSEW and LRFB

It will be remembered from the task descriptions in chapter 2 that, for this task, we simply asked the children to point to the four cardinal directions (NSEW), first outside of the school building, and then inside the testing room, and we

Table 7.1. *Sample characteristics, Kathmandu*

Types of schools	English schools			Nepali schools		
AGE	GENDER			GENDER		
	Boys	Girls	Total	Boys	Girls	Total
4	11	11	22	10	11	21
5	11	11	22	11	11	22
6	11	11	22	11	12	23
7	11	11	22	11	11	22
8	11	10	21	11	11	22
9	11	12	23	11	11	22
10	12	11	23	11	11	22
11	10	13	23	12	12	24
12	11	11	22	11	11	22
Total	99	101	200	99	101	200

also asked them for their knowledge of the egocentric terms (LRFB). We expected that getting the cardinal directions right outside is relatively easier, since one can locate the position of the sun, and that the difficult part is to carry this knowledge inside. This is particularly true insofar as some of the school rooms that were used for testing were rather dark, and it would have been difficult to locate the sun through the windows. However, for the children in this study, it made no difference. The correlation between the performance outside and inside is .998.

Table 7.2 shows the frequencies by age groups of the number of cardinal directions that are known correctly. The maximum score is 4.

In the youngest age group, almost none of the children know the cardinal directions, while starting with age 7–8 in the English group and 9–10 in the Nepali group, about half of the children do so. Some of the children get one axis correct but not the other one.

The NSEW system, while it is the cultural norm for children in both types of schools, is in fact not acquired by all of the children even by age 11–12. This provides sufficient variation for correlational analyses, looking into which variables are linked to the use of the geocentric FoR. ANOVA indicates a significant effect of age, and a significant difference between the school groups, in favor – surprisingly – of the English school group ($F = 4.83$, $p < .05$).

But all children also have to learn the egocentric FoR. When we ask the children about LRFB, English schooling does have some impact, insofar as all

Table 7.2. *Knowledge of cardinal directions, indoors, by age group and school type*

		Age groups				
	Items correct	4–6	7–8	9–10	11–12	Total
English	0	57	18	16	7	98
	1	1	4	1	0	6
	2	5	3	10	12	30
	3	0	0	0	1	1
	4	3	18	19	25	65
	Total	66	43	46	45	200
Nepali	0	64	32	14	12	122
	1	1	0	1	3	5
	2	0	5	6	5	16
	3	0	0	0	0	0
	4	1	7	23	26	57
	Total	66	44	44	46	200

four egocentric references are known perfectly at age 5 in the English school, while in the Nepali group some of the children before age 8 know only "left/right." ANOVA indicates a significant difference between the school groups ($F = 9.173$, $p < .01$) in favor of the English group.

Spatial language development

Perspectives task Spatial language development in Kathmandu is illustrated in Figure 7.1 by the language used spontaneously on the Perspectives task (the graph shows the mean number of items, out of nine, for each language category).[1] Note that for geocentric language (G), we distinguish between the simple use of cardinal directions and their correct use (G+).

Language in the younger age groups (4 to 6) is strongly characterized by D (deictic – "this way"), usually accompanied by a gesture. It will be remembered from chapter 4 that D is also prominent at that age in the village of Nepal, and in both locations in India, while it does not occur in Bali. We will analyze this in great detail in chapter 11, where we use the children's gestures to show that, in most cases, D corresponds to a geocentric FoR.

[1] At each age, the total adds up to 9; minor discrepancies are due to a few missing or non-codable items. A presentation with bar graphs would have pointed this out better, but a line graph brings out the changes of language use with age. The language categories are presented in Table 2.1.

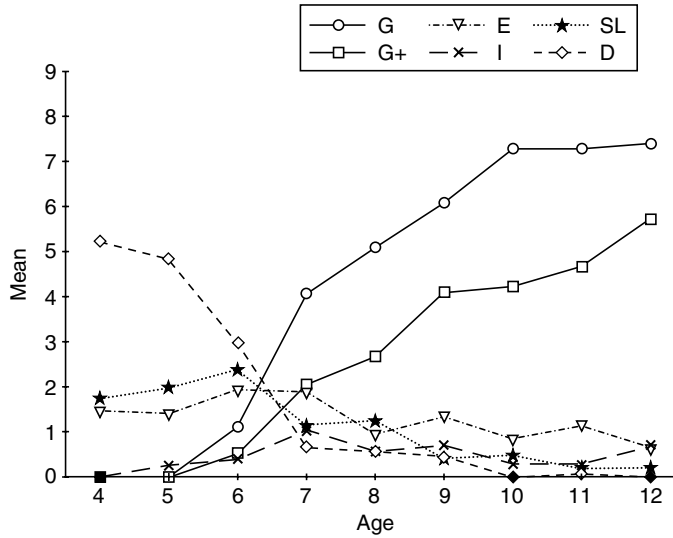


Figure 7.1 Spontaneous language on Perspectives

In this younger age group, situational landmarks (SL – e.g. "to the window") also occur, and diminish with age. Egocentric (E) language occurs throughout the age groups, but only to a small extent (on average 1.5 items out of 9 up to age 7, 1 of 9 thereafter), and is generally speaking correct. Some intrinsic (I) references occur in the middle age group, while conventional landmarks (CL) are almost never used (the graph therefore does not show the lines for E+ and CL).

Geocentric (G) language clearly replaces D by age 7, and it continues to increase with age to predominate fully over all other language categories. The difference between G and G+ shows that, while using cardinal directions becomes the norm, it is not so easy to do it correctly, at least inside a room and for such a table-space task. Even in the older age groups, there remains a gap.

It might be expected that this pattern of language use would be quite different between the English and the Nepali school pupils. That this is not the case is illustrated in Figure 7.2, where the same data are analyzed by school type.

Contrary to our expectation, there is no major difference between the two school groups in the language the children use. G language increases with age in both groups, and there is a similar difference between G and G+ in both groups. ANOVA indicates a significant effect of age, but no difference between the two school groups (and no interaction effect). E language occurs in both

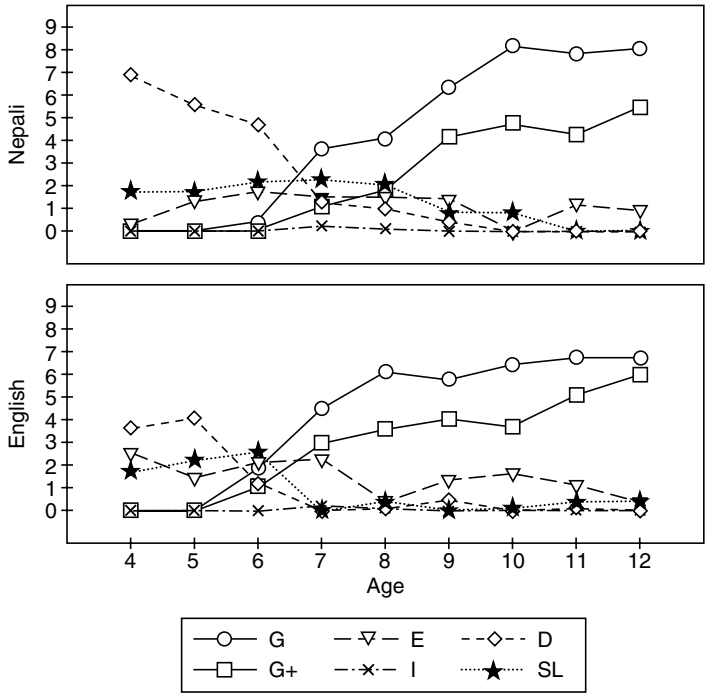


Figure 7.2 Spontaneous language on Perspectives by age and school type

groups to about the same extent (Mean E = 1.4 and 1.1 respectively in English and Nepali schools); ANOVA indicates no significant difference between the two school groups, and no significant effect of age. Note that D is significantly more frequent in the Nepali school.

Road task The results for this task are provided in Figure 7.3. On this task, the children in the Nepali school produce significantly more G (and G+) language than in the English group ($F = 29.556$, $p < .01$ for G, $F = 13.948$, $p < .01$ for G+), and the opposite for E language ($F = 13.948$, $p < .01$). There is also a statistically significant effect of age, and an age by school group interaction for G and E. These results are hence closer to what was initially expected, given the language of instruction. This is possibly due to the fact that this task deals with movement in space rather than with the static description of positions on Perspectives.

A small mishap occurred with this task in Kathmandu: since the table-top model had toy objects displayed along the path, many children used these objects on the display to give directions (e.g. "go to the house, now turn to

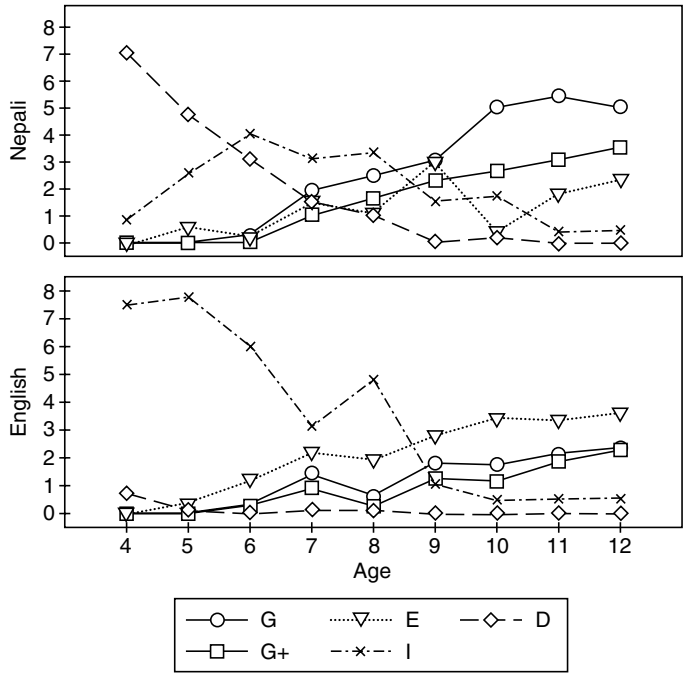


Figure 7.3 Spontaneous language on Road by age and school type

the tree"). Using such landmarks on the display is akin to what we classify as intrinsic (I) language, which unfortunately tells us little about whether a G or E FoR is being used. This is particularly frequent in the English school group at ages 4 to 8 years, but also occurs to some extent in the Nepali group, in which an important part of the language used is D up to age 7, while this is not the case in the English group.

Language on encoding tasks On items 4 and 5 of the three encoding tasks, the youngest age group again uses many D, as well as some E and SL up to age 9. ANOVA indicates a significant difference between the two groups in the use of E (Mean 1.4 and .5 respectively in English and Nepali groups, $F = 30.288$, $p < .01$). Geocentric language predominates in both groups by age 8, and further increases with age. There is no significant difference between school types on G.

Language summary measure In order to produce a summary measure for geocentric language combining all three tasks, geocentric language

Table 7.3. *Princals analysis of language elicitation tasks*

	Dimension 1	Dimension 2
Perspectives	.93	−.28
Road	.46	.89
Encoding	.96	−.15
Cronbach's alpha	.77	−.19
% variance explained	67	30

scores were computed by subtracting E from G items. The scores of the three tasks were combined by Princals and the outcome is shown in Table 7.3. The factor scores on dimension 1 are used for further analyses.

If we compare the two types of school on this summary variable, an analysis of variance shows that the only significant effect is that of age ($F = 10.888$, $p < .001$); school type, and the interaction between age and school type, are not significant.

In conclusion, learning English and learning in English at school makes little difference to what spatial language is used, especially for static spatial displays. We had expected that becoming familiar with and using a language in which the egocentric FoR usually predominates would give this frame more importance, and increasingly so with age, as this experience accumulates. Why is this not so?

Since the teachers are all Nepali in both school systems, even those who teach in English in fact seem to use the culturally normative geocentric spatial orientation system, rather than egocentric references. What counts is actual language use in a speech community, and in this case, the use of spatial references seems to deviate from those usually expected for English.

Encoding

Urban/rural comparison To look at the results for the three encoding tasks, let us first of all compare the new city results to those of our previous study in rural Nepal (Dolakha). For this, we will use the data with five items only for Animals and Chips, considering only the orientation of three animals in a row, and presenting them in the same format (R-A gradients, i.e. proportion of G encoded items out of five items, with distractors, if any, counting as half) as in our previous study.

Note that this rural/urban comparison is not as well controlled as the one in Bali or in India; all of the children know Nepali, but that does not mean that it

Table 7.4. *R-A gradients on three spatial encoding tasks by age-group, rural/urban*

	Dolakha (rural) [N = 144]			Kathmandu (urban) [N = 400]		
	Animals	Chips	Steve's Maze	Animals	Chips	Steve's Maze
4–5	59	42	—	41	49	49
6–8	75	57	47	51	41	38
9–11	83	64	45	70	46	32
12–14	88	71	43	73	51	31

is their first language in the rural area. The R-A gradients are shown in Table 7.4.

The R-A gradients of geocentric encoding are systematically lower in the city than in the village of our previous study, except for the 4–5 year olds on Chips. On Chips and Steve's Maze, they are even below .50 in the city, which means that, in fact, an egocentric encoding is slightly predominant on these tasks as it is with Steve's Maze. Overall, these results confirm the ecological factor that we have found in India and in Bali, namely that the geocentric FoR is more pronounced in rural compared to urban areas, no doubt because an egocentric FoR is more functional in the city.

The three tasks produce rather different trends with age. Animals shows a clear increase of geocentric encoding with age, Chips also but more strongly in Dolakha, and Steve's Maze exhibits the opposite trend (correlations with age in city sample: .45** for Animals, .12* for Chips and –.26** for Steve's Maze).

Task specificity What we can also see in the above data is that the three encoding tasks systematically produce different results, with more geocentric encoding for Animals, intermediate for Chips and lowest for Steve's Maze. This task specificity has also been confirmed in India and Bali.

So far, for comparative purposes, we have used the R-A gradient for five items on each task. The question arises whether using more stringent measures changes the results. R-A gradients computed with the new measures (four animals, seven items including two with 90° rotation) are presented in Table 7.5 (note that on Steve's Maze, no change was made to the procedures).

The more stringent measures produce a lower R-A gradient. This is particularly noticeable on Animals. It is therefore likely that our previous measures were overestimating geocentric encoding. In the task format with a single

Table 7.5. *Mean R-A gradients (and SD) by age group and task demands*

Age groups	Animals			Chips	
N	3 animals 5 items	4 animals 5 items	4 animals 7 items	5 items	7 items
4–6	45 (27.6)	31 (23.8)	25 (20.1)	46 (24.6)	38 (21.4)
132					
7–9	57 (31.9)	44 (31.61)	39 (28.8)	43 (29.6)	36 (27.4)
132					
10–12	71 (30.4)	60 (31.0)	55 (29.4)	48 (35.3)	46 (34.7)
136					

Table 7.6. *Princals results on non-verbal encoding tasks*

	Dimension 1	Dimension 2
Animals	.87	−.13
Chips	.86	.18
Steve's Maze	−.04	.99
Cronbach's alpha	.50	.04
% variance explained	50	34

line of three animals, some intrinsic responses can be mistaken as geocentric. However, the overall pattern, particularly the age trend, does not change.

There is a .40** correlation between Animals and Chips (which is not spuriously produced by the same age effect: controlling for age and years of schooling, the partial correlation is .37**). On the other hand, there is no correlation between these two tasks and Steve's Maze.

Summary measure, encoding The results of the data reduction carried out with Princals are presented in Table 7.6. As in Bali and Varanasi, Animals and Chips show a similar contribution to dimension 1, while Steve's Maze loads on dimension 2. Despite a low alpha value, object scores on dimension 1 will be used as the summary measure.

School type and encoding ANOVA comparing the English and Nepali groups on the encoding summary score shows a significant difference ($F = 5.115$, $p < .05$), with more geocentric encoding in the English group.

There is also a significant ($F = 3.548$, $p < .01$) school type by age interaction. This effect of more geocentric encoding in the English group, and a stronger increase with age in that group, is just the opposite of our prediction, since we expected more egocentric encoding in the English school.

To summarize this section on encoding, the findings replicate our previous research on the impact of urban vs. rural ecology, and the fact that the choice of a FoR for encoding is not homogeneous across different tasks. In particular, in all of our data, Steve's Maze always fosters more egocentric encoding than the two other tasks. Specific to this study, the comparison between English and Nepali schooling contradicts the predictions we made on the basis of the results of bilingual children in Bali. In Kathmandu, bilingualism with English does not seem to foster more egocentric encoding.

G language and encoding Of interest also is the correlation between G language and G encoding. In any form of the linguistic relativity hypothesis, this correlation should be high. However, here again, we find a statistically non-significant correlation (.11) in Kathmandu, much lower than in Varanasi (.39**, partialed for age .33**) and Bali (.46**, partialed for age .38**). Note that, if these correlations are computed separately for the two school groups, it is somewhat higher in the English group (.22*) but even lower (.002) in the Nepali school.

Again, these results argue against a strong link between language use and encoding. Nevertheless we will see at the end of this chapter, when we look at a path model including many variables, that we get a better model fit with such a link (contrary to what happens in Bali and Varanasi).

Language and encoding on specific items At the micro level of single items on the encoding tasks, we can also compare the encoding to the justification given by the children, and see whether these correspond. The data are presented in Table 7.7. Only items on which both G and E language and encoding could be clearly coded are included. On Steve's Maze, for example, there are 190 items where deictic language was used by the youngest children, and SL or "shape" by the older ones, so they do not enter this computation.

The percentage of coherence (40 to 65 percent) is, generally speaking, slightly lower in Kathmandu than in Bali (overall 60 percent) and Varanasi (78 percent for Animals, 73 percent for Chips, but only 48 percent for Steve's Maze). For the incoherent combinations, we again see that E encoding tends to be explained by G language.

In order to see whether coherence might increase with age, we computed the data for three age groups separately. The percentage of coherence is presented in Table 7.8.

Table 7.7. *G and E language and encoding on items for three tasks (frequencies)*

		Animals		Chips		Steve's Maze	
		Language					
		E	G	E	G	E	G
Encoding	E	66	106	99	176	79	240
	G	82	288	68	185	47	117
	Total		542		528		483
% coherence		65		49		40	

Table 7.8. *Coherence between language and encoding (in percent)*

% coherence	Tasks		
Age groups	Animals	Chips	Steve's Maze
4–6	51	62	43
7–9	60	50	44
10–12	73	55	63

There seems to be an increase of coherence with age for two of the tasks, which comes from more systematic G language and encoding in the older age group. With age, language and encoding tend to converge towards the geocentric norm.

Overall, however, there is a striking lack of correspondence between language and encoding, which has now been found in every sample of our research, but is strongest in our Kathmandu study. This no doubt comes from the fact that in Kathmandu, egocentric encoding is more frequent than elsewhere, but geocentric language is still the norm.

Spatial ability

Both BDT and SPEFT are conceptualized to measure spatial ability (spatial analysis and restructuring) and psychological differentiation, and often they are found to be highly mutually correlated. In this case, the correlation is rather moderate (r = .57**, partialing age, r = .21**, partialing age and school grade, r = .16**). When submitting the data to a Princals data reduction, the two tasks

produce two different dimensions. We will therefore treat them as two distinct measures in further analyses. Both tasks have been scored as the number of items correct, and as a timed performance; the two types of scores give identical results, so we will report only items correct.[2]

In previous research (see chapter 4), we had looked for relationships between the use of geocentric language and encoding and Piagetian spatial development tasks, in order to see whether using a geocentric FoR had some wider implications in cognitive development. A weak but statistically significant correlation was found between language (but not encoding) and Piagetian concept development. Similarly, following previous research by Niraula and Mishra (2001a/b), we expect a link between G language and spatial ability as measured by SPEFT and BDT.

If we consider the complete sample, there are significant correlations of SPEFT and BDT with geocentric language (respectively .32** and .37**) and encoding on Animals and Chips (.24** and .41**), and negative correlations with Steve's Maze (–.21** and –.27**). However, these correlations could be due to a common change with age and/or with schooling. Using the summary measure for encoding, and controlling statistically for age and school grade, the only statistically significant partial correlation we find is with BDT (r = .17**).

One of the possible reasons for the absence of structural relationships could be that we are dealing with too wide an age range if we include all children from 4 to 12. It is quite difficult to test children in the younger age groups, so the results may be less reliable than with older children. Also, as we have seen above, geocentric language is not well established before the age of 8, and geocentric encoding also increases with age (at least for Animals).

We therefore consider only the children from age 9 to 12. Note that this age range is still quite wide, so that we still have to partial out age and school grade. If we consider this sample of older children, we find the same results, in fact. Controlling for age and school grade, the only statistically significant partial correlation we find is between encoding object score and BDT (r = .15*). Such a low correlation is somewhat surprising in comparison to previous research by Niraula and Mishra (2001a) and our results from Varanasi, where a more substantial correlation (.32**) is found for encoding (and .19** with G+ language).

Bilingualism

The main feature of the study in Kathmandu is the bilingualism of the English pupils, who speak Nepali in the home, but full-time English at school. In

[2] In cross-cultural studies, timed measures are often considered to be unreliable.

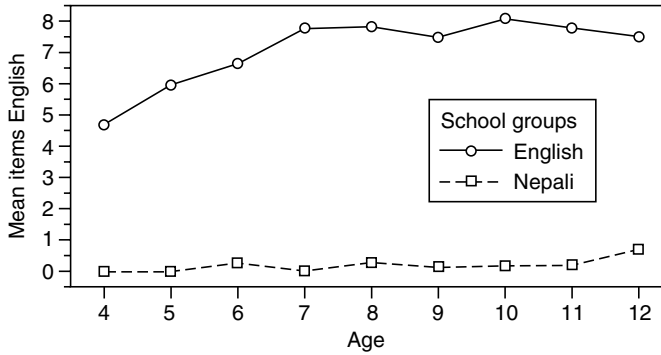


Figure 7.4 Mean use of English on Road task, by age and school type

contrast, although they learn some English at school, the Nepali school children can be considered monolingual.

The testing was done in the preferred language of each child; unfortunately, we did not record which one this was on every task. However, we did code how many of the descriptors on the Road task were spontaneously given in Nepali or in English. This is shown in Figure 7.4.

In the Nepali school, virtually no English is ever used on this task. On the other hand, in the English school, the younger children tend to mix English and Nepali, while after age 7–8, English has become the norm. In this group, the correlation between using English and age is .36**.

In the overall sample, using English on the Road task is highly correlated with years of schooling (.50**), with speaking English in the home (.36**) and with SES (.81**), as well as with contact with media (.25*) and in particular video games and newspapers (.45**).

Using English on the Road task is also correlated significantly with using less G and G+ language on the same task (r = −.19** and −.10* respectively, .14* and .09 NS when partialed for age and school type) and more E and E+ language (r = .26** and .22**, partialed .15** and .07 NS). On the other hand, there is virtually no correlation between using English on the Road task and G or E language on the other two language tasks (except .20** with using E on the encoding tasks). This results in a zero correlation with the geocentric language factor score combining the three tasks.

Correlations are weak and contradictory between using English on Road and encoding. There is a −.14** correlation with Steve's Maze, which means that using English leads to slightly more egocentric encoding on that task, but there is also a .14** correlation with the Animals and Chips tasks, indicating slightly more geocentric encoding for those who use English.

We can do a similar analysis with English spoken at home. Out of the sample of 400 children, 86 use both English and Nepali at home, of which 70 are in

the English school group (meaning they also had more preschooling, schools of better quality, etc.). Surprisingly, there is no relationship between using English in the home and the measures of language use on our tasks. Even more surprisingly, there is a positive correlation of .15** with geocentric encoding on Animals and Chips (and −.12* with Steve's Maze). This means that those who speak English at home produce *more* geocentric encoding than those who don't on two of the encoding tasks.

In summary, these detailed sub-group analyses produce a coherent picture in terms of the socio-economic correlates of using English in the home or on our tests. However, contrary to what happens in Bali, the effects of this language use are very limited. There is little relationship to the more general use of G or E language, and a small but statistically significant effect opposite to our prediction for encoding: using English, in this particular community, produces more and not less geocentric encoding on Animals and Chips.

While speaking Indonesian in Bali implies a reduced exposure of children to the traditional way of life, in Nepal we find that speaking English seems to go along with reinforced traditions. We come back to this issue with more data in the next section, where we analyze background data from questionnaires.

Child and family questionnaires

In Kathmandu, S. Niraula and her team were able to collect information from the children with a questionnaire (see Appendix 1) from the whole sample. We use this information here to give a description of daily activities and other background information derived from this information. We will present it as a contrast between the two types of schools.

Mobility

A first series of questions dealt with the child's mobility. The main results are summarized in Table 7.9.

The Nepali children do not go downtown very often (59 percent less than once a month), the English children more so (45 percent once a month, 12 percent once a week). In summary, there is greater passive mobility (being driven or taken) for the English children. This is of course linked to the families' social status, in particular owning a car or motorbike.

Activities outside of school

In terms of daily activities, both groups of children play and practice sports, with slightly more sports in the English group, and more play in the Nepali group. Examples of sports include cricket, basketball, football, volleyball, handball, karate, martial arts and wrestling (*kusti*), badminton, table tennis,

Table 7.9. *Results of child questionnaire for mobility, by school type (in percent)*

	English	Nepali
Family owns a car	23	0
Family owns a motorbike	49	4
Family owns a bicycle	10	26
Child owns a bicycle	66	11
Home less than 500 m from school	33	33
Home more than 2 km from school	60	21
Taken to school by car	60	2
Taken to school on motorbike	9	2
Walk to school	33	94
Taken for a ride by car	23	0
Taken for a ride on a motorbike	50	4
Taken for a ride on a bicycle	9	25

and swimming. Rather surprisingly, most of these sports seem to be practiced rather close to home. Play, also mainly carried out at home, included cycling, rubber band (*chungi*), skipping, swinging, passing a ball, hide and seek, Ludo, snakes and ladders, chess, Carom, playing with stone pebbles (*gooti*), blocks (designing), memory game, puzzles, cards, playing stickers, and several others. The Nepali group children get to play with peers more often, and further away from home. The difference between the two groups is not significant on getting tutoring (English 15 percent vs. Nepali 9 percent), which usually happens at home and so does not mean moving around.

Artistic activities included drawing and coloring, paper craft, singing, dancing and playing music (*madal*, mouth organ, guitar, piano), composing poems, and acting (*natak*). These are also practiced slightly more often in the Nepali group, mostly at home. Similarly, chores are mainly performed at home, slightly more often in the Nepali group (80 percent vs. 70 percent more than once a week), and include cleaning (sweeping, cleaning utensils), washing clothes, cutting vegetables and cooking food, working in the kitchen garden, or sitting in the family's shop. Very few outside chores were recorded, among them fetching water and shopping.

Family outings are somewhat more frequent in the English group; these are described as shopping, going to see relatives, picnics or going to restaurants, fair, zoo, movies, and visiting different places of Kathmandu (e.g. Newroad) or taking foreign trips. On the other hand, the Nepali group seems to have more frequent religious activities; these occur more often close to home than in the English group. Descriptions include worshipping at home, visiting temples or monasteries, reciting the Veda, watching religious movies, and singing religious songs (*bhajans*).

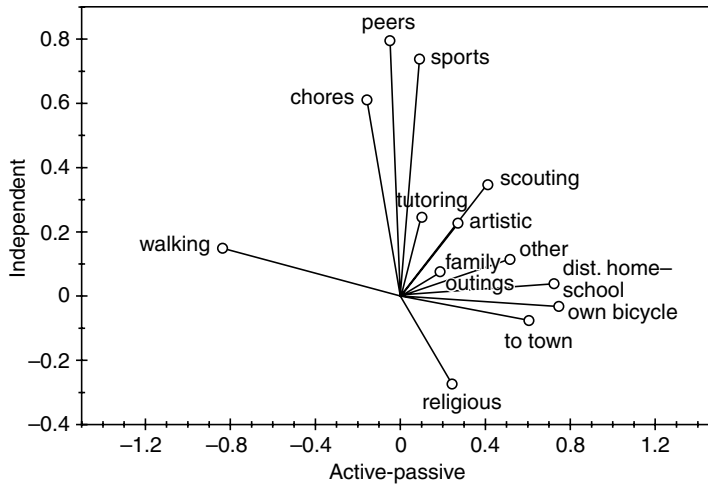


Figure 7.5 Princals analysis showing two dimensions of mobility

A number of these variables were used in a Princals analysis; except for owning a bicycle, walking to school and the frequency of going to town, all the variables represent the distance at which the respective activities are carried out. The graphic representation of the component loadings is shown in Figure 7.5.

Dimension 1 (Cronbach's alpha = .70, 21 percent of variance accounted for) can be interpreted as representing the dimension of active to passive mobility, and dimension 2 (Cronbach's alpha = .51, 15 percent of variance accounted for) as the radius of "outward" or "independent" mobility. A positive index is related to playing further away with peers or carrying out chores such as shopping, a negative index to staying at home, where religious activities are often carried out.

Contact with village

Another part of the child questionnaire dealt with the frequency of contacts with the rural area, either in terms of visits there, or having relatives in a village who might also come for visits to the city.

In the Nepali group, 95 percent of the families have relatives in a village (only 73 percent in the English group) and a family member visits them more often. The children themselves also go for a visit to a village more often in the Nepali group. In the Nepali group, 84 percent of the children also report that they stay in a village for more than one week; only 61 percent do so in the English group. Visits from the village are also more important in the Nepali group.

Table 7.10. *Princals component loadings on contact with village*

	Dimension 1	Dimension 2
Relatives in village	.98	−.18
Family visits to village	.98	−.15
Frequency of child's visits to village	.96	.01
Child spends at least a week in village	.81	.59
Visit from village	.98	−.17
Cronbach's alpha	.97	−1.67
% Variance explained	91	9

All of these variables produce significant chi-square values, or, using ANOVA, significant differences in the mean values when comparing the two school groups. These variables were used in a Princals analysis, resulting in two dimensions with the component loadings indicated in Table 7.10. Dimension 1 provides a good summary measure of village contact, while dimension 2 can be left aside.

Dimension 1 of contact with the village is linked to school type[3] (−.29**) and to the SES score from the home interviews described below (−.29*), as well as to English used in the home (−.15**).

Languages spoken in the home

Nepali is the first language spoken in the home for all families except for two in the English group, where it is English. Another eighty-six children in that group report that English is also used in their families. No other languages are reported to occur.

Home questionnaire

An additional questionnaire was used with a sub-sample of seventy families (see Appendix 1). The parents were interviewed at home. The questions included the family's history of migration and contact with the rural areas, and various socio-economic indicators including contact with media.

SES

A socio-economic status indicator was constructed through a Princals analysis including the variables listed in Table 7.11.

[3] School type is scored English = 1, Nepali = 2.

Table 7.11. *Princals component loadings of SES indicators*

	Dimension 1	Dimension 2
Level of affluence	.95	−.09
Father's education	.78	.24
Mother's education	.91	−.00
Residence type	.83	−.02
Quality of residence	.95	−.07
Number of rooms	.94	−.06
Vehicle ownership	.82	−.08
Cronbach's alpha	.93	.42
% variance explained	64	18

Table 7.12. *Princals component loadings of contact with media*

	Dimension 1	Dimension 2
Newspapers	.61	−.58
Books	.70	.01
Radio	.48	.64
TV	.33	.57
Video games	.76	−.20
Cronbach's alpha	.79	−.19
% variance explained	54	17

Most of the indicators load on a single dimension; the second dimension is represented by the father's education.

We also looked at the families' contact with media. A Princals analysis produced the results shown in Table 7.12.

Dimension 1 summarizes contact with media; dimension 2 seems to differentiate between media that are widely available such as radio and TV and those that are more specific, such as newspapers and video games. Indeed, out of seventy-one families, sixty-seven have a radio and sixty-six a TV, but only fifty-six have a newspaper in the home and thirty-one a video game. Note that the questionnaire was not very precise about the type of video games.

Migration history

The parents' and children's migration history was first computed as three scores representing the proportion of their life-time spent in the city vs. in

Table 7.13. *Princals component loadings on migration history*

	Dimension 1	Dimension 2
Child in city	.76	.89
Father in city	.81	−.50
Mother in city	.90	−.30
Cronbach's alpha	.77	.16
% variance explained	64	36

a village. A Princals analysis of these scores produced the two dimensions shown in Table 7.13.

The first dimension represents the families' overall length of life in the city, while dimension 2 opposes the parents and the children. Dimension 1 is correlated with some of the social measures, such as SES (.38**), speaking English in the home (.26*) and school type (−.36**). These figures are coherent with the fact that there has been more migration from the village in the Nepali group.

Parents' language

During home interviews, the researchers also asked the parents for a route description and the description of the location of three objects (as in the Perspectives task, but without moving around the display). Data for this part are available for thirty-one mothers in the English group and thirty-nine in the Nepali group (for fathers respectively thirty and thirty-two).

On the route description, fathers and mothers used mainly conventional landmarks (CL), on the average for five out of eight segments, and some egocentric (E) language, significantly more in the English medium group. On Perspectives, they used mainly G (about 1.5 out of three items in the English group, 2 in the Nepali one for the fathers, 0.8 and 1.5 for mothers, the latter difference being significant at the .01 level) and the mothers more E in the English group (1.5 vs. 0.9; $p < .01$).

We see here a coherent picture, with geocentric language (including conventional landmarks, which often go with geocentric descriptions) being predominant, but slightly more egocentric language in the English school group. However, there are no significant correlations between the parents' and their children's language on the tasks. This is true whether we take the summary measures for the children, or scores on individual tasks.

This apparent lack of relationships between parents' and children's use of spatial language on our tasks could be due to the fact that the language measures for the parents come from a more reduced sampling of language. Also, the

two language elicitation tasks may have been a bit awkward for adults, which is why they were tacked on at the end of the interview. In summary, the data may be less reliable for parents than for children.

If we take the absence of correlation at face value, it may mean that the family is not the main source of language socialization.

Correlations among background variables

The correlations among the background variables are provided in Table 7.14. The correlations among the background variables derived from the questionnaires produce a coherent picture. The Nepali group has a lower SES, less contact with media, speaks less English at home, but has more contact with the village, and the families who have migrated have spent less time in the city. As far as mobility is concerned, they live closer to the school and hence there is less passive mobility for their children, but the latter show more independent mobility. Age is related to having more passive mobility and independent mobility, and speaking English in the home, while gender is only linked to independent mobility (girls being more restricted to activities at home). Years of schooling is correlated positively with SES, because the English group children receive more preschooling, and the other correlations are consistent with this fact. The same is true of English spoken in the home.

Relationships between background variables and language and cognition

The correlations between these background variables and measures for geocentric language and encoding, knowledge of the cardinal directions and the spatial ability measures are provided in Table 7.15.

G language is used more in the lower SES group and in families who have migrated from the village more recently. It is also related to independent mobility. Geocentric encoding and the knowledge of the orientation system are linked to both mobility measures.

In previous research by the authors, Dasen (1984, 1988b) used spot observation techniques to study daily routines of children in East and West Africa. He found that the variety of places they visited to carry out their chores or for play was significantly related to spatial cognitive development. Similarly Mishra (1996) studied unschooled children of the Birjia cultural group in Bihar using SPEFT and the Indo-African EFT. Distances traveled away from home, either in the forest or within the village, and self-directed activities of children were assessed. The findings revealed that children moving into the forests traveled longer distances and engaged in more self-directed activities than those moving within the village

Table 7.14. *Pearson correlation coefficients among background variables*

	English in home	Passive mobility	Independent mobility	Family contact with village	SES, affluence	Media	Family migration
School type	−.53**	−.71**	.19**	.29**	−.81**	−.57**	−.36**
Age	.13**	.29**	.49**	−.05	.09	−.12	−.11
Gender	.03	.05	−.15**	−.05	.13	−.13	.02
Years schooling	.39**	.63**	.32**	−.18**	.55**	.26*	.15
English in home		.61**	−.15**	−.28**	.59**	.40**	.26*
Passive mobility			.00	.33**	−.75**	−.47**	−.37**
Independent mobility				.12*	.05	.04	.02
Contact with village					−.29*	−.12	−.24*
SES, affluence						.64**	.38**
Media							.23
N	399	399	400	400	70	70	70

School type: English = 1, Nepali = 2; Gender: Male = 1, Female = 2; * $p < .05$, ** $p < .01$.

Table 7.15. *Correlations between background variables, language and cognition*

		G language	G encoding	Knowledge NSEW inside	SPEFT	BDT
English in home	399	.03	.11*	.09*	.23**	.30**
Passive mobility	400	.07	.23**	.28**	.30**	.53**
Independent mobility	400	.25**	.23**	.24**	.32**	.34**
Contact with village	400	−.03	.01	−.07	−.10*	−.14**
SES, affluence	70	−.24*	.11	−.11	.33**	.41**
Media	70	−.08	−.03	.02	.05	.25*
Family migration	70	−.28**	−.08	−.05	.04	.06

* $p < .05$, ** $p < .01$.

surroundings, and they scored significantly higher on both the spatial measures. These findings were explained in terms of greater self-exploration opportunities and high differentiation demands placed on children in the forest ecology.

Among the daily activities, we might expect a relationship of spatial ability with various experiences, particularly those that allow children (and more often boys than girls) to move freely away from the home. A meta-analysis on the role of experience in spatial test performance has been reported by Baenninger and Newcombe (1989). They found a weak but reliable relationship between spatial activity participation and spatial ability, for both females and males. However, they remark that most research available at that time was conducted with adults (and of course mainly US Americans), using retrospective reports, and that "perhaps the most important need in this area is more research with children" (p. 335). The only study with preschool children that they report is one by Connor and Serbin (1977), who found that "for males, masculine activity preferences were significantly associated with performance on the Pictorial Embedded Figures Test (PEFT) ($r = .803$, $p < .05$) but not performance on the Block Design; however, feminine activity preferences were significantly negatively correlated with Block Design performance for males ($r = -.67$, $p < .05$) … None of the correlations for females was significant" (Baenninger & Newcombe, 1989, pp. 335–336).

In our current data, we find a statistically significant correlation between BDT and SPEFT and both measures of mobility. If these correlations are computed separately for boys and girls, contrary to Connor and Serbin (1977) we find that the results do not differ by gender.

Summary and discussion

In summary, this study in Kathmandu provides us with another full-range developmental study of a city sample. Compared to the rural sample studied

in Nepal (Dolhaka), we find the same ecological contrast as we found in India, namely and overall predominance of geocentric language in both locations, but an almost complete absence of egocentric language in the village, while it does occur more in the city. The "up/down" descriptors that we find in the village are not used in the city, where the use of cardinal directions prevails.

Ecology

The impact of this ecological dimension is even more noticeable on encoding. In Kathmandu, a predominance of geocentric over egocentric encoding occurs for only one task, Animals, and in the older age groups only. In other words, we are faced here with a discrepancy between a predominance of geocentric language along with a majority of egocentric encoding. This discrepancy is obvious not only from the overall trends, but individually, in the very low correlation coefficients between language and encoding. At the micro level, it is most visible when we compare encoding and the language used to explain it on the three encoding tasks.

This discrepancy reflects the co-presence of the egocentric and the geocentric FoR in an urban environment such as Kathmandu, even more so than in the cities of Varanasi in India or Singaraja in Bali. The geocentric frame is emphasized more by the cultural environment (including, as we will see, the school curriculum) and the egocentric one is more functional in daily city life.

Bilingualism

The major unexpected result comes from the comparison between the English and Nepali school groups. We expected that becoming bilingual with a European language such as English, and spending the whole day in this language environment, would influence the children strongly towards using egocentric language and encoding. Yet, this is not the case. While there is significantly more geocentric language used in the higher age groups of the Nepali group, the difference goes in the opposite direction for encoding, with *more*, not less, geocentric encoding in the English school group. In other words, bilingualism with English does *not* seem to foster more egocentric encoding in the Kathmandu situation (contrary to what we found in Bali with Indonesian).

This lack of effect of bilingualism with English is further confirmed by a micro-analysis of the impact of actually choosing English on the Road task. A similar analysis in Bali showed that choosing Indonesian had a significant

relationship with preferring egocentric language and encoding. We get the opposite effect in Kathmandu: there is in fact a small but statistically significant positive correlation (.14**) between choosing English and geocentric encoding (on Animals and Chips), and this finding is confirmed by a .11* correlation between using English in the home and encoding.

We have here a coherent set of data to show that, in this case, bilingualism with English does not have the same effect as was found with Indonesian in Bali. The finding is sufficiently surprising to warrant some discussion as to possible explanations, such as other differences between the English and Nepali school groups that could provide alternative explanations (or, at least, post hoc hypotheses). The link of religious practices to SES is one of these.

SES and religious practices

Although SES could be a relevant variable in this case, if we take our results from Bali, this should lead to opposite results (in Bali, higher SES was linked to more egocentric language and encoding). The English group in Kathmandu is clearly composed of families with higher SES, higher contact with the media and less contact with the rural area. In our results (based on home interviews with a sub-sample of seventy families), we found that high SES children indeed use less geocentric language (–.24*), but there is no relationship with encoding. In other words, SES does not "explain" the finding by itself. But SES is of course a "packaged" variable, a composite of many possible variables.

One of these could be religious practices. Our ethnographic observations indicate that the English school families spend more time on Hindu rituals in the home (and, as we know, cardinal directions are very important in these). Our data also indicate that there are slightly more Brahmin families in this group. This emphasis on the symbolic aspects of geocentric spatial orientation could therefore explain why geocentric encoding is as important in this group as it is in the Nepali school group, possibly for other reasons. While, according to our data from child interviews, religious outings (such as visits to temples) are reported to be more frequent in the Nepali school group, we know that in the higher SES families, religious rituals are observed more frequently at home. Unfortunately, we had only one question in the interview on this topic, among many other extra-curricular activities. Knowing, as we do now from our study in Varanasi, how important Hindu religious rituals can be in fostering a geocentric FoR, it would have been interesting to collect more detailed information on these practices in both the home and child interviews.

Curriculum

Another aspect that needs to be discussed here is the school curriculum. Among the school-related differences between the two groups, which are numerous and have been described earlier (more preschooling in the English school group, better overall school quality, etc.), there are possible differences in curriculum. However, on this point, and at least in relation to space and a geocentric orientation system in particular, what is more striking are the similarities. Basically, the curriculum followed by the two strands is the one set by the Ministry of Education, and is the same irrespective of language of instruction.

This is illustrated by extracts of a grade 2 textbook from both school types (see Appendix 3). It shows a boy in a landscape looking (we are told in the text) at the rising sun. The two drawings look somewhat different, because the rising sun is to the right of the picture for the English version, and to the left for the Nepali one; why this is so is not clear, but it should make little difference.

Note that the lesson starts with egocentric language, i.e. learning about front and behind, and right and left. It is, then, in relation to this egocentric body orientation that the cardinal directions are introduced: if one faces east (sunrise), then south is to the right handside, and north is left.

Since, in the English schools, all the teachers are Nepali with English as their second language, even though they use it for teaching, it is quite likely that, in fact, the teachers tend to use the locally predominant spatial system, namely cardinal directions, when they speak about space. And this is most likely to be true even for small-scale space, inside the classroom. The same is probably true of parents who speak English in the home. Similarly, in Bali, we found through some casual observations that at least some of the teachers were using the local Balinese orientation system even when teaching in Indonesian.

This is, we think, the most likely explanation of what happens: English may be the medium, but what is being transmitted, and what is important, is the cultural norm. And that happens to be, even in the city, the geocentric FoR.

Other background variables: spatial experience

Our analysis of various background data derived from interviews shows at least one interesting finding, the relationships of "passive mobility" and "independent mobility" with the various language and cognitive measures. This confirms our previous findings that experiencing mobility in space is important in building up spatial ability. Whether it be on the way to school, or for various extra-curricular activities, those children who move around more and especially further, have more opportunity to build up spatial knowledge such as a precise cognitive map of a more or less extensive area. And if the latter is culturally based on a geocentric FoR, it also means building up geocentric language and encoding.

If we look again at the correlations in Table 7.15, we find that the two mobility dimensions correlate most strongly with the measures of general spatial ability. The correct knowledge of cardinal directions inside a room comes next in the order of magnitude of correlations, then encoding, and finally language. It seems that the way the children experience spatial mobility, i.e. whether they move around independently or whether it is passive mobility (such as being driven to school), does not matter much, contrary to the expectation that independent mobility is more effective in terms of spatial learning than passive mobility. But possibly our data are not detailed enough for these dimensions to be properly measured. Instead of the children's own verbal reports, this would have needed an observational study, for example using "spot observations" (Rogoff, 1978) that would have allowed us to quantify various aspects of spatial mobility. In a previous study in Africa using this technique, Dasen (1988b) found that (Piagetian) spatial concept development was linked not so much to the distance covered but to the variety of places visited.

Developmental aspects

In a final point of discussion, we need to come back to developmental issues, and in particular that of the precocity of the geocentric FoR.

We have seen that in Kathmandu, in terms of language development, a clear use of geocentric terms does not come in before the age of about 7 to 8 years. The knowledge of cardinal directions (whether outside or inside a building) also starts about that age, with about half of the children getting the directions correct (and this somewhat earlier in the English school group than in the Nepali one), and even at age 11–12 years, it is not fully established for the complete sample. As to encoding, in Kathmandu we do not get the rather high proportions of geocentric encoding that we found in Bali in very young children. In the earlier age groups, there is as much egocentric as geocentric encoding, and the latter increases with age mainly for one of the tasks, Animals, much less so for Chips, and there is even the opposite trend for Steve's Maze.

All of these data point to a rather "late" development of the geocentric FoR in Kathmandu, in both sub-groups, certainly later than in the village we studied in Nepal, and later than in the two locations in India and in Bali. Among the various locations from which we have data, with the exception of Geneva of course, it is, in fact, the one in which we get the least geocentric encoding. However, this does not mean that we get much more egocentric language in those early years, since the predominant category is D, and – as our study of gestures shows (see chapter 11) – is in fact likely to represent a geocentric FoR more often than an egocentric one.

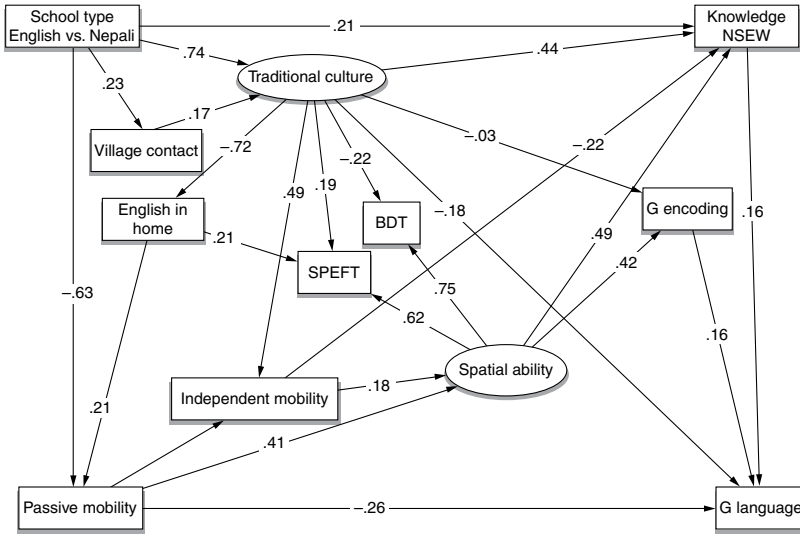


Figure 7.6 Amos summary model for Kathmandu
CMIN = 20.0 df = 32 p = .952
RMSEA = 0 GFI = .986 CFI = 1 TLI = 1.025

If we take all the data together, what seems to happen is that the very young children first develop a geocentric FoR, which they are incapable of expressing in language and do not use systematically for encoding. They also learn quite early about right and left (and subsequently front and back), but don't in fact use egocentric language very much. Later (by about age 8), they turn more and more to geocentric language and they learn to use the cardinal directions correctly. But that does not mean that they necessarily resort systematically to geocentric encoding, the "choice" of a frame for non-verbal encoding being more linked to variables such as task specificity, or to personal characteristics such as spatial experience.

A summary model

In Kathmandu, since the age range is large (4 to 12), it was difficult to find an Amos model suitable for the whole sample. The main model discussed here (Figure 7.6) is produced with the middle and older age groups (7 to 12). The same model produces reasonable fits when applied to the separate age groups of 7 to 9 year olds and 10 to 12 year olds. On the other hand, it

does not fit well for the youngest group; among other things, negative links were needed between SPEFT (−.32) and BDT (−.14) and G encoding, which probably indicates that these two psychometric tests are difficult to use with very young children. For clarity's sake, age as a variable is not shown in the graph; it has a −.30 link with English in the home, .21 with passive mobility, .19 with independent mobility, .57 with spatial ability, and .16 with G language.

The model is the most complex of the three locations, notably because we were able to use several of the socio-cultural variables derived from the child questionnaire (available for all children in Kathmandu only), including some process variables on spatial mobility, but also some of the additional cognitive tests of spatial ability (BDT and SPEFT). The model therefore has both of the virtual variables, the "traditional culture" as in Bali, and "spatial ability" as in Varanasi.

In Kathmandu, the traditional culture variable does not function in the same way as it does in Bali. It is linked to school type (more traditional families in Nepali schools), and contact maintained with the village, and also to whether English is used in the home (−.72). While in Bali, traditional culture is clearly linked to using a geocentric FoR more, this is not the case in Kathmandu: the links with G language and encoding are negative, even though they are quite small (−.18 and −.03). This finding is congruent with what other data analyses indicated, namely that the pupils of the English school show not less but more G encoding than the Nepali school group.

On the other hand, we get a positive link to the knowledge of the NSEW system, which dissociates this variable somewhat from G language and encoding, even though it is itself linked positively to G language.

Like in Bali, a variable reflecting the foreign (and egocentric) language spoken in the home is part of the model. It is linked to passive mobility, which makes sense (English-speaking children live further from school and are driven there).

The link between this variable and SPEFT could reflect some higher test sophistication in the upper-class children speaking English. On the other hand, there is also a positive (.19) input from traditional culture, which could be due to the fact that this test – contrary to BDT, for which the input from traditional culture is negative (−.22) – has been adapted, in terms of content, to make it more appropriate to the Indian sub-continent.

The second virtual variable is "spatial ability," measured through BDT and SPEFT, and influenced by both mobility variables. This shows that both passive and independent mobility are linked to increased spatial ability. Spatial ability, in this model, is directly linked to knowledge of cardinal directions and G encoding, but the link to G language occurs only through knowledge.

Passive mobility has a separate negative direct link to G language, indicating that being driven through the city may foster an egocentric rather than a geocentric FoR.

In this model, contrary to Bali and Varanasi, G language and encoding are linked, although not very strongly (.16). Reversing the arrow (from language to encoding) would diminish the statistical fit of the model.

8 Panditpur

Research in this location was conceptualized as a challenge to our main ecological hypothesis, namely that a geocentric FoR is more adaptive in rural areas while an egocentric one is more useful in the city. Previous research by Pederson (1993) with Tamil in south India, and our own research in Bali, India and Nepal have systematically brought this out. So, how generalizable is this conclusion?

During a discussion with the late Professor Babban Mishra, a psycholinguist at the University of Gorakhpur in northern India, he mentioned that he knew of a rural area in the vicinity where people systematically used an egocentric FoR in spatial language. He took us there, and we informally elicited some spatial language, particularly by drawing our standard "route" on the ground, and asking a few informants to use this to give directions. Indeed, many of these informants did use egocentric language, at least partly. When one young man used geocentric language systematically (NSEW cardinal directions), he was scolded by an elder, who shouted "Speak properly, this is not how one gives directions, you have to say 'turn right, and then left'!"

This convinced us that an egocentric FoR seemed to be the standard in that village, and that it was worthwhile looking at this possible "exception" more closely. Professor B. Mishra later took us for a short visit to another village, Panditpur, where we made the same informal observations. We therefore organized data collection with our standard tasks and a child questionnaire (see chapter 2). The location is described in chapter 3. Sample characteristics are given in Table 8.1. The age initially given for some of the children proved to be unreliable; the ages reported here were checked against records. For data analysis, the single 12 year old child is grouped with those of eleven. Table 8.2 presents the cross-tabulation of checked age by grade.

In addition to the children tested at school, we included a sample of forty adults, aged 21 to 85 years, with equal numbers of males and females. These were asked for a route description, and were given the standard Perspectives language elicitation task, as well as Chips for non-verbal encoding.

Table 8.1. *Sample characteristics, Panditpur*

Age (checked)	Boys	Girls	Total
6	5	6	11
7	8	5	13
8	5	8	13
9	4	6	10
10	7	3	10
11	6	6	12
12	0	1	1
Total	35	35	70

Table 8.2. *Sample characteristics, age by grade*

	Grade							
Age	1	2	3	4	5	6	7	Total
6	5	6	0	0	0	0	0	11
7	3	6	4	0	0	0	0	13
8	3	4	4	2	0	0	0	13
9	0	0	1	2	2	3	2	10
10	1	0	0	1	0	5	3	10
11	0	0	0	0	0	9	4	13
Total	12	16	9	5	2	17	9	70

Results for children

Language

Perspectives task The age trend in spontaneous language use on this task is shown in Figure 8.1. There is almost no egocentric (E) language; a few situational landmarks (SL) occur at age 6, but not later. It is only geocentric (G), namely NSEW, that children of all age levels use; by the age 7, the use of G is almost exclusive, though not always correct until age 10. Other language categories, such as deictic (D) and conventional landmarks (CL) are not used.

Road task Generally speaking, children do not use E or SL language categories on this task. There is a predominance of G language, and by the age of 7 almost all children begin to use it, although not always correctly, even at the age of 11 (Figure 8.2).

Thus, for both the Road and Perspectives tasks, it is G language that predominates, starting at age 7. Its correct use increases with age, until about age 10.

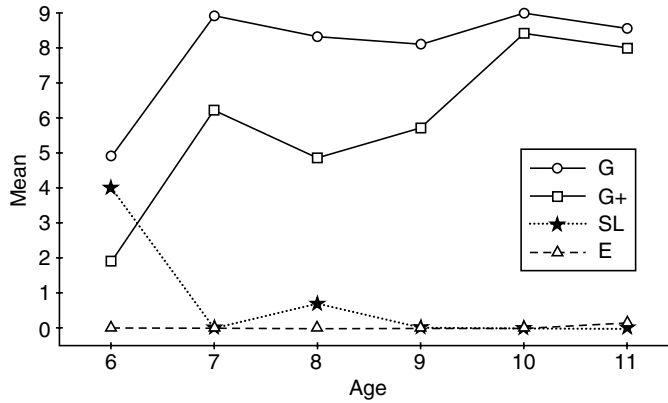


Figure 8.1 Spontaneous language on the Perspectives by age

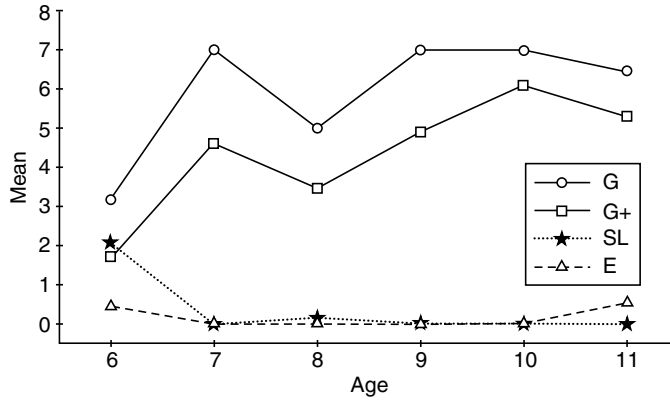


Figure 8.2 Spontaneous language on the Road by age

Language data obtained from the Perspectives, Road and items 4 and 5 of the encoding tasks were subjected to Princals analysis. The results are presented in Table 8.3. The three tasks contribute about equally to dimension 1, the G language score, which accounts for 85 percent of the variance.

Encoding The results of the encoding tasks by age groups are presented in Figure 8.3.

The results of the three encoding tasks present us with quite a different picture from other locations. The most striking feature is that there is no obvious age trend, with possibly a curvilinear (reversed U-shape) relationship with age. Steve's Maze now shows about the same proportion of geocentric encoding as Animals; this is due to the fact that this task has not been changed, while the

Table 8.3. *Component loadings of language tasks on Princals analysis*

	Dimension 1	Dimension 2
Perspectives	.96	.00
Road	.90	.41
Encoding tasks	.90	–.41
Cronbach's alpha	.91	–2.99
% variance explained	85	11

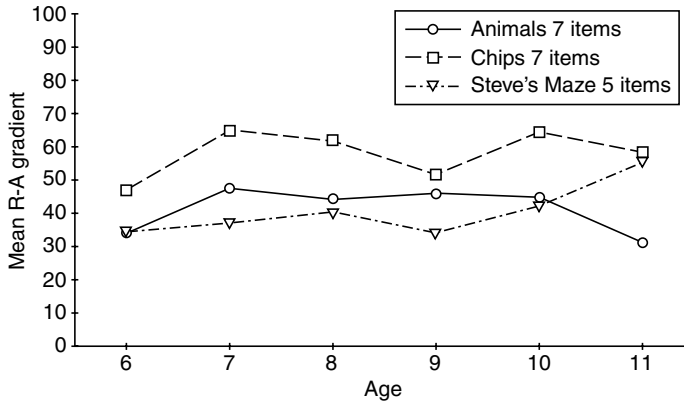


Figure 8.3 R-A gradients on encoding tasks by age

task demands for the other two tasks have been increased (four animals instead of three, seven items including two with a 90° rotation).

The curvilinear trend becomes even more marked when we plot the same results against school grade rather than age (Figure 8.4). There is an increase in R-A gradient up to grade 5, and a decrease thereafter. We will discuss possible reasons for this trend later in this chapter.

On the other hand, Princals (Table 8.4) gives us very much the same picture as found at other locations. Animals and Chips go together on dimension 1 with Steve's Maze placed along dimension 2.

Child questionnaire

Mobility We analyzed data obtained from the child interviews regarding the mobility of children and the various chores they carried out. Princals was used to examine the structure of variables. The results of this analysis are presented in Figure 8.5.

Table 8.4. *Component loadings of encoding tasks on Princals analysis*

	Dimension 1	Dimension 2
Animals	.86	–.24
Chips	.88	–.05
Steve's Maze	.27	.96
Cronbach's alpha	.59	.04
% variance explained	55	34

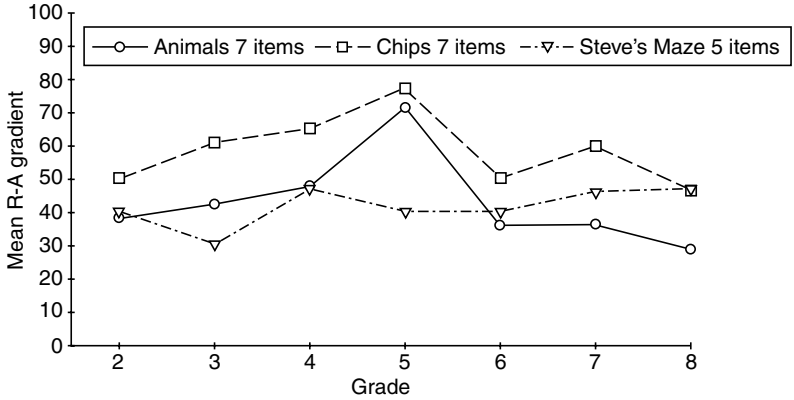


Figure 8.4 R-A gradients on encoding tasks by grade

This structure is not the same as we found in Varanasi and Kathmandu. While dimension 1 comes close to the "independent" mobility index found in the other locations, the second dimension does not clearly represent active vs. passive mobility. This is probably because in a village, every child walks to the school that is nearby, and children are never driven or taken anywhere.

Contact with city Since the children live in a village, the questionnaire was phrased as contact with the city. The Princals analysis is summarized in Table 8.5. Dimension 1 is a good summary score for city contact.

Correlations

Pearson correlations were computed between knowledge of cardinal directions (NSEW), G encoding, G language with each other, and with some variables that came from the child questionnaire. Knowledge of NSEW

Table 8.5. *Princals component loadings for city contact*

	Dimension 1	Dimension 2
Relatives in city	.73	.65
Family visits to city	.78	−.07
Frequency of visits to city	.80	−.56
Spending a week in city	.79	−.56
Visits from city	.66	.71
Cronbach's alpha	.81	.44
% variance explained	57	31

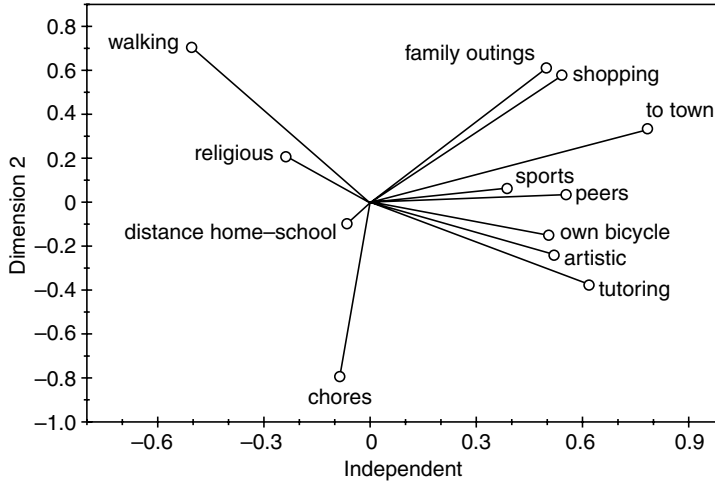


Figure 8.5 Princals component loadings of activities

correlates positively with G encoding (.21*) and G language (58**). The correlation between G encoding and G language is positive (.17), but not significant. Socio-economic status (SES) does not show any significant relationship with these variables, which is not surprising, since SES is very homogeneous in such a village. The Princals derived summary variables of child's mobility and the family's contact with the city produce no significant correlations.

Conclusions

The results of the study with children show that, contrary to expectation, the spatial language in this village is not egocentric but geocentric. We take this to

reinforce our ecological hypothesis, even though we do not exclude the possibility of finding an egocentric FoR elsewhere in a rural area. The remainder of the results show that, contrary to what we found in other locations, there is no age trend for encoding, and there are no significant relationships between the language and cognitive measures and background data.

Adults at Panditpur

Having found a strong preference for G language in children, we decided to check whether this corresponds to the adult norm. A sample of forty adults, aged 21 to 85 years, with an equal number of males and females, was asked to give a description of the route from the village to a junction on the main road. Contrary to our standard "route" task in which the number of segments is fixed, a free route description can elicit a large range of spatial terms. They were also given our standard Perspectives and Chips tasks.

On the route description, males used an average of fifteen terms, with five G, four E and six CL; females used only six terms on average, two G, two E and two CL. Given that we did not use a free route description as one of our standard measures at other locations, language elicitation through this task with adults at Panditpur cannot be given much weight. However, it does point out that spatial language is itself context specific. Describing how to move on a road over a fairly long distance may well elicit more E language (turn left and right), and conventional landmarks, especially for the men who move on the road more often than women.

On the Perspectives task, males used a majority of G (on the average eight G out of nine positions) with an occasional E or CL, and females used exclusively G. Generally speaking, there is no doubt that a geocentric FoR is predominant in language for the adults.

On the Chips task, men produced an average R-A gradient of 71 (SD 30.48) and females 77 (SD 21.85), which shows that for non-verbal encoding also, the frame tends to be geocentric. If we look at correlations between encoding (R-A gradient on Chips) and language, it is G language on the Chips task that gives the highest correlation (.67**), then Perspectives (.31*), while route description (.18) is not significant. In fact, these correlations between encoding and language are very high compared to what we have found in children in various locations, and they do not change when gender is controlled statistically.

Discussion

The dominance of G in language data in this village reinforces our ecological hypothesis that in rural settings in India, G is the dominant frame. Children

acquire this frame in language by about 7 years, and it gradually develops further with age. In early years the use of G+ language is less than perfect, but by age 10, children use NSEW almost correctly. Other language categories, such as SL, CL, E, or D hardly find representation in children's vocabulary.

With respect to encoding, the evidence for the use of a geocentric frame is less convincing; the R-A gradients are close to an average of 50. While G language shows an increase as a developmental trend, G encoding does not; the curves turn out to be almost flat between 6 and 12 years, showing no major influence of age. On the other hand, when the R-A gradients are plotted against school grade (Figure 8.4), the trend is curvilinear, with an increase up to grade 5 and a decrease thereafter. This may be due to a number of reasons. Our discussion with teachers and observations of children in school bring out the following possibilities:

1) From grade 4 onwards, army-like physical training is compulsory for all children in school, with exercises requiring the mastery of LRFB, since the commands for marching and other exercises are carried out in egocentric terms (e.g. "right turn, left turn, move forward," etc.). The marching exercise in fact requires regular verbal repetition of "left-right" by teachers (and also by children) to ensure the coordination of hand and leg movement of all children participating in the march.
2) From grade 1 to 5 the teachers lay emphasis on learning of cardinal directions by children, considering it something to be learnt in school. Once they are mastered, children are left on their own to use or not use them. In later grades, there are lessons relating to traffic rules on the road, which again encourage the learning of left and right.
3) From grade 6 onwards, children also get several lessons on equations in mathematics, which require transfer of certain parts of the equation from left to right or vice versa in order to solve them. While teaching these equations, teachers use only left and right to explain the transfer of equations (often accompanied by the movement of a hand in the corresponding direction).
4) Teachers also feel that it is rather easy for them to communicate in egocentric language, which they claim to be widely used in the area (contrary to our empirical findings).
5) Teachers engaged in grades 5 and onward are also more urbanized than those teaching at lower grade levels. In fact, two of them also stayed in the city.

It is rather difficult to suggest which of these observations may be the most dominant influence on children's performance (maybe all of them combined). The paradox is that these would influence encoding but not language.

The overall findings do not confirm our expectation that the egocentric FoR is used more at this location, as our informant and the little pilot study in the village had suggested. While the results on encoding tasks are somewhat ambiguous, the study demonstrates a clear dominance of the geocentric FoR in language, both in children and in adult samples.

9 Geneva

When discussing the results of our research of 1994 and of 1999–2000 with colleagues, we were often asked why we had not included a group of Western children as a comparison or "control." The easy answer, of course, is that we all know that Western children do not use a geocentric FoR. On the other hand, quite a lot is already known about the cognitive and linguistic development of Western children, although not on the particular language elicitation and encoding tasks of our study. As to encoding, Levinson's team had only studied Dutch adults, and as far as children are concerned, Troadec (2007) is to our knowledge the only one to have carried out a study with French children, but he did not use the encoding tasks without some verbal manipulation in the instructions.

We therefore decided to include a sample of children in Geneva, although a somewhat smaller one than in the other locations (N = 75, age 4 to 12). The characteristics of this location are described in chapter 3. The sample characteristics are shown in Table 9.1.

The first language spoken in the family was recorded, and is presented in Table 9.2. It will be noted that most of the bilingual children know another European language, so bilingualism should make no difference to the topics we are studying. We will nevertheless examine this question when analyzing the data.

We also recorded migration history. The distribution is presented in Table 9.3. From these data, we see that even among the thirty children who speak only French, some have migrated to Geneva. This situation is not unusual for Geneva, and our sample can be considered quite representative.

Although the children come from many nationalities, and some of the children are bilingual, the spatial language used in this community is quite homogeneous, namely using the egocentric (LRFB) FoR only.

Our data analysis will be much shorter than for other locations, because – as expected – we find little else than the use of the egocentric FoR for both language and non-verbal encoding.

Table 9.1. *Sample characteristics, Geneva*

	Gender		Language in home		
Age	Boys	Girls	Monolingual	Bilingual	Total
4	2	3	1	4	5
5	4	5	3	6	9
6	6	4	5	5	10
7	5	4	2	7	9
8	5	3	5	3	8
9	3	5	2	6	8
10	5	4	6	3	9
11	4	4	3	5	8
12	5	4	3	6	9
Total	39	36	30	45	75

Table 9.2. *First languages spoken by children*

Language	Monolingual	Bilingual	Total
Albanian	0	3	3
Arab	0	4	4
English	0	4	4
French	30	0	30
German	0	4	4
Portuguese	0	19	19
Spanish	0	9	9
Somali	0	1	1
Tamil	0	1	1
Total	30	45	75

Table 9.3. *Migration history*

	N	Percent
Non-migrants	20	27
Parents migrants, child born in Geneva	36	48
Migrants	16	21
Missing	3	4
Total	75	100

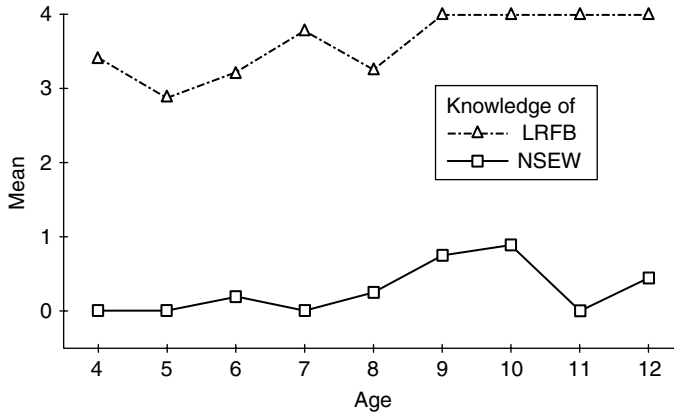


Figure 9.1 Knowledge of LRFB and NSEW

Results

Knowledge of NSEW and LRFB

Figure 9.1 traces the mean number of items correct when asked about right, left, front, and back, and about cardinal directions. Note that, in Geneva, this task was used only inside the classroom used for testing, which, however, had a wide window bay.

The top line shows the knowledge of LRFB, which is known by most of the younger children, although mistakes occur up to age 8. Left and right are more difficult for the children than front and back, but it is for the latter two words that we find a significant gender difference, in favor of boys. The knowledge of these terms is also better in monolingual children; this is, of course, because testing was carried out in French, the school language, and the bilingual children might well have known these terms better in their own first language.

The school in which we did the study had a huge wind rose in the playground, with the four cardinal directions clearly marked. Despite the fact that the children saw this every day, only two of them, a boy of 9 and a girl of 10, managed to indicate the four cardinal directions correctly. Questioning them further showed that they had learned this through scouting. A few other children got two of the directions correct, but this seemed to be quite haphazard.

Language elicitation

Perspectives task The language categories produced on the Perspectives task are presented in Figure 9.2. The very young children (4–5

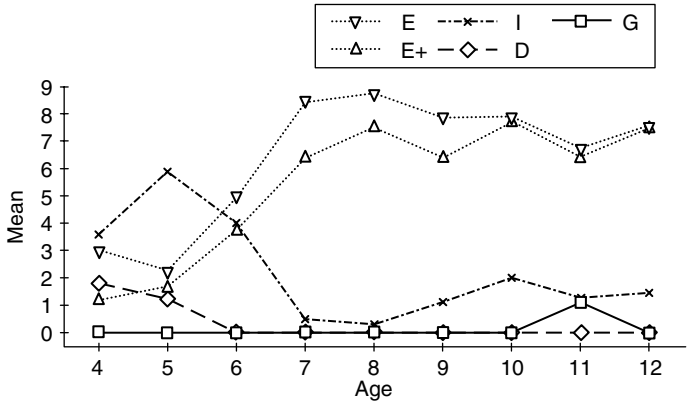


Figure 9.2 Spontaneous language on Perspectives by age

years) use mainly intrinsic (I) descriptions, as well as some egocentric (E) and deictic (D) expressions at age 4. Starting at age 6, E language becomes the predominant and then almost exclusive category. The latter is not absolutely correct until age 10. In the older age group, we see some intrinsic descriptors coming back, and even an attempt by two children (age 11) to use geocentric language for all nine items of the task,[1] but the latter was never correct. Landmarks (SL, CL) never occurred.

Road task The results for the Road task are presented in Figure 9.3.

Again, most of the language is egocentric, even if not necessarily correct. The 4–5 year olds use deictic. No geocentric language is used at all (except for one 10 year old, who tried it for two of the segments). Some children occasionally use "up/down" (U), although never for more than three segments; this was coded separately. It is not the geocentric "up/down" of the Nepalese village, but rather another way of saying "away from me" (up on the model) and "towards me" (down), i.e. it is in fact egocentric.

Language on encoding tasks On Animals, the children use mainly intrinsic language, sometimes mixed with egocentric. On Chips, it is mainly egocentric, and on Steve's Maze, the children describe a shape, sometimes mixed with egocentric language. There is no geocentric language (except for three children, who attempt it for one item each on Chips).

[1] Unfortunately, we did not ask them where they got this idea from. Possibly, the teachers, who were fully informed of our project, talked about it in class.

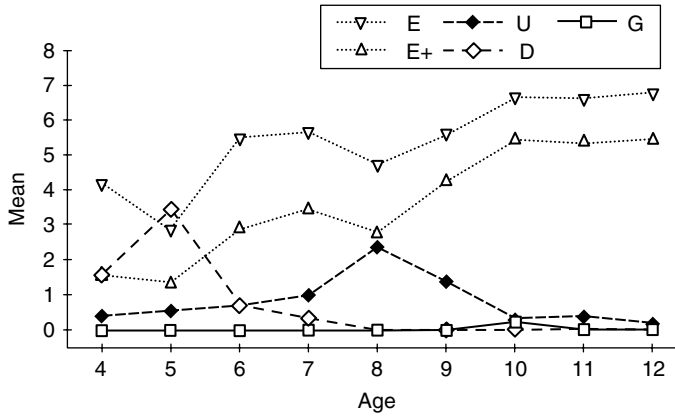


Figure 9.3 Spontaneous language on Road by age

Since there is no G language, and not much variation in the E language that is produced, it does not make sense to compute a language summary score using Princals.

Encoding

The results of the three encoding tasks are presented in Figure 9.4. If we first consider the tasks with five items only, some geocentric encoding seems to occur in the first two age groups, even though it is quite low (R-A gradient 20 to 40). On Steve's Maze, in particular, there seems to be a decline of geocentric encoding with age (r = −.45**). However, when the more stringent criteria are applied for Animals and Chips (four animals, seven items, including two with a 90° rotation), geocentric encoding disappears completely and encoding becomes completely egocentric (two superimposed lines on zero in Figure 9.4).

The conclusion is that in Geneva, if the tasks are organized so as to eliminate hidden intrinsic encoding, there is no geocentric encoding at all.

Language and encoding

At the group level, we have confirmation of the fit between language and encoding: the egocentric frame is dominant and almost exclusive for both. At the individual level, we have a paradox: the correlation between language and encoding should be perfect, since all children use E language and also produce E encoding. Yet, when computing correlations, no significant correlations appear (at least none that cannot be explained by the common factor of age,

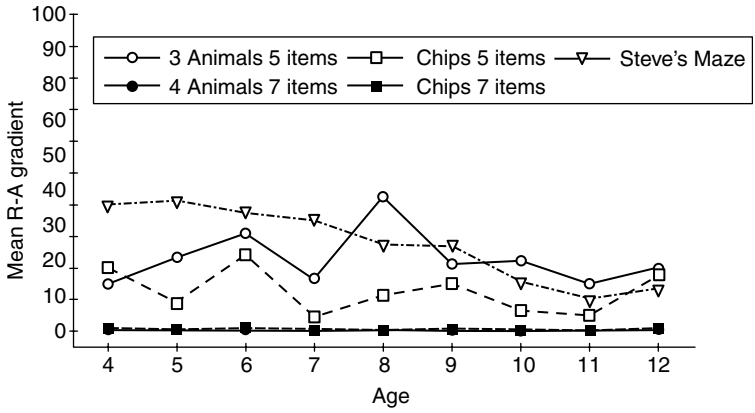


Figure 9.4 R-A gradients on three encoding tasks by age, and changes in procedures

and which disappear if partialed for age). There is also no correlation between the correct knowledge of LRFB and encoding. We attribute the absence of correlation to the fact that there is not enough variation in the data to allow correlations to be computed meaningfully, or rather to the fact that the variation that does exist is irrelevant, because it comes from using the intrinsic frame (I) in language and for encoding on the non-verbal tasks.

The correspondence between language and encoding on items 4 and 5 of each task is presented in Table 9.4. The figures are given in percentages of the total items for which clear language scores were available.

As mentioned above, intrinsic descriptors are used in 89 percent of the items for Animals, and shape in 83 percent for Steve's Maze. This fact does not leave much room for testing the coherence between E and G language and encoding. It is on Chips that we see 74 percent coherence between E encoding and E language. Coherent G encoding explained by G language never occurs.

Bilingualism

Overall, no differences were found between monolingual children and those who were bilingual with another European language, nor indeed with the few children speaking Arabic, Somali or Tamil.

Conclusion

We knew in advance, because it is the familiar cultural environment of one of us, that French-speaking children just simply never use geocentric language for table-top spatial descriptions. However, it remained to be shown with

Table 9.4. *Correspondence between language and encoding on items 4 and 5 of encoding tasks*

Encoding	% of items		Language E	G	I	Shape
	Animals	E	**11**	0	75	
		G	0	**0**	14	
		Total	11	0	89	
	Chips	E	**74**	2	11	
		G	8	**0**	5	
		Total	82	2	16	
	Steve's Maze	E	**8**	0	5	63
		G	3	**0**	1	20
		Total	11	0	6	83

empirical data. On the other hand, we might have expected them to know more about cardinal directions, at least the older ones, since the school yard had a wind rose, but only the practice of scouting seems to have an impact in this respect. One aspect of the findings we find interesting is the demonstration that encoding tasks, when used with the standard procedure of five items and 180° rotation only, produce some answers that could be interpreted as geocentric. Adding more stringent procedures (four animals, 90° rotation) eliminates these completely, which shows that they consisted either of random answers (due to distraction, fatigue, etc. especially in young children), or of intrinsic answers that cannot be distinguished from geocentric ones in the standard procedure. This interpretation is supported by the fact that the language used by the children on the Animals task was indeed mainly intrinsic.

The complete absence of a geocentric FoR seems to indicate that the processes linked to this frame simply don't occur in Geneva children. This raises the question of whether they could be induced by changing the instructions, as Troadec (2007) has done, or through some training procedure. Unfortunately, Troadec's results in France are not very convincing, because he used landmarks as allocentric indications in his instructions. As we have seen in our research, landmarks, be it SL or CL, do not occur in French-speaking children's spontaneous language.

In the Geneva school, some of the older children were obviously trying to guess what hidden scheme there might be behind our encoding tasks, which no doubt seemed too easy to be taken at face value. This is probably what produced some apparent geocentric answers. One boy of age 10 produced four G

answers out of the first five items, saying "I do it as if I were on the other side of the table. This produces the same photograph as here, because they are the same." In other words, he imagined himself being in the same position as in front of table 1, which produced apparent G encoding through mental rotation, but which, in fact, amounts to E. On the two items with 90° rotation, he then produced systematic E answers. The reactions of one girl aged 12 years were very similar. She explained her geocentric performance with the following theory: "If the animals go one way on this table, on the second table they have to go the other way. One has to reverse everything. The elephant looked the other way on that side, it was left, so here it is right." Her theory broke down with the 90° rotations, where she reverted to systematic E encoding.

These individual examples seem to suggest two things: 1) In this sample, there are no spontaneous G encoding answers that are genuinely geocentric. They are always either egocentric or intrinsic. 2) On the other hand, older children seem to consider the possibility of changing the frame of reference. With appropriate training, they could probably achieve the flexibility needed to switch from an egocentric to a geocentric frame. But this speculation still needs to be tested.

The discussion of whether Geneva children could have both E and G frames potentially available in their cognitive repertoire will come up again in chapter 15, when we interpret our overall findings in terms of cognitive styles.

Part III

Additional studies

10 Spatial language addressed to children

The first language children hear in this world is the language of their parents, and generally that is the language they first acquire as their mother tongue. Language is largely a product of parent–child interaction, particularly in early years (Bates, Dale, & Thal, 1995; Harris, 1992; Snow, 1995). In later years other influences (e.g. peers, schooling) also shape language development (Bates, 1975). Much research in developmental linguistics has described the manner in which children acquire language and the way in which they grasp the meaning of concepts (Bowerman & Levinson, 2001). While the existence of "motherese" is no doubt universal, there are wide cultural as well as individual differences in its forms (Masataka, 2008).

One way to understand the processes underlying the development of a spatial frame of reference is to analyze the spatial language addressed by adults, especially mothers, to children in early years of life. Such analyses may permit an understanding of the language transmission processes. Given a situation in which mothers find an opportunity to talk to young children about the spatial location of objects or spatial events, it may be assumed that they would use the mode of spatial description predominant in the local context in ways that would be understandable to children. In other words, we assume that mothers will use their preferred spatial FoR in describing objects or situations by tailoring it to the level of understanding of the particular child.

The purpose of this study is to investigate the spatial language children encounter as they grow up in a context where geocentric language and the use of a geocentric orientation system are the adult norm. The best way to understand the language adults use with children is to observe adult–child interactions in naturally occurring situations.

We set out to study such interactions at Roopchandpur village (for a description of this site, see chapter 3). Twenty children, four at each age from 1 to 5 years, were selected, and adults interacting with these children were observed four times in five different settings (feeding, toilet training, bathing, storytelling, and sleeping). Each observation lasted for about an hour. Thus, we collected almost 100 hours of observations of mother–child interactions. Since many of the interaction episodes occurred inside the house, these observations

were carried out by local female research assistants. They were known to the families and could follow mothers and children to any part of the inner house. During the period of observation, the interactions of all adult members with the children were recorded using audio tape.

In a second location, the city of Gorakhpur (Uttar Pradesh, north of Varanasi), we were helped by a local female doctoral student at the University of Gorakhpur who was using spontaneous language recordings for her doctoral thesis. Twenty-four mothers interacting with children of 1 to 12 years were observed in the five settings mentioned above. Each observation lasted for about an hour. All interactions between mothers and children during the observation episodes were recorded in a notebook, since the families did not feel at ease with the use of a recording device.

The analysis of data for both locations was disappointing, and demonstrated that recording spontaneous language used in the presence of children often poses difficulties. Besides the fact that the assistants had to wait for a long time for the relevant situation to occur in its natural course, the amount of information obtained was quite inadequate. Except for the use of some intrinsic words, there were hardly any other spatial terms in the language of mothers that could provide us with a basis for discovering the roots of geocentric language development among children through their interaction with adults.

In order to handle this problem, we decided to arrange certain situations that could provide mothers with an opportunity to talk to the child in more specific ways. Assuming that in such experimental situations the mothers would use the spatial language that they use in normal spontaneous interaction situations, we designed four tasks to elicit mothers' spatial language with young children.

Three studies were carried out with twenty mothers in each study. Two of these were conducted at Roopchandpur (India), one with mothers of children of 2–11 years, and another with mothers of 1–5 year olds. The third study was carried out at Dolakha (Nepal; see chapter 3) with mothers of 2–11 year old children. Thus, the total number of mother–child pairs studied is sixty.

Tasks

Four tasks were designed in which the mothers had to describe a situation to the child or ask the child to do something. The children were always seated to the left side of their mother. On each task, the mother's language was recorded. The tasks are briefly described below.

1) Orientation of toys

In this task, a toy car (fronted object) was put in front of the mother and the child, oriented away from them. A doll was placed behind the car, and the

mother was asked to tell the child where the doll was. Then the car was turned around so that it would now face the mother–child dyad, and the doll was placed behind the car, and then to the car's right and left. The mother had to tell the child where the doll was placed each time. This procedure was repeated with a house (fronted object), a red round pot and a yellow square pot (non-fronted objects). In all, sixteen descriptions were obtained from each mother on this task.

2) Pulling a car

In this task, a toy car with a doll in it was moved a short distance in front of the dyad, away from, towards, right, and left of them. With movement in each direction, the mother had to tell the child where the doll went for a drive. Thus, four descriptions were recorded on this task.

3) Description of toys

In this task two identical dolls were placed to the front and back, and then to the right and left of a car, a house, a red pot, and a yellow pot (the same objects as used in task 1). The researcher would point to one of the dolls through gestures, without using any language. The mother was requested to ask the child verbally (not through pointing or gesturing) to bring the doll indicated by the researcher. Overall eight descriptions were obtained on this task.

4) Description of village sites/route to sites

In the first study at Roopchandpur, the mothers were asked to tell the child the location of eight local village sites, which were fully known to the mothers, and possibly to older children also. In the second study, they were asked to describe to the child the routes to three local sites from the place where the tests were being carried out. This task was not used in Dolakha.

Results

Mothers' spatial language in Roopchandpur

The analysis of data from Roopchandpur was carried out on the combined samples (N = 40), except for the description of village sites. Since there was no significant difference in the mother's language for fronted and non-fronted objects, data were combined to obtain a total score for each language category (G, E, I, etc., using the categories defined in Table 2.1). The frequencies of language categories were counted over the three tasks to obtain a total score for

Table 10.1. *Mothers' language addressed to children in Roopchandpur*

	Language categories (%)						
Age of children (years)	N	I	E	SL	CL	G	D
1–2	8	60	2	3	1	34	0
2–3	10	46	8	2	5	38	0
4–5	9	53	5	7	0	35	0
6–8	6	68	0	1	0	30	1
9–11	7	10	0	2	0	88	0
Total	40						

each category, ranging from 0 to 28. The percentages of language categories used with children of various ages are presented in Table 10.1.

The two language categories used most frequently are intrinsic (I), i.e. objects described in relation to each other, and geocentric (G), i.e. the use of cardinal directions (NSEW). The former dominates until age 8, at which time they are replaced by the latter. The other language categories are hardly ever used. Out of a total of forty mothers, only two used some E language, with children of less than 5 years. Landmarks (mainly situational) are used occasionally.

Geocentric language (NSEW) The individual data with respect to the use of G language are presented in Figure 10.1.

Individual differences in the use of G language are clearly in evidence: some mothers do not use any G at all, others use it almost exclusively. There is no significant difference in the use of G language with boys and girls. The most interesting finding is that mothers use some G language even with children younger than 2 years. The regression line ($R\ Sq = .224$, $p < .01$) indicates a significant increase in the use of this language category with increasing age of children. The overall conclusion is that G language is used with children even at an early age, and shows a significant increase as children advance in age.

Description of village sites and route to sites The individual counts of G and CL language used by mothers in describing village sites in Study 1 and routes to sites in Study 2 are shown in Figure 10.2.

On these tasks, there is also evidence for individual differences in the use of G; two mothers do not use any, others use it exclusively. Mothers seem to start with G references even with children younger than 2 years, and they continue to use it more often with older children.

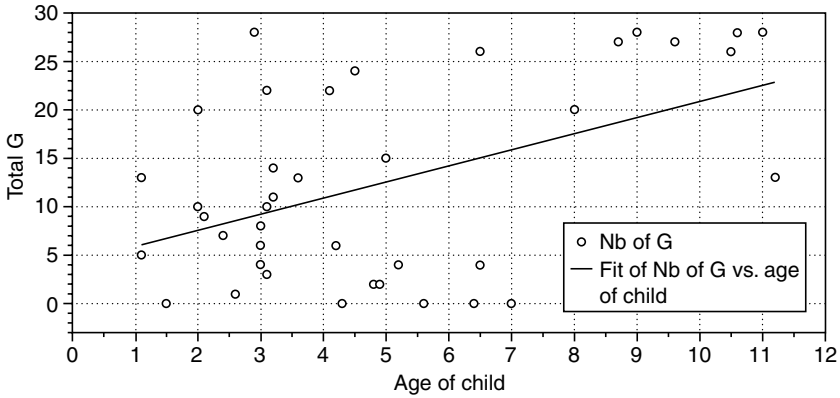


Figure 10.1 Frequencies of geocentric (NSEW) language addressed by mothers in Roopchandpur to children from 1 to 11 years

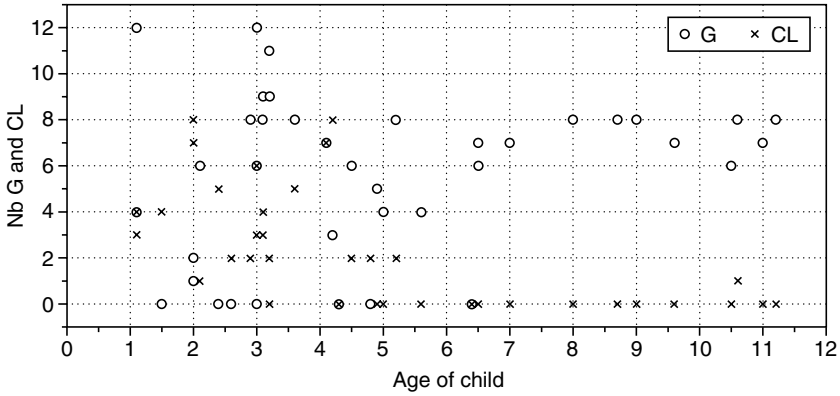


Figure 10.2 Frequencies of correct geocentric (NSEW) language addressed by mothers in Roopchandpur to children when describing village sites

The analysis also reveals that mothers use conventional landmarks (CL) in describing a route to village sites (mean 4.1, SD 2.25) more often than when they talk about the location of the sites (mean 0.35, SD 0.75). Like the use of G language, some mothers use it quite often, whereas others do it less. Some landmarks are used even with 1 and 2 year olds.

Mothers' spatial language in Dolakha

Using the same tasks (but no site/route description), twenty mothers with children aged 2–10 years were studied in Dolakha, Nepal. The analysis revealed

Table 10.2. *Mothers' language addressed to children in Dolakha*

		Language categories (%)							
Age (years)	N	I	E	SL	CL	T	U	G	D
1–2	1	32	18	21	00	0	7	7	14
2–3	3	15	1	1	18	0	33	12	19
3–6	3	4	5	0	26	0	24	11	31
6–8	6	3	1	1	18	0	36	14	27
9–11	7	4	4	1	10	0	42	20	19
Total	20								

no difference in the use of language on fronted and non-fronted objects, hence, data were combined. The results are shown in Table 10.2. Language categories are defined in Table 2.1; T refers to *terso* (see chapter 4), U to "up/down" as used in this particular location, and G to the use of cardinal directions (NSEW).

The most compelling feature of mothers' language in this location is the use of "up/down" with young as well as older children. G (NSEW) is also used with children of all age levels. E language is used rarely, and only by a few mothers, particularly with 1–2 year olds. Similarly, SL is used in that age group, and CL thereafter with children at all age levels.

Some use of intrinsic language may be noted with young children, but rarely with older children. Overall, the frequencies of I are much lower than in Roopchandpur. On the other hand, a striking feature of mothers' descriptions of situations in Dolakha is the use of hand movements (gesturing, pointing) to refer to objects, often supported by the words "this way/that way" (called deictic). D is commonly used by mothers at this location, with frequencies from 1 to 12 and a mean of 8.

It may be noted that, of the forty mothers tested at Roopchandpur, only two used D, each on a single occasion. Thus, the use of gestures in describing objects or situations seems to be a characteristic feature of mothers' behavior in Dolakha right from early childhood to later years, but it does not occur in Roopchandpur.

In summary, the findings with regard to mothers' spatial language use clearly suggest that both in Roopchandpur and in Dolakha, the use of geocentric language, even with children as young as 1 year, is the norm, and children are exposed to it more and more as they advance in age. In early years, the mothers also use some I in Roopchandpur and D and SL in Dolakha, followed later by some CL. Egocentric language is rarely used in these locations.

Comparison of language used by mothers and by children

How does the language mothers use with children in Roopchandpur and Dolakha compare with the language children of the same age produce themselves on spatial language elicitation tasks? For this comparison, we draw upon data from our first study (see Table 4.5). It may be noted that our first study was carried out with children between 6 and 14 years, whereas mothers' language is available for children from 1 to 12 years. Thus, there are certain obvious limitations to this comparison: the data do not come from dyads but from separate samples, the age groups do not overlap completely, the number of mothers is fairly restricted, and the language elicitation tasks are not the same. Hence, the findings are more suggestive than really conclusive. However, despite these limitations, we get strikingly similar results between mothers and children, and some interesting differences as well.

Mother–child comparison: Roopchandpur

There are both similarities and differences between the language of children and mothers. One obvious similarity between the two groups is a near absence of E and CL, and the use of a lot of G (NSEW). It may be noted that the latter starts at age 1–2 years in mothers' language, and constitutes about a third of all expressions used up to age 9, when it becomes the major spatial language. In the child sample, on the other hand, we find G language used only after age 6, but it becomes the dominant spatial language of the child after age 9.

With respect to differences, it may be noted that mothers use SL rarely, but children do it a lot, especially the younger ones. On the other hand, mothers use a lot of I, which children use only rarely. This difference could be induced by the nature of the tasks, since those used with mothers were much more prone to intrinsic labeling than those used in the main study with children. Another striking difference between mothers and children is that in Roopchandpur, mothers never use D (contrary to Dolakha, where it is used quite frequently), while children, especially in the age group 4–5, use it frequently (72 percent).

Mother–child comparison: Dolakha

There is a striking correspondence between the spatial language of mothers and of children. For example, there is almost no E, the use of CL is quite similar, and about 40 percent "up/down" appears in both samples. The use of NSEW (about 20 percent in age group 9–11, and somewhat less in the younger age group) is also fairly comparable, and there is considerable use of D.

There are also two main differences between children and mothers. One is with respect to the use of SL, which children use in the 6–8 age group

mainly (and even some in older groups), while mothers do not use it at all (the one mother, with a baby of 2.5 years, is probably an exception). Another difference concerns the use of *terso*, which children use, but the mothers apparently do not.

Discussion

These studies of mothers' spatial language allow us to understand partly why children in the villages in India and Nepal use a geocentric frame of reference in defining the location of objects or themselves in their environment. In the village in India, where use of cardinal directions is the norm, mothers start using them with children as early as 1 year of age. Although children in early years use more deictics with occasional reference to SL, by the age of 6 they also begin to use cardinal directions quite often, and by age 9, this becomes established as the only spatial language in their cognitive repertoire. This provides us with at least one clear example of how adult language precedes child language.

A similar line of evidence for children's language learning comes from Dolakha. Mothers use not only a lot of "up/down" and CL, but also a good amount of D with children from the age of 2 onwards. We find the same language categories primarily used by children in early years on our spatial cognitive tasks. By the age of 6, even D is diminished, and is taken over by "up/down" and NSEW language categories, signifying a geocentric frame of reference in language.

The normative use of spatial G language by mothers at both these locations with children from an early age suggests that people do use spatial language in a preferential manner dictated mainly by ecological and cultural conditions. In Roopchandpur, where the terrain is flat, and there are no clearly visible landmarks, the use of NSEW anchored by the directions of sunrise and sunset turns out to be highly functional. A number of Hindu religious and cultural practices organized with reference to cardinal directions (in terms of "dos" and "don'ts") on a daily basis reinforce the use of these directions in people's lives. In organizing various activities in the village setting, people spontaneously use these orientations, which children pick up through their active and guided participation with parents.

We find a similar situation in Dolakha. The high-peak mountains all around the village divide the terrain into clearly distinguishable "up" and "down" segments. This forms the main axis of spatial orientation. Location of places (e.g. villages or markets) is primarily determined with reference to "up" and "down", to which further details are added by reference to a CL, or pointing to the place to specify the exact angle. Also, a number of religious and cultural practices that regulate people's daily lives are organized with reference to

cardinal directions. Thus, the vocabulary of cardinal directions also gets used in several contexts, and we see in our data that children at this location pick up these vocabularies quite early in life.

Hickmann (2006, p. 281) concludes from a study of French and English motion descriptions in 3 and 5 year old children that "from early on children construct a spatial language that tightly fits the adult system and further tune into this system during language and cognitive development." The close correspondence between the adult and child spatial language observed in this study seems to support the idea that spatial language is a cultural product which is transmitted to children mainly through their parents, but also through many significant others, such as members of the family and peers. However, as children grow older and start making their own way through the local context, they also seem to discover some convenient ways of dealing with spatial realities other than those learnt from parents. For example, at both locations we find children making fairly good use of the SL language category, which is hardly ever used by their mothers. Similar is the case of D in India, which 4–5 year olds use a lot, but mothers do not use at all. In Nepal, we find a similar example of *terso*, which is used by children as frequently as CL, but is not used by mothers at all.

In summary, our findings suggest that spatial language, like any other aspect of human behavior, is adaptive to local ecological and cultural conditions. Children do learn the spatial language from their parents, but as they negotiate life in the environment, they also acquire new ways of dealing with spatial realities.

11 Geocentric gestures before language?

A major question of our research is how early children are able to use a geocentric FoR, either in language (when describing a spatial array) or in other cognitive tasks (such as encoding a spatial array in memory). Much of our data suggests that, in the children we have studied in Bali, India and Nepal, a geocentric FoR is predominant, is used very early, and further increases with age. The study reported in this chapter seeks further evidence for the precocity of a geocentric FoR expressed through gestures, before geocentric language is available. Iverson and Goldin-Meadow (2005) state:

> In development, children often use gesture to communicate before they use words … The fact that gesture allows children to communicate meanings that they may have difficulty expressing verbally raises the possibility that gesture serves a facilitating function for language learning. If so, changes in gesture should not only predate but also predict changes in language. (p. 367)

These authors provide empirical research that supports this assumption, and conclude:

> Our findings underscore the tight link between gesture and speech, even in children at the earliest stages of language learning. At minimum, gesture is a harbinger of change in the child's developing language system, as it is in other cognitive systems later in development (Goldin-Meadow, 2003). Gesture may even pave the way for future developments in language. (p. 370)

Following this lead, we hope to use gestures to clarify which spatial FoR is used before it is expressed clearly in language.

The study is carried out with Nepalese children in the city of Kathmandu. In our first study in India and Nepal we found that young children (especially 4 to 5 year olds, and to some extent up to 8 years old) were often using what we have called deictic language (D) in describing a spatial array: they just say: "This way/that way," accompanied by a gesture of a finger or the whole

The research reported in this chapter was first published in Dasen, Changkakoti, Abbiati, Niraula, Mishra, & Foy (2009).

hand (see Table 4.5). This phenomenon was found again in the main study in Kathmandu (see Figure 7.1).

The status of the D category is inherently ambiguous in terms of geocentric vs. egocentric encoding: it could be body related since a body movement is involved, and could mean "to the left/right" (i.e. egocentric), but the movement may also point to a direction that is outside of the display. The latter interpretation is reinforced by the fact that, in both samples in India, the very young children also use what we have called situational landmark (SL) references (i.e. outside of the display, but within the room), a category that is still quite strong at age 6–8, but then disappears with age. At the time of our first study, we concluded that the status of D "needs more detailed research, because it could hide markedly different processes (egocentric and geocentric)." (Mishra *et al.*, 2003, p. 379).

Indeed, given the early predominance of geocentric language, D may well be geocentric too (confirming a developmental path that does not exist in Western contexts), but it could also be egocentric, confirming rather the classical (Western) developmental theories claiming that spatial development always starts egocentrically with reference to the body (Miller & Johnson-Laird, 1976; Piaget & Inhelder, 1956).

How could we decide whether D is geocentric or egocentric? Possibly through gestures. Indeed, Levinson (2003) makes a distinction between absolute (geocentric) and relative (egocentric) gestures, in which he describes typical geocentric gestures as being large, made with the outstretched arm or even the whole body, and egocentric ones much smaller, close to the body:

> [Geocentric] gestures are large, with arms outstretched, allowing accurate sighting of the angles depicted. Unlike our [Western] gestures, they occur in all directions, for example behind the body. (p. 244) …
>
> Absolute [geocentric] gestures are large and expansive. [They] are made with fully extended arms, and thus lie naturally far away from the trunk. This contrasts with the data … for American English speakers (said to be the same for speakers of other European languages), where the vast majority of gestures occur right in front of the trunk. (p. 252)

Hence, if we were to look more closely at which gestures accompany D language, we might be able to tell which FoR the children are in fact using, a geocentric or an egocentric one. What we propose to do is to look first at the language data and gestures of the children whose language is not ambiguous (mainly the older ones), to see whether what we think are geocentric and egocentric gestures do correspond to the respective frames in language use. In other words, this will validate our coding for gestures in this particular cultural context. Once we are satisfied with the correspondence between language and gestures, we will apply the coding to the younger children, those who use the ambiguous D language. The gestures they predominantly use will tell us in which FoR they are functioning.

Table 11.1. *Scoring of language and gestures*

	Scoring of gestures
Code	Description
L	Large scale, away from body, arm fully extended for a fairly long time, often with body movement
M	Medium scale, away from body, arm not fully extended, often of short duration
S	Small scale, with hands only, in front of trunk
I	Pointing to one object in relation to another

Procedure

About halfway into the study in Kathmandu (see chapter 7), we started taking videos of the Perspectives task (described in chapter 2). Although we tested 400 children in all, video recordings are available for 234 of the children (200 of which were from the Nepali-medium schools).

The coding categories for language are those presented in Table 2.1. The scoring of gestures is presented in Table 11.1. In further analyses, we will ignore the intrinsic category, which is irrelevant to our hypothesis (and not very frequent in occurrence).

The coding of the language was done in Kathmandu, while the coding of gestures was done independently in Geneva, by researchers who did not have the information on the language codes, and did not understand Nepali. Although they could hear the sound recording (if only to be sure of which position was being asked about), they scored gestures independently of any language. Only the first, spontaneous gesture was scored for each position (ignoring I, which often occurred first just to confirm which object was being talked about). Out of a potential total of 2,106 items that were scored independently for both language and gestures, 1,583 items were codable for both.

A set of seventy subjects was scored initially for training purposes, and then rescored when the procedure had been fully established. A fairly high inter-scorer reliability (88 percent) in scoring gestures was attained after extensive training and discussion.

Results

Consistency between language and gestures

We first look at the consistency between language and gestures on the 1,135 items where the language was explicit (non-D). The data are presented in Table 11.2.

Table 11.2. *Consistent (in bold) and inconsistent items between language and gestures*

		Gestures			
		S	M	L	Total
Language	E	**66**	58	71	195
	SL	13	**64**	**115**	192
	G	62	**332**	**354**	748
	Total	141	454	540	1135

Inconsistency is found on 129 items where E language is accompanied by an M or L gesture and 75 items where SL and G language goes with an S gesture, amounting to a total of 18 percent of inconsistent items. Strict consistency (E/S, SL/M, G/L) is found in 484 items (43 percent), and we can consider the 447 SL/L and G/M items to be consistent as well, since they both refer to some direction outside of the display, and are at least non-egocentric gestures. The category G/M, combining geocentric language with a medium size and short duration gesture, is quite frequent. Total consistency is hence estimated at 82 percent. This gives us sufficient confidence to conclude that gestures indeed reflect the same frame of spatial reference as language. Our argument is therefore that, since gestures are a good reflection of the frame of reference expressed in language in the older children, they can also be used to determine what frame the younger children are using when they give an ambiguous D verbal answer.

Looking at which gestures go with the deictic verbal answers (Table 11.3), only 17 percent of the answers are accompanied by an egocentric gesture (D/S), 35 percent by the medium-scale geocentric gesture (D/M) and the majority (48 percent) by a clear, large-scale geocentric gesture (D/L).

It could still be the case, if the theory of a universal egocentric developmental starting point were true, that the very young children would use more D/S than the older ones. That this is not the case is illustrated in Figure 11.1.

Even at age 4, D accompanied by large geocentric gestures (D/L) form the majority, followed by medium geocentric gestures (D/M). The mean of D/S is significantly lower than D/G at age 4 ($t = 2.384$, $p = .023$) and significantly lower ($p < .01$) than D/L + D/M in each age group. In the age group 7–9 years, there is no D/S at all.

Discussion

We have demonstrated in this study that we can rely on gestures to clarify which frames of spatial reference children use when they give ambiguous

Table 11.3. *Deictic language and three types of gestures*

D + gesture	N	Percent
D/S	61	17
D/M	130	35
D/L	176	48
Total	367	100

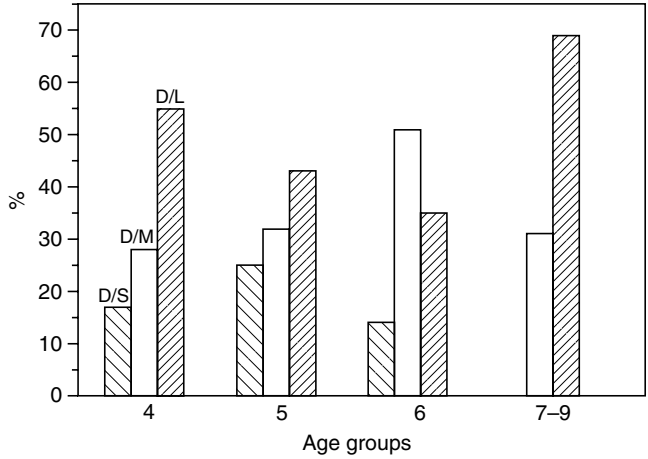


Figure 11.1 Three types of gestures with deictic language, by age

answers such as "It is this way." In a situation such as Kathmandu, where both the egocentric and the geocentric frames are potentially available in the language, it might have been expected that young children start with the egocentric reference and move to the geocentric one later. This is clearly not the case. The study of gestures comes to reinforce our overall findings of a predominance of the geocentric frame even early in life. Even at age 4, geocentric gestures predominate over egocentric ones. Whether we would find the same results with even younger children, at ages 2 or 3 years, is a question open for future research – although it would require a lot of patience and the development of specific methods, because it is already very difficult to carry out this sort of testing with 4 year olds.

In fact, Kathmandu was not the ideal place to carry out this research, since generally speaking it is the location in which we found the latest development of the geocentric FoR (excluding Geneva, of course). Bali would have

been a more ideal location because we have many indicators of the very early establishment of the G frame, and indeed casual observation indicates that large geocentric gestures are used there; however, no D language is used in Bali. On the other hand, the study could have been carried out in Roopchandpur, where D is quite frequent (72 percent at 4–5 years; see Table 4.5), and the G FoR seems to be established earlier than in Kathmandu. But it so happens that we had video recordings for Kathmandu and not for the other locations. The study came as an afterthought, when all the data had already been collected.

So the question arises as to what status this early gestural G frame may have in these very young children, considering that their language is ambiguous, and there is no indication of an early geocentric non-verbal encoding. It is quite obvious that these young children do not use a cardinal grid system in any Euclidean sense of the term. They know about the system, but don't understand it. As we have seen in Table 7.3, only one out of sixty-four children (age 4 to 6) in the Nepali school group knows all four directions correctly. What seems to be happening is that they are picking up the adult norm and imitating it. They know that location is designated by far-away directions that one can show in gestures. It is probably a sort of procedural knowledge, without proper understanding.

In any case, what we are witnessing is a particular developmental path that is different from the one described by mainstream developmental psychology for Western children. Very young children do start with a geocentric system, even though it still has to be fully learned and adjusted to reality. It is interesting to note that they can do this non-verbally, through gestures, before they can express it in language. If anything, it seems to be cognition that eventually guides language and not the opposite.

12 Spatial organization schemes

In this chapter, we have a close look at how children using a geocentric frame organize and describe a spatial layout. The first part will deal with what happens when the participants move around the display and describe it from different directions, or when the display is rotated. In part 2, we move further into a micro-analysis of how the children seem to organize a layout of three objects such as our Perspectives task.

Part 1: description of Perspectives when moving around a display

The three spatial frames of reference, intrinsic, egocentric and geocentric, have interesting properties when a display is rotated (Levinson, 2003, pp. 52–53). This is illustrated in Figure 1.2 (from Levinson, 2003, p. 52) in chapter 1. An important consequence of using a particular spatial FoR can be noted when a person describes a spatial layout from different positions either by moving around the display, or when the display itself is rotated. Levinson (2003) explains the logical properties of the three FoR by analyzing theoretically the effects of rotation of the viewer, the ground object and the whole array. With the geocentric frame, the same description can be given irrespective of the location of the viewer ("The ball is north of the chair" remains true irrespective of the position of the speaker), while this is not so with an egocentric frame.

However, this may be a slight simplification, which does not necessarily apply to more complex displays. Even when there are just three objects, such as in our Perspectives task (see chapter 2, particularly Figures 2.1 and 2.2), it is possible to organize the display in several ways (see the next section on "schemes" in this chapter).

From any one of the three positions, the square box can be described as being north, and the two round ones south. However, it can also be west together with the large circle and the small circle is east, or all three objects can be situated towards the same direction from an edge ("They are all east"). Hence, a geocentric description can change from each of the three positions: for example,

the square can be north from position 1, west in position 2 and north-west from position 3. While a rotation around such a display automatically produces a different description with an egocentric FoR, it may or may not elicit the same description in a geocentric one.

A rotation paradigm has been used in some recent experimental studies carried out with adults as well as young children. Following a body of developmental studies that describe transitions from "egocentric" to "allocentric" responses to stimuli in early childhood (e.g. Acredolo, 1978; Bremner & Bryant, 1977; Piaget & Inhelder, 1956), the new studies have tried to demonstrate that different frames of reference are not mutually exclusive, but they generally operate in parallel (Nadel & Hardt, 2004).

Studies of adult spatial memory (Simons & Wang, 1998; Wang & Simons, 1999) have demonstrated parallel effects of frames of reference defined in reference to the body and to the surrounding environment. In these studies participants were shown an array of five objects and were asked to tell which of the objects had been moved. Between presentation and test, the participant's position and the array's orientation within the room were manipulated so that the array of objects remained either consistent or inconsistent with its initial position egocentric to the body and the room. In the baseline condition, where both frames of reference were available, participants were tested from the same place in the room and the array did not move. When they moved to a new place in the room, and hence saw a new view of the array, the body–array relation was made inconsistent. The room–array relation was made inconsistent when participants moved to a new place, but the array was simultaneously rotated so that their view of it matched the view seen at the beginning. Finally, when the array was rotated but participants answered from the same place in the room, both relations were made inconsistent. The results showed that the frames of reference provided by body and environment had additive effects on recall accuracy. Recall was most accurate when both were consistent between presentation and test, and least accurate when neither was consistent.

An important finding of this study was the improved performance when the array remained stable in the surrounding room. For example, participants who moved to a new viewing position performed better than those who experienced the equivalent viewpoint change by rotation of the display. This advantage has been explained in two different ways. In the first place, it is argued that allocentric representations of object locations within the surrounding framework of visual cues may lead to improved accuracy. Array rotation would disrupt these relationships. Second, participants who walk to a new position have the advantage of self-motion cues to the distance and direction of their displacement. These cues could be used for "internal updating" of object locations.

Table 12.1. *Same or different description on Perspectives when moving around display*

	Samples			
Descriptions	India, village	India, city	Nepal, village	Total
3 different	118	127	128	373
2 same	27	12	8	47
3 same	14	7	8	29
Total	159	146	144	449

Chi square = 14.99, df = 4, p = .055.

Study 1

In our first study (see chapters 2, 3 and 4 for a description of methods, locations, samples, and general results), while seeking a description of the display from three different positions by moving around it, the assumption (in line with Levinson's hypothesis) was that children from villages in India and Nepal (where geocentric language predominates) would not change the description of objects when moving to a different position, whereas those from Varanasi city (where some egocentric language is also used) might change the description in relation to their body position while moving around the display.

To test this assumption, we analyzed children's descriptions given from positions 2 and 3 relative to the descriptions produced at position 1. In particular, we assessed whether the last two descriptions were the same as or different from description 1. The criterion for a "same" description was not only the use of the same general FoR, but keeping the same spatial organization of the display, i.e. using exactly the same referents. Thus, if the objects are described as being west and east in position 1 but north and south in position 2, it is counted as different. The results are presented in Table 12.1.

Since G language is predominant in the two villages (in Nepal and India) compared to the city, we would expect to find more "same" descriptions in those two locations. However, the tendency to provide three "different" descriptions was significantly higher in all samples than the tendency to provide two or three "same" descriptions. The level of children's age or schooling (including absence of schooling) did not change this pattern. These findings suggest that the use of a geocentric spatial language by children does not always lead them to describe the objects in a display independently of their point of view. Children generally change the description of objects when they view a display from different positions.

Table 12.2. *Same or different descriptions according to G and E language FoR*

Locations	India, village		India, city		Nepal, village	
Language	G	E	G	E	G	E
3 different	89	2	47	46	89	5
2 same	13	0	2	6	5	1
3 same	9	0	7	0	5	0
Total	111	2	56	52	99	6

Since we have recorded the actual spatial language used by the children, we can refine the analysis further. Table 11.2 displays the predominant language used by the children on the language elicitation tasks and whether they give the same description or not.

Those children who predominantly use G (which includes "up/down" in Nepal) are indeed those who occasionally give the same description two or three times, but most of them don't. Those who use E (mainly in the city of Varanasi), usually give three different descriptions. These results are not very impressive, but the trend is in the expected direction.

Still another way to look at the data is to compute the correlations between the number of same descriptions and the language used on the Perspectives task. These correlations are very low, and the only one to reach statistical significance is a negative correlation ($-.09$, $p < .05$) with E language.

We conclude from this first study that the hypothesis regarding the properties of the frames under rotation receives only partial support from the data. Those who use an egocentric FoR indeed use different descriptions, and those who use a geocentric one occasionally use the same description, but certainly not always.

Study 2

When discussing these results with David Wilkins (personal communication), he suggested that, for the experiment to be complete, we should also rotate the display. We did this in the main study. First the child moved around the display to position 2, and then, in position 2, the display was rotated by 180°. This is illustrated in Figure 2.2.

The assumption is that G speakers can give the same description in positions 1 and 2, but E speakers can't, while the latter should give the same description in positions 1 and 3 (after the display is rotated), but not G speakers. A first way to look at this hypothesis is simply to see how many children, in the various

Table 12.3. *Frequencies of children giving different or the same descriptions in positions 2 and 3 in various locations*

		Bali	Varanasi		Kathmandu		Panditpur	Geneva
			Hindi school	Sanskrit school	Nepali school	English school		
Pos. 2								
Different		101	181	101	160	156	49	60
Pos. 2								
Same	N (%)	63 (38)	39 (18)	54 (35)	40 (20)	44 (22)	21 (30)	12 (20)
Total		164	220	155	200	200	70	72
Pos. 3								
Different		112	196	149	195	182	68	20
Pos. 3								
Same	N (%)	4 (3)	24 (11)	6 (4)	5 (2.5)	18 (9)	2 (3)	52 (87)
Total		116	220	155	200	200	70	72

locations, do or do not give the same description in positions 2 and 3. The data are provided in Table 12.3.

In position 2, the same description is never predominant, but does appear in about one-third of the children in Bali, in the Varanasi Sanskrit school and Panditpur. As to getting the same description in position 3, this occurs as a majority only in Geneva, and to some extent in the Varanasi Hindi school and Kathmandu English schools. Again, these results are not very impressive but are nevertheless consistent with what is expected from language use in these locations.

Another way to test the hypothesis is to compare through t-tests, in each location, those who give the same description and those who don't on various outcome measures, such as summary scores of G language and G encoding. The results are presented in Table 12.4 for Varanasi. The differences (t-tests) are statistically significant in the predicted direction for G language and encoding, as well as for BDT and the knowledge of directions. Similarly, t-test results are presented in Table 12.5 when the display is rotated.

For position 3, those who give the same description use significantly less G language, less G encoding and display less knowledge of the orientation system, i.e. they are those who tend to use an egocentric FoR.

In Bali, those who give the same description in position 2 use significantly more G language and encoding, and the opposite is true for those who give the same description in position 3. As to the details of the results from Kathmandu, they are presented in Table 12.6.

Table 12.4. *Varanasi: t-tests between groups giving same or different description on position 2*

	Description positions 1 and 2	Mean	SD	Sig.
G language	different (N=282)	−.07	1.03	.01
	same (N=93)	.23	.85	
G encoding	different	−.06	1.03	.01
	same	.20	.83	
Knowledge NSEW	different	2.69	1.69	.05
	same	3.06	1.56	
BDT	different	3.05	1.57	.00
	same	3.74	1.72	
SPEFT	different	16.15	2.32	.20
	same	16.51	2.35	

Table 12.5. *Varanasi: t-tests between groups giving same or different description on position 3 (rotation of display)*

	Description positions 1 and 3	Mean	SD	Sig.
G language	different (N=345)	.09	.93	.00
	same (N=30)	−1.02	1.17	
G encoding	different	.04	.95	.03
	same	−.36	1.29	
Knowledge NSEW	different	2.85	1.63	.02
	same	2.00	1.88	
BDT	different	3.22	1.64	.79
	same	3.30	1.58	
SPEFT	different	16.24	2.34	.86
	same	16.17	2.25	

T-test values are significant for encoding and BDT in position 2, and for language and SPEFT in position 3. In Panditpur, on the other hand, no significant differences are found.

Conclusions, part 1

What we can conclude from these analyses is that, overall, there is a statistically significant confirmation that those who use a geocentric FoR tend to give

Table 12.6. *Kathmandu: t-tests between groups giving same or different description on positions 2 and 3*

Position 2	Description positions 1 and 2	Mean	SD	Sig.
G language	Different (N = 316)	–.04	1.01	.18
	Same (N = 84)	.13	.98	
G encoding	Different	–.09	.92	**.00**
	Same	.33	1.21	
Knowledge NSEW	Different	1.43	1.76	.23
	Same	1.70	1.87	
BDT	Different	2.56	1.79	**.04**
	Same	3.08	2.20	
SPEFT	Different	15.65	3.09	.92
	Same	15.61	3.21	
Position 3	Description positions 1 and 3	Mean	SD	Sig.
G language	Different (N = 377)	.04	1.00	**.00**
	Same (N = 23)	–.61	.76	
G encoding	Different	.01	1.01	.39
	Same	–.18	.87	
Knowledge NSEW	Different	1.50	1.80	.47
	Same	1.22	1.78	
BDT	Different	2.69	1.91	.18
	Same	2.22	1.59	
SPEFT	Different	15.75	3.05	**.02**
	Same	13.83	3.59	

the same description when moving around a display more often than those who don't. The results are particularly clear for Bali and Varanasi, only partly in Kathmandu and not at all in Panditpur. However, it is quite obvious that using a geocentric description does not imply the obligation to use the same description from different positions; it is only a possibility, never used by more than a third of the informants.

The hypothesis is confirmed by the data on position 3, when the display is rotated; in this case, the children in Geneva are those who give the same description, and in the other samples this is not the case.

Instead of looking only at whether the children give the same description or not, we also tried to study how they actually go about organizing a display like the three objects in Perspectives. This is the theme of part 2.

Part 2: organization schemes

Some studies indicate that the understanding of spatial locations involves a categorical coding, which children are capable of carrying out fairly early in

infancy (e.g. Quinn, 1994, 2004). For example, a rectangular space can be divided into two halves by mentally drawing an imaginary line in the middle of the space. This is more likely to take place in smaller spaces, perhaps because they can be perceived at a single glance. Children's bias to divide small-scale spaces into halves has been noted by the age of 4 (Huttenlocher, Newcombe, & Sandberg, 1994).

Researchers have tried to assess the situations in which children may change the organization of objects in a display by imposing spatial categories. One experimental strategy to study this phenomenon is to present children with an array of objects in a manner that suggests a certain organization in the display, and then change it to a different organization. Hund and Plumert (2005) displayed twenty objects in a large square box in an order that either emphasized the organization of objects by quadrant or in relation to the sides (i.e. edge) of the box. It was found that while adults could reorganize the display as suggested by the structuring of the display, children as old as 11 years found difficulty in switching to the new organizational scheme. Huttenlocher, Hedges, Corrigan, and Crawford (2004) noted that the availability of horizontal and vertical lines (defining the edge of the space) provides a precise alternative organization scheme, which adults are able to use, but the children are not.

The experimental laboratory studies on spatial frames of reference that we were able to review are characterized by fascinating methodological manipulations, but they tell us nothing about the schemes that children might use in partitioning the objects of a table-top display in different spatial regions in order to remember them. An implicit assumption (and a Western ethnocentric bias) inherent in these studies is that children will never use the wider geocentric spatial frames of reference (such as NSEW) in partitioning and encoding the objects of a display. Knowing that "intrinsic" encoding of spatial objects is a universal feature of spatial cognitive development (and hence there is no surprise that it is used before egocentric encoding) the question is: which schemes could be useful for children in encoding spatial objects, and will they remain constant or change as the child moves around the display and describes the objects from a different position, or when the display itself is rotated?

In this section we describe studies carried out in India, Nepal and Indonesia, which try to examine: 1) the spatial organization schemes that children in these locations use to describe a spatial display and their development with age; 2) the stability of their spatial reference/organization schemes in describing the display from various positions while moving around it or when the display itself gets rotated; 3) the relationship of spatial language with the use of spatial reference/organization schemes; and 4) the relationship of spatial reference/organization schemes with other spatial cognitive abilities and processes.

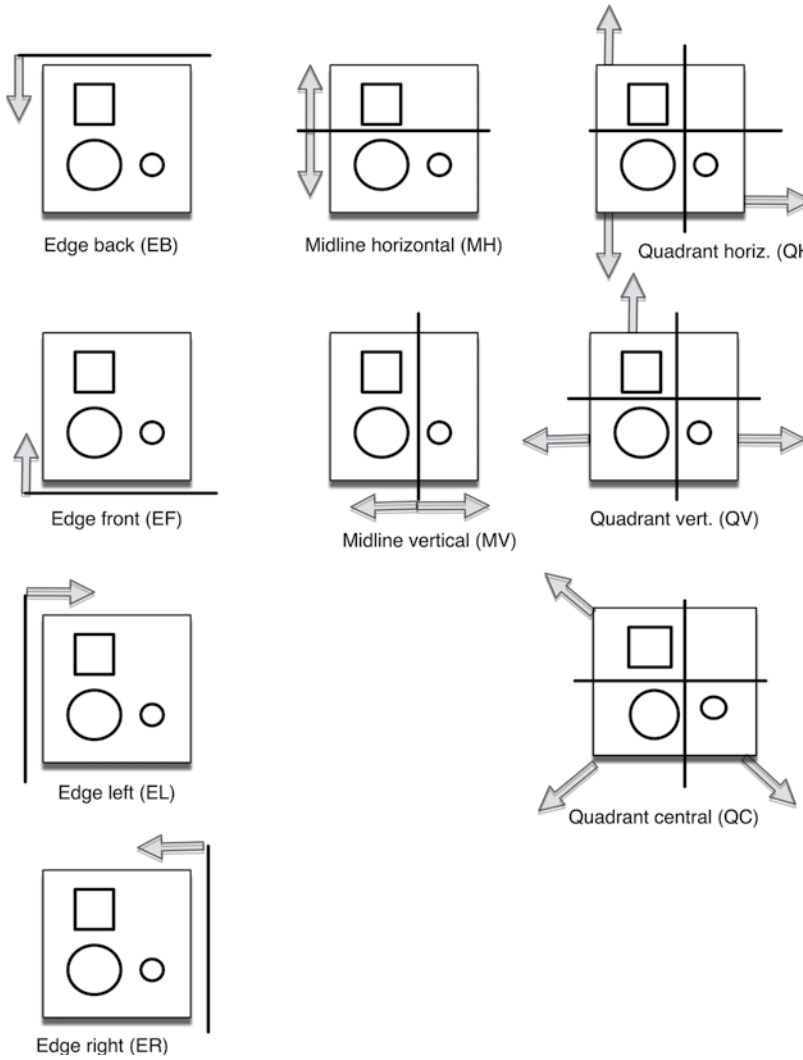


Figure 12.1 Classification of schemes

Method

The study was carried out with 376 children (10–14 years) in Varanasi, 170 children (4–12 years) in Bali and 400 children (4–12 years) in Kathmandu. All children were given the Perspectives task as shown in Figures 2.1 and 2.2. The classification of various schemes is illustrated in Figure 12.1.

Table 12.7. *Percentage of spatial schemes used by Hindi- and Sanskrit-school children at position 1, position 2 and after rotation of the display*

	Hindi vs. Sanskrit school	Edge	Midline	Quadrant	Chi-square	df	p
Position 1	H	5	22	30	24.89	2	.00
	S	3	7	33			
Position 2	H	8	24	24	17.13	2	.00
	S	6	10	28			
Rotation	H	4	27	25	39.38	2	.00
	S	5	7	32			

In the edge scheme, any of the four edges of the display is used as the reference point to describe the objects. The midline scheme involves a division of the display into two parts by mentally drawing a line across the middle. There are two options, midline horizontal (MH) and midline vertical (MV). For quadrants each object is viewed as being placed in a separate segment of the display. Depending on how the child begins and ends the description, a distinction is made among quadrant horizontal (QH), quadrant vertical (QV) and quadrant central (QC). Note that theoretically, both geocentric and egocentric descriptions are possible for each of the schemes, although edge and quadrants are rather unlikely to be used with an egocentric FoR, where midline is the more likely choice (as we will see from the data collected in Geneva).

Results in Varanasi

Use of schemes Table 12.7 presents the distribution of children of Hindi and Sanskrit schools using the edge, midline and quadrant schemes at positions 1 and 2, and after rotation of the display respectively.

Very few children use the edge scheme in the description of the display, the most dominant scheme being quadrant. It is used by Sanskrit-school children more often than those in the Hindi school, who prefer midline.

Stability of spatial schemes We also examined the stability of the spatial scheme used by children on different occasions. For this purpose, the schemes used at position 1 were compared with those used at position 2, and after display rotation. Table 12.8 summarizes these findings.

It may be noted that the schemes used at position 1 generally remain stable at position 2 (77 percent concordance), and after display rotation (79 percent), suggesting that switching from one scheme to another is an uncommon feature. The difference between the percentages of switch and

Table 12.8. *Correspondence of spatial schemes at position 2, and after display rotation, relative to schemes at position 1 (in percent)*

		Position 2		
	Schemes	Edge	Midline	Quadrant
Position 1	Edge	**7**	1	0
	Midline	4	**22**	4
	Quadrant	3	11	**48**
		Rotation		
Position 1	Edge	**6**	2	1
	Midline	1	**23**	5
	Quadrant	2	10	**51**

non-switch from one scheme to another is highly significant at position 2 (chi square = 248.96, df = 4, $p < .000$), and after display rotation (chi square = 250.22, df = 4, $p < .000$), indicating that children generally stay with their schemes not only when they move and describe the display from a new position, but also when the display is moved.

Schemes and the description of the display In order to examine whether children using a particular scheme give the "same" or "different" descriptions of the display after their movement to position 2, or after rotation of the display, we counted the number of descriptions that remained the "same" (i.e. did not change) and those that were changed. The findings are summarized in Table 12.9. It may be noted that children who use an edge or a midline scheme generally provide a different description of the display at Position 2 as well as after display rotation. On the other hand, children who use a quadrant scheme provide 22 percent of same descriptions at Position 2, but a different description after display rotation.

Developmental change in schemes Is there any pattern of developmental change in the use of edge, midline and quadrant schemes? To answer this question, we computed correlations between age and the use of different schemes. Almost no relationship of age with edge or midline scheme was found, but a low significantly positive correlation (.12*) between age and quadrant was noted.

Relationships between schemes and other variables In what ways are the three schemes related to spatial language, encoding and other spatial

Table 12.9. *Same versus different schemes at position 2, and after display rotation*

	Schemes	Different	Same
Position 2	Edge	14	0
	Midline	30	4
	Quadrant	30	22
Rotation	Edge	8	1
	Midline	29	5
	Quadrant	55	2

Table 12.10. *Partial correlation (age controlled) of schemes with other spatial cognitive variables*

Control variable: age	Edge	Midline	Quadrant
G language	.06	**–.37****	**.37****
G encoding	–.09	–.08	**.14****
Knowledge NSEW	–.03	–.09	**.18****
BDT	–.07	–.02	**.15****
SPEFT	–.04	–.02	.07

df = 373.

cognitive measures? To answer these questions, correlations of different spatial schemes were computed with other spatial cognitive variables.

Since the quadrant scheme is also significantly correlated with age, in order to make sure that the relationship with other spatial cognitive measures is not just due to age, we partialed out the age variable. The outcomes are presented in Table 12.10.

There is a significantly negative correlation of midline scheme with G language. With the quadrant scheme, on the other hand, we find significantly positive values of correlation with G language and G encoding, knowledge of directions and BDT. The edge scheme is not significantly related to any of these measures.

The QV, QH and QC sub-schemes It may be recalled that the quadrant scheme combines three different sub-schemes, namely QV, QH and QC. We examined these three quadrant sub-schemes separately in terms of their development with age. There is a developmental increase in the use of QC (r = .16**). The other two sub-schemes are not significantly linked to age.

Results in Bali

The procedure adopted in Bali was the same as in Varanasi except that in Bali the rotation of the display in position 2 was introduced only halfway into the study. So, the data from this location is slightly limited to examine the use of spatial schemes and their relationship with other variables.

There is almost no use of edge by children in Bali at any age level, while midline is used especially by young children, and then less and less by older ones. It is only the use of quadrant that shows a significant increase with age. These trends are statistically confirmed by a negative correlation between age and use of midline ($r = -.18^*$), and a positive correlation between age and use of quadrant ($r = .36^{**}$). In this respect the trend of results noted for quadrant is similar to that found in Varanasi, although the rise in the use of quadrant is even steeper since the age span is larger.

As in Varanasi, we again find quadrant as a dominant scheme of children in Bali. In general children use QV and QH more often than the QC scheme. While the three schemes show an increasing trend with age, the increase in the case of QC is most systematic. On the other hand, in Bali, none of these schemes is significantly linked either to G language or G encoding, or the knowledge of directions.

How the different schemes relate to the description of the spatial display from position 2 or after display rotation was examined. The number of "same" and "different" descriptions is presented in Table 12.11.

The findings indicate that children who use an edge or midline scheme generally provide a different description of the display at position 2, but half of those who use a quadrant scheme provide the same descriptions. This trend is statistically significant (chi square = 7.31, df = 2, $p < .01$). After display rotation, on the other hand, children using any scheme provide mainly a different description.

Results in Kathmandu

The study at Kathmandu followed the same procedure as in Varanasi, but the age range of children was 4–12, as in Bali. First we look at how the three schemes are used by children in different age groups. Figure 12.2 presents the mean scores on different schemes according to children's age.

It may be noted that there is some use of edge, especially by young children; midline is used a bit more than edge, but again mainly by the younger children, and both of these schemes diminish with age. Quadrant appears to be a dominant scheme; it is used even by children as young as 4 years, and it shows continuous increase up to age 12.

Within the quadrant scheme, we again notice the dominance in the use of QV (54 percent) over QH (35 percent) and QC (11 percent) sub-schemes. There is no

Table 12.11. *Bali: same versus different schemes at position 2, and after display rotation (in percent)*

	Schemes	Different	Same
Position 2	Edge	3	0
	Midline	21	9
	Quadrant	36	31
Rotation	Edge	2	0
	Midline	30	1
	Quadrant	65	3

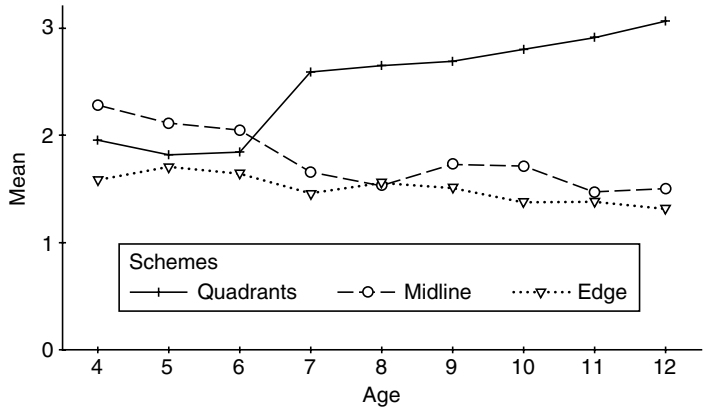


Figure 12.2 Development of schemes with age in Kathmandu

significant developmental trend in the use of QC and QV schemes. It is the QH sub-scheme that presents us with some systematic increase from age 4 to 12.

These sub-schemes do not show any significant relationship with G language, G encoding, knowledge of directions inside, or performance on SPEFT or BDT, whether we look at the overall sample, or the young (4–8 years) and the older (9–12 years) age groups separately.

The relationship of different spatial schemes with the description of display from position 2 and after display rotation was examined at this location also. The percentage of "same" and "different" descriptions is presented in Table 12.12.

The findings indicate that children who use an edge or a midline scheme generally provide a different description of the display at position 2 as well as after display rotation. On the other hand, about one-third of the children who use a quadrant scheme also provide the same descriptions at position 2

Table 12.12. *Kathmandu: same versus different schemes at position 2, and after display rotation (in percent)*

	Schemes	Different	Same
Position 2	Edge	18	2
	Midline	28	4
	Quadrant	32	**16**
Rotation	Edge	18	1
	Midline	26	2
	Quadrant	50	3

(chi square = 23.74, df = 2, $p < .000$), but mainly a different description after display rotation.

The relationship of these different spatial schemes with other spatial cognitive measures (e.g. BDT, SPEFT, knowledge of directions inside, G language and G encoding) was analyzed with Pearson correlations. Edge shows a significantly negative correlation with knowledge of directions (–.12*), and midline shows significantly negative correlations with BDT (–.19**), SPEFT (–.16**) and G language (–.19**). Quadrant shows significant positive correlations with all language and cognition measures, varying from .12* with G encoding to .30** with G language. The analysis also indicates age to be significantly negatively correlated with edge (–.11*) and midline (–.23**), but positively with the quadrant scheme (.33**). When age is partialed out, all significant correlations disappear except the one between G language and quadrant, suggesting that most of the relationships among variables are accounted for by age.

Results in Geneva

In Geneva, 72 percent of the children use midline and 28 percent use quadrant; edge is never used. Figure 12.3 shows the change with age.

Contrary to age trends in the other locations, it is midline that is predominant and increases with age and quadrant that decreases. The partial correlations, controlling for age, between types of schemes and I and E language on Perspectives are shown in Table 12.13.

Midline in the form of MV (but not MH) is positively correlated with E language and negatively with I, and quadrant (QC and QH) in the opposite way, positive with I and negative with E. This, of course, makes sense, MV being the obvious scheme when left and right are predominant. The quadrant scheme is difficult to express in egocentric language, but is easier with intrinsic references.

Table 12.13. *Partial correlations between schemes and language in Geneva, controlling for age*

Control variable: age	I	E
MH	.19	−.14
MV	−.50**	.55**
Midline	−.37**	.45**
Quadrants	.55**	−.49**
QC	.40**	−.44**
QH	.48**	−.39**
QV	−.10	.13

N = 70.

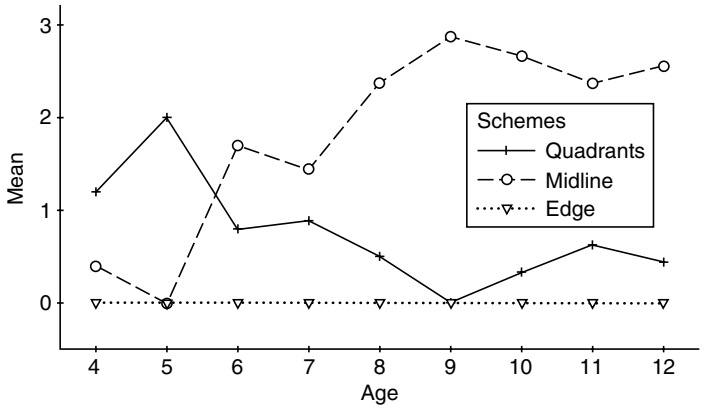


Figure 12.3 Development of schemes with age in Geneva

Discussion

In the "rotation" experiment, it was found that most children change their description of a display when they move around it, even if they use a geocentric FoR, but some of them don't. This study on organization schemes allows us to analyze further how these children organize their description of the display.

The findings reveal that the tendency to provide the same or different descriptions is linked to the scheme used in organizing the spatial display. Children who use an edge or midline scheme in interpreting the display generally change their descriptions when they move to a new position, or when the display itself is rotated. Those who use a quadrant scheme more often give the

"same" description when they move to a new position, but a different description when the display itself is rotated.

While the descriptions may change, the schemes generally remain fairly stable despite the change in children's position or the rotation of the display. Of all the children tested in this study, approximately 25 percent produce the same description of the display when they move around it. We notice in Varanasi as well as in Bali that these are the children who predominantly use a G language and engage in G encoding of the visual display. In Varanasi these children also have a higher BDT score than those who produce different descriptions. (In Bali and Kathmandu, we do not find supportive evidence for this relationship.) These findings support Levinson's (2003) hypothesis in the sense that the children who provide the "same" descriptions of the display while moving around are those who use a G language. On the other hand, there are many others in our sample who use a G language but do not provide the same description of the display.

While children may employ different schemes for encoding of spatial objects, the present findings indicate the dominance of quadrant over other schemes in Varanasi, Bali and Kathmandu, and midline in Geneva. The quadrant scheme seems to be linked to allocentric space, with intrinsic (I) in Geneva and with geocentric (G) in the other locations. Although it increases with age in these locations, children as young as 4 years can employ this scheme quite effectively, reinforcing the finding that a geocentric frame comes into play quite early in life.

13 Neurophysiological correlates of geocentric space

Part 1: Spatial frames of reference and hemispheric dominance

In this section we report a study that explores the linkage between language, spatial frames of reference (FoR) and hemispheric dominance. We also explore the relationship of these measures with psychological differentiation.

A striking feature of research on spatial cognition is the diversity of tasks and mental processes subsumed under this term (Linn & Peterson, 1985). The involvement of different brain structures makes it even more complex (Kemmerer, 2006). Many researchers attempt to define spatial cognition in terms of the tasks that are processed predominantly by the right hemisphere. Witelson and Swallow (1988) have presented an overview of the tasks that clearly involve a strong spatial component and are processed by the right hemisphere of the brain. However, they also mention other spatial tasks that are found to be more dependent on the left hemisphere. This makes prediction of spatial cognition difficult in terms of hemispheric lateralization theory.

Studies using neuroimaging techniques show that both hemispheres of the brain are active in almost all tasks (e.g. Grimshaw, 1998; Sergent, Ohta, & MacDonald, 1992; Zaehle, Jordan, Wustenberg, Baudewig, & Dechent, 2007), but there is some sort of compromise with regard to the division of labor between them so that they function in a highly coordinated manner. This is partly accomplished by dividing stimulus inputs. The right hemisphere deals mainly with information available in the left visual field, and the left hemisphere deals mainly with information available in the right visual field. While the same type of processing may occur in each hemisphere, it has been proposed that the corpus callosum aids parallel processing by shielding each hemisphere from the other until some late integration stage (Chiarello & Maxfield, 1996). This implies that task characteristics may play an important role in determining a greater involvement of one hemisphere over the other (Witelson & Swallow, 1988). Zaehle *et al.* (2007) did not find support for the existence of independent neural circuits. While an independent neural processing mode would predict unique processing resources for egocentric

and allocentric spatial coding, they found that the areas of brain activation for both tasks overlapped widely. They propose a hierarchical processing network in which the egocentric spatial coding requires only a sub-system of the processing resources of the allocentric condition.

The evidence for a hierarchical processing network has also led researchers to propose both phylogenetic and ontogenetic differences in the use of egocentric and allocentric encoding (Zaehle *et al.*, 2007). Berthoz (2002) considers allocentric encoding as more powerful because it "enables the mental manipulation as well as manipulation of relations between objects without having continuously to relate them to the own body" and is therefore "constant with respect to a person's own movement" (Berthoz, 2002, p. 99). Such a conceptualization of spatial encoding processes has led researchers to believe that allocentric coding mechanisms have "developed late in phylogenesis as well as ontogenesis, probably based on egocentric coding and in consequence partly relying on the same yet also recruiting additional neural resources" (Zaehle *et al.*, 2007, p. 99).

On the other hand, developmental studies provide evidence for allocentric encoding earlier than egocentric encoding, and this presents us with a contradiction in the sequence of spatial cognitive development, which still remains an unresolved issue.

Some neuroimaging studies indicate that there is a parallel processing of egocentric and allocentric information in the parietal lobe and hippocampal formation, with eventual transfer to the hippocampus for long-term storage of information in allocentric coordinates (Feigenbaum & Morris, 2004; Kesner, 2000; Péruch, Gaunet, Thinus-Blanc, & Loomis, 2000; Save & Poucet, 2000). The importance of frontal and parietal cortical regions in human spatial processing has been particularly demonstrated by neuroimaging investigations. Galati, Lobel, Vallar, Berthoz, Pizzamiglio, and Le Bihan (2000) and Vallar, Lobel, Galati, Berthoz, Pizzamiglio, and Le Bihan (1999) have carried out fMRI studies to examine the neural underpinning of different FoR. They used tasks in which the subjects had to judge the localization of a visual stimulus either with respect to their body or an object. Both studies revealed a bilateral, mostly right-hemispheric parieto-frontal network related to the egocentric FoR. Galati *et al.* (2000) also reported posterior parietal and frontal premotor activations with a similar right-sided asymmetry associated with the allocentric FoR. In another fMRI study, Commiterri, Gelati, Paradis, Pizzamiglio, Berthoz, and Le Bihan (2004) compared the viewer-centered, object-centered and landmark-centered coding of visually presented 3D information. They found that the viewer-centered egocentric coding was carried out mainly in the dorsal stream and frontal areas, whereas allocentric coding required dorsal as well as ventral regions.

Although the results of these studies are not always consistent, Nadel and Hardt (2004) suggest that these results combined with others (e.g. those based on research on spatial neglect) provide strong evidence for the involvement of

separate neural networks in the processing of spatial information in egocentric and allocentric ways. These studies indicate the existence of functionally and anatomically independent egocentric and allocentric spatial frames of reference, and point out the relevance of parietal areas in the use of the allocentric frame. They also bring out the limitations of lesion studies by indicating that they cannot yield precise information regarding anatomically defined neural circuits underlying egocentric and allocentric spatial codings (Zaehle *et al.*, 2007). Inter-individual differences in size and site of lesions, as well as compensatory processes during rehabilitation, often create difficulties in coming up with clear and definite interpretations of lesion effects in the use of spatial frames.

In view of these limitations, it is argued that data from brain-damaged patients cannot provide a definite neuroanatomical basis for the distinction between egocentric and allocentric FoRs. The problems are no less serious in neuroimaging studies that try to search for egocentric and allocentric spatial judgments in spatial navigation. Problems relating to the specific involvement of different sub-regions of the brain in egocentric and allocentric coding of spatial information, the amount of overlap in parietal regions, the possible interference due to visual stimulation, and the modulating influence of individuals' strategies still seem to be unresolved issues. Nonetheless, some studies (e.g. Galati *et al.*, 2000) do indicate that allocentric spatial judgments involve the posterior parietal cortex, mainly in the right hemisphere. Others have also reported a right-sided involvement of posterior parietal areas during allocentric spatial coding. For example, Zaehle *et al.* (2007) found that the right superior parietal cortex showed specific activation for the coding and maintenance of allocentric spatial information. These findings seem to be in line with studies that indicate a left-side neglect of individual objects as a consequence of right-hemispheric posterior parietal lesions (Vallar, Bottini, & Sterzi, 2003).

At this point it may be noted that the allocentric FoR used in neuroimaging studies is an "object-based" reference, which in our scheme refers to the intrinsic (I) category or at most to situation-specific landmarks (SL) that are clearly visible to subjects. The studies have not used further-away reference objects, those that are not visually present in the situation, such as conventional landmarks (CL). The studies have also not focused on the use of more abstract cardinal directions (NSEW). Further, the studies make use of egocentric and allocentric frames mainly in terms of encoding of information. They do not deal with frames as they operate in people's language, and the ways in which these linguistic frames may be linked to spatial representations in the areas of the human brain.

A distinction is often made between analytical and global processing, the former being predominant in the right hemisphere and the latter in the left.

Distinguishing written words is an example of analytical processing, distinguishing faces of global processing. With regard to face processing, studies indicate that it requires both componential (a left-hemispheric function) and configurational (a right-hemispheric function) processes (Moscovitch, 1979) to operate in parallel (Sergent, 1984). No substantial support is found for a dominant role of either the right or the left hemisphere in processing facial information (Mandal & Asthana, 1999; Sergent *et al.*, 1992). Tasks that require some sort of interpretation or elaboration, which often happens with verbal materials, are mainly carried out in the left hemisphere (Gazzaniga, Ivry, & Mangum, 2002; Wolford, Miller, & Gazzaniga, 2000).

Another line of research on spatial cognition (Niraula, 1998; Niraula & Mishra, 2001a), based on the use of behavioral techniques, suggests that Nepali children who are cognitively more differentiated (judging by their performance on SPEFT, described in chapter 2) predominantly use an absolute FoR (NSEW) to describe spatial information, whereas those who are cognitively less differentiated describe spatial information by using a predominantly egocentric FoR (LRFB). Witkin and Goodenough (1981) cite several studies that tend to support the hemispheric lateralization hypothesis of psychological differentiation. Children who perform cognitive tasks in a more differentiated (analytic) manner demonstrate right-hemispheric dominance, whereas those who perform cognitive tasks in a less differentiated (global) manner demonstrate left-hemispheric dominance. Taylor and Tversky (1996) suggest a probable linkage between the predominant spatial reference system (encoding) and hemispheric lateralization, but convincing data linking spatial FoR with hemispheric dominance and psychological differentiation are lacking.

In this section we report a study in which we have attempted to examine the relationship of hemispheric dominance with psychological differentiation, G language and G encoding. On the basis of the literature on allocentric space reviewed above, and since the geocentric FoR is also allocentric, it was hypothesized that there would be a link (in terms of a positive correlation) between geocentric language, geocentric spatial FoR, psychological differentiation, and hemispheric lateralization in normal subjects. It was further expected that this relationship would stand even after controlling for the effects of age, gender and schooling. In the second part of this chapter, we report a similar study carried out with right-brain-damaged patients.

Samples

The study was carried out in Varanasi with the selected sample of eighty children (see chapter 6) and in Kathmandu with a sub-sample of seventy children (see chapter 7).

Table 13.1. *List of peripheral laterality tasks*

Hand	**Eye**
Writing	Snapping photograph or video
Unscrewing a jar	Shooting gun
Throwing a ball	Looking through a small hole
Using scissors	Looking through tube
Inserting a key in a lock	
Foot	**Ear**
Kicking a ball	Listening on telephone
Skipping	Hearing pocket radio
Climbing stairs	Ticking movement on watch
Stepping over obstacle	Ear phone of Walkman
Long jump	

Tasks and tests

For hemispheric lateralization we used a peripheral and a central measure. The measure of *peripheral laterality*, i.e. handedness, footedness, eyedness, and earedness (in analogy to handedness), was adapted from Mandal, Pandey, Singh, and Asthana (1992a). It consisted of a number of tasks that the child could do with the hand, foot, eye, or ear. Children were first asked about their preference to do the task with the left or right limb/organ, and whether they would do it like that "always" or "sometimes." Then they were asked to perform the tasks. Table 13.1 lists the separate tasks. The use of the right or left limb/organ was recorded. For these tasks we used some locally available objects, toys and situations (e.g. climbing stairs).

The *central laterality* measure consisted of a brain lateralization task administered with the help of a laptop using a program developed by M. K. Mandal (personal communication). It involved the "split-field" technique in which the child was asked to concentrate on a black spot that appeared in the center of the computer screen. Then at the fixation point appeared an arrow that pointed either to the left or right in a random order. The child was asked to look at the stimuli that appeared in the direction of the arrow. The arrow and the stimuli appeared simultaneously. The distance between the fixation point and the stimuli on the computer screen was 12 cm. The child had to respond by pressing a key as soon as s/he had recognized the stimulus designated by the arrow.

Two sets of stimuli were used. One set included words (names) of familiar objects (lamp, shoe, ball, pen, bag, cap) and animals (dog, lion, cat, cow, goat, hen). The child had to tell whether the word referred to an object or an animal. The second set of stimuli included photographs of Indian male and female faces. The child had to distinguish between male and female faces.

These sets of stimuli were designed to generate different demands on information processing. The facial photographs were cognitively less demanding, since they could be identified even on the basis of a single feature (e.g. hair style) to allow the child to distinguish between male and female faces. Processing social stimuli such as human faces is carried out mainly in the left hemisphere. In contrast, the processing of words in terms of conceptual categories requires not only identifying the stimuli, but also linking them to the appropriate category on the basis of the abstracted property of the verbal stimuli. Abstraction and inference are the key functions of the right hemisphere. In view of this, we expect that right-hemispheric dominance is linked more with efficient processing of words as categories than with distinguishing between male and female faces. We also expect right-hemispheric dominance in the processing of words to be positively linked to the use of a geocentric FoR.

Three practice trials were given to each child. In the first trial, human faces and words were presented for 800 msec to either side in a random order. The child responded to the items, but the key was pressed by the experimenter to demonstrate for the child what was to be done in terms of response. In the second trial, the same stimuli were presented again for 800 msec, but this time, the child had to respond to them by pressing the key. In the third trial, the same stimuli were presented for 180 msec to which the child had to respond by pressing the key. The child was allowed to proceed with the main experiment when the stimuli were correctly responded to on eight out of twelve presentations. If the child did not meet this criterion, further practice trials were given until the criterion was reached.

The main experiment was carried out with a stimulus presentation time of 180 msec for twelve trials in each sequence (words and faces). The child's reaction time (RT) to stimuli presented to the left and right was assessed with the help of the computer program. Accuracy of response was recorded manually.

The analysis of reaction time presented some difficulty. For some items it was zero and for some it was very high (several thousand msec), producing distributions that deviated considerably from normality. With respect to a zero reaction time, children must have pressed the key before perceiving the stimuli on the screen. A very long reaction time probably indicated that children forgot to press the key. We took two steps to resolve these problems: a log transformation of scores took care of the skewed distribution, and scores were calibrated by counting reaction time only for correct responses. We calculated for each subject the difference between scores of the right and left sides (right minus

Table 13.2. *Variables used for brain lateralization study*

Variables	Explanation
Processing speed	Total reaction time on accurate items of words and faces
Words right-hemispheric dominance	Laterality quotient derived on the basis of reaction time on accurate items for words
Faces right-hemispheric dominance	Laterality quotient derived on the basis of reaction time on accurate items for faces

left), separately for faces and words, and weighted it against the total possible score (right + left). This gave us a proportion, which was construed to represent "right-hemispheric dominance" for each subject. These score transformations gave us a number of variables, which are summarized and briefly explained in Table 13.2.

Children were also given the BDT and SPEFT described in chapter 2 (see Figures 2.11 and 2.12). These measure spatial ability and psychological differentiation. In previous studies, they have been found to load on a common factor (Mishra *et al.*, 1996; Witkin & Goodenough, 1981), while we found them to be only weakly correlated (see chapters 6 and 7).

Results

Correlations of the hemispheric dominance variables, both peripheral and central, with other measures were computed. Since age, gender and school type could be confounding variables, they were used as control variables in partial correlations.

There was no significant correlation between peripheral and central laterality measures. In the entire analysis (and for both locations, Varanasi and Kathmandu), peripheral laterality, whether computed separately for each sense/limb or as a Princals summary measure, showed no correlation with any of the language or cognition measures. The only statistically significant correlation was between the peripheral summary score and the "affluence" dimension of SES ($r = .27$, $p = .033$), indicating that in more wealthy families, evidence for right-limb dominance is greater than in less wealthy families. The analyses also revealed no significant relationship with BDT or SPEFT scores.

Table 13.3 presents the values found with the Varanasi sample of partial correlations of the central hemispheric dominance variables with G language and G encoding (assessed through the Princals object scores presented in chapters 6 and 7), controlling for age, gender and school type.

Table 13.3. *Partial correlations of hemispheric dominance variables with G language and G encoding in Varanasi*

	G encoding	Processing speed	Words right-hemispheric dominance	Faces right-hemispheric dominance
G language	.35**	.32**	.24*	.14
G encoding		.20*	.30**	.15
Processing speed			−.08	.06
Words right-hemispheric dominance				.10

There is a significantly positive correlation of right-hemispheric dominance with G language and G encoding, suggesting that a geocentric FoR seemingly has a neural basis in the right hemisphere, like the allocentric FoR. As expected, this is statistically significant only for the categorical processing of words. While right-hemispheric dominance shows no significant correlation with overall processing speed, we find a significantly positive correlation of processing speed with G language and G encoding. This indicates that geocentric frame users have a faster processing speed, i.e. the geocentric FoR is seemingly linked to other brain processes than lateralization. These relationships cannot be attributed to the confounds of age, schooling or gender.

Similar analyses were carried out with data obtained from Kathmandu. The findings revealed no significant relationship of either peripheral lateralization or hemispheric dominance or processing speed with G language or G encoding. It is difficult to point out a reason for this failure to replicate the Varanasi results in Kathmandu. The younger age level of children tested in Kathmandu may be one probable reason.

Discussion

The findings of the study show that in Varanasi and Kathmandu, peripheral measures of lateralization are related neither to G language nor to G encoding. They also do not correlate with other cognitive factors measured by BDT and SPEFT. The pattern of results is the same for preference and performance measures. This suggests that the use of a geocentric FoR is not linked to lateralization of brain functioning measured at the peripheral level.

In Kathmandu, the central laterality measures also fail to provide us with evidence of a relationship between a geocentric FoR and right-hemispheric dominance. In Varanasi, in contrast, both G language and G encoding are clearly

linked to right-hemispheric dominance, indicating more efficient processing of words in the right than in the left hemisphere.

It may be mentioned here that the present study has attempted the analysis of brain lateralization only at the functional level. Hence, no claim can be made that the use of a geocentric FoR has a specific structural or neural organization in the right brain. As Witelson and Swallow (1988) indicate, brain lateralization studies with normal subjects demand that before attempting to determine brain lateralization in a new group with a new task, certain conditions must be fulfilled. For example, it is necessary to ensure that the new task has been validated with individuals who can be claimed to have structural brain lateralization. If this condition is not fulfilled, it is not possible to specify the mechanisms underlying differences in performance of subjects.

Efficiency of performance on a cognitive task can be explained in terms of physiological mechanisms (for example, differential neural organizations) as well as psychological mechanisms (for example, use of differential cognitive strategies). The laterality task used in this study still requires validation with individuals who are claimed to have well-established lateralization of the brain at the structural level. In the absence of such a validation, our claim regarding a link between right-brain dominance and the geocentric FoR is confined to the functional aspects of the brain and the particular tasks used in this study.

Part 2: Brain-damage study

In the preceding section we have reviewed some neurophysiological and neuropsychological studies of spatial cognition that reveal the existence of functionally distinct neural bases of egocentric and allocentric frames of spatial reference. As we have seen, the areas of the brain implicated in spatial perception, cognition and action mainly include the parietal cortex and the hippocampus. Previously they were considered to work independently of each other, but neuroimaging of brain functions now shows that they work together in the performance of everyday spatial tasks (Burgess *et al.*, 1999). Homing may be taken as an example of such a task. It involves the use of allocentric representations of one's current location and the location of home, but it also involves egocentric representations in terms of body movements in correct directions without which reaching home may not be possible.

Besides neuroimaging studies, another important source of information about the role of the parietal cortex in spatial perception and cognition is provided by lesion studies. These studies inform us not only about the egocentric and allocentric spatial reference frames within which information is represented in different sub-regions of the parietal cortex, but also about the ways these representations are modulated by actions (e.g. one's movements) and the ways in which they are combined or used together.

The parietal cortex is composed of an anterior and a posterior part, the latter being divided into superior (upper) and inferior (lower) lobules. Studies indicate that damage to superior regions of the posterior parietal cortex in humans commonly results in impaired visually guided reaching (called optic ataxia). On the other hand, damage to inferior regions in one hemisphere often results in a neglect of the contralateral half of the perceived space (called hemineglect). However, the neglected region of space is often found to vary with the movements of the observer. This fact has led several researchers to consider the spatial framework generally as "egocentric," with its origin linked to a receptor (e.g. the retina) or body axis (e.g. the trunk or arms), but many do not agree with this conceptualization (e.g. Bisiach, Capitani, & Porta, 1985; Karnath, Christ, & Hartje, 1993). For example, Vallar (1999) considers it as a problem related to the translation of frameworks. An interesting symptom of right-sided parietal damage is "object-centered neglect" in which the left half of an object or stimulus is neglected despite being presented to the right of the patient's midline. This feature has been taken as evidence for an "object-centered representation" (i.e. allocentric frame) in the parietal cortex (Driver, 1999).

In spite of differences in the interpretation of deficits, the studies clearly suggest that damage to the right parietal cortex is linked to processing of spatial information in a significant manner. Viewer- or body-related neglect indicates problems with the egocentric FoR (e.g. Beschin, Cocchini, Della-Sala, & Logie, 1997; Karnath & Fetter, 1995), whereas stimulus- or object-related neglect indicates problems with the allocentric FoR (Driver & Halligan, 1991). However, none of these studies informs us about the geocentric framework in which the reference is mainly to abstract cardinal directions (NSEW).

Here we report a study carried out in Varanasi with brain-damaged patients. Since we do not know about the possible consequences of brain damage on the use of a geocentric frame, the study is exploratory. However, in very general terms, we may expect more problems of spatial disorientation or inconsistent behavior patterns on tests in the case of parietal lobe damage as compared to intact brain functioning.

Subjects

The study was carried out with twenty hospitalized patients in the Neurosurgery Ward of Sir Sunder Lal Hospital at Banaras Hindu University, Varanasi. All patients had undergone brain surgery. Most of the patients had been admitted to the hospital following brain injury as a result of an accident, except for a few cases who were hospitalized because of spatial behavioral abnormalities, later diagnosed as resulting from a brain tumor. The patients came from villages or townships close to Varanasi. Their age ranged from 8 to 70 years, and

educational level varied from no formal education to BA level. There were eighteen males and two females in the group of patients.

Based on CT and/or MRI scans, the patients were diagnosed as having clear damage either in the frontal lobe (N = 6), posterior parietal lobe (N = 7), posterior and anterior parietal lobe (N = 4), or temporal lobe (N = 3). The size of lesions varied from a minimum of approximately 50 × 45 × 30 mm to a maximum of 65 × 60 × 50 mm, and showed little to moderate spread to the adjacent brain regions in some cases. All the cases were categorized as "severe" by the consulting surgeon. The scans showed signs of edema with mass effect and midline shift of tissues, as well as effaced and mildly dilated ventricles. Before surgery the clinical symptoms included altered sensory levels, poor verbalization, use of incomprehensible words, reduced limb movements, overall slow reactions, seizures, vomiting, drowsiness, spatial disorientation, and memory loss. It would have been unethical, and in fact impossible, to test the patients before surgery.

Although the parietal lobe was involved to some extent in all the cases, the patients were put into two separate categories depending on the involvement of damage in the frontal and temporal regions. The expectation was that the latter type of cases would show lesser disorganization in spatial cognitive functioning than those bracketed under the "parietal lobe damage" category.

Test materials and procedure

The subjects were tested in a separate room attached to the Neurosurgery Ward of the hospital within three to five days following their surgery. The consulting neurosurgeon advised on when a patient could be tested according to her/his physical and mental condition.

The patients were administered our standard set of tasks: Animals in a Row, Chips, Steve's Maze, Perspectives, Route, knowledge of NSEW (inside), BDT, SPEFT (see chapter 2), and tests of peripheral and central laterality (see part 1 of this chapter). We also examined some qualitative features of performance that patients demonstrated during testing. For example, there were some problems on the Animals and Chips tasks in terms of their alignment or choice (called distractors, D). Inconsistent use of limbs on laterality measures was another feature that we considered.

The tasks were given in two to four sessions (depending on the patient's condition during testing) in the same order to all patients, and under the close supervision of the neurosurgeon. Two female doctoral students of psychology carried out the testing.[1] Patients in general showed great cooperation in the

[1] We thank Ms. Surabhi Prakash and Ms. Sunita Singh for their help in data collection, and Professor S. Mohanty, Department of Neurosurgery, Institute of Medical Sciences, Banaras Hindu University, for arranging facilities to work with patients in the hospital.

study. Except for two cases, we did not meet refusals for testing. On the other hand, we had to suspend testing with three patients who did not appear to be testable. Testing was carried out with patience and subjects were allowed to rest whenever they wanted.

Results

In the first level of analysis, differences among various categories of brain-damaged patients with regard to the use of G language, G encoding, knowledge of cardinal directions (inside), performance of BDT and SPEFT, and measures of central and peripheral laterality were examined. On none of the measures did Kruskal–Wallis tests reveal a difference across groups to be statistically significant, suggesting that the four groups were functionally not different. This allowed us to treat them as one homogeneous group characterized by brain damage associated with a similar pattern of test performance.

We examined the level of performance of brain-damaged cases against a "normal" control group of twenty-two subjects of age 12–14, all of the older children in the sub-group of eighty children of our main study. Although this comparison does not appear to be legitimate because of the wide difference in age range of the two groups (i.e. 12–14 years vs. 8–70 years), studies related to the features of brain development indicate that by the onset of puberty, most of the brain structures acquire full maturation and an optimal level of functioning (Epstein, 2001; Mercado, 2008). In any case, we treat the differences in performance as "exploratory" in nature.

The mean scores of the two groups on various measures are given in Table 13.4. For G language and G encoding, these are Princals derived object scores; the lateralization scores have been described above. On processing speed, negative values indicate a better performance.

Comparison of groups on t-tests reveals that G language and G encoding do not differ significantly between the two groups, but knowledge of cardinal directions (NSEW) is significantly better in the normal group. The groups also differ significantly on BDT and SPEFT measures. On the central laterality task measures, there is no significant difference between the groups, except for processing speed. On all measures where the differences between the groups are significant, the scores of the brain-damaged group are lower than those of the normal group.

A significant difference is also noted on the peripheral laterality measure, the brain-damaged group showing overall more left-handedness. This group also shows more inconsistency between the four senses/limbs compared to the normal group. We tested this by examining the reliability of the scale produced by the four summary scores. Cronbach's alpha for the brain-damaged

Table 13.4. *Mean scores of brain-damaged (group 1) and normal (group 2) subjects on various measures*

	Groups	Mean	SD	t-test
G language	1	−.18	1.26	1.33
	2	.27	.93	
G encoding	1	−.10	.78	1.91
	2	.40	.92	
Knowledge of NSEW	1	1.70	1.75	3.38**
	2	3.36	1.43	
SPEFT items	1	11.21	4.92	5.51**
	2	17.45	1.87	
BDT accuracy	1	1.60	1.67	4.95**
	2	4.18	1.70	
Processing speed	1	−88.49	21.35	−5.15**
	2	−120.21	17.62	
Words right-hemispheric dominance	1	−5.70	43.31	.43
	2	.54	27.63	
Faces right-hemispheric dominance	1	.97	32.91	.41
	2	.34	14.09	
Peripheral laterality	1	−.56	1.46	2.29*
	2	.23	.60	

Group 1 = brain damaged (N = 20), Group 2 = normal (N = 22);
* $p < .05$, ** $p < .01$.

group is .70 whereas it is .80 for the normal group, and Hotelling's T-squared test is significant at the .001 level for the brain-damaged group, while it is not significant for the normal group.

Besides the analysis of performance differences between brain-damaged and normal groups on the standard measures, we also looked at some specific features of their performance. On the encoding tasks, for example, misalignment of animals (e.g. placing animals in disoriented positions as compared to their original position) and the choice of distractors on Chips and Steve's Maze were the distinguishing features of performance. On the Perspectives and Road tasks, the use of G language in an incorrect manner (G-) was another distinguishing feature.

We compared the two groups in terms of these features of performance with a Mann-Whitney test, a rank-order test which is more appropriate when the distributions are not normal (Table 13.5).

The findings indicate that on all encoding tests, significantly more D responses are made by brain-damaged subjects than those in the normal group. On the Perspectives task (and marginally on the Road task) we notice that brain-damaged subjects use G language more inaccurately than the normal

Table 13.5. *Use of distractors (D) by brain-damaged and normal subjects on encoding tasks and G- on Perspectives and Road tasks*

Measures	Groups	N	Mean rank	Sum of ranks	Mann-Whitney U
D on Animals task	Brain damaged	20	25.35	507.00	143.0**
	Normal	22	18.00	396.00	
D on Chips task	Brain damaged	20	24.33	486.50	163.5*
	Normal	22	18.93	416.50	
D on Steve's Maze	Brain damaged	20	23.70	474.00	176.0*
	Normal	22	19.50	429.00	
G- on Perspectives task	Brain damaged	20	27.48	549.50	100.5**
	Normal	22	10.70	353.50	
G- on Road task	Brain damaged	18	22.94	407.00	154.0+
	Normal	22	18.50	413.00	
Intrinsic response on Animals, items 6 and 7 (90° rotation)	Brain damaged	20	26.98	539.50	100.5**
	Normal	22	16.52	363.50	

+ $p < .10$, * $p < .05$, **$p < .01$.

subjects. A significant difference is also found in the intrinsic responses on the Animals task on items 6 and 7, in which the table was rotated by 90°. An intrinsic choice reflects an alignment of the animals with the table edge, an easy solution if disoriented. All these results suggest that brain-damaged subjects have problems of spatial disorientation.

Discussion

The findings of the study suggest that brain damage in these subjects results in a lower level of performance of SPEFT and BDT (measures of spatial ability), overall processing speed, and the incorrect use of G language linked to spatial disorientation. On the other hand, it does not seem to influence the use of a geocentric FoR.

In the present study, we do not find evidence to support the claim that G language and G encoding are linked to right-hemispheric damage. The lack of difference between normal and brain-damaged subjects on these measures suggests the possibility that mechanisms other than the structural features of the right hemisphere may regulate G language and G encoding. That the overall geocentric spatial frame is not influenced by damage in the parietal lobe leaves the door open for arguing that this frame either has its locus also in other parts of the brain, or else it is resilient to cortical damage in case it is localized in the right hemisphere.

With respect to processing of words and faces in the left and right hemispheres, we find no difference between brain-damaged and normal groups. A lack of difference on the laterality quotient for faces is understandable in view of the fact that facial recognition is not the main function of the right hemisphere, and the patients' left hemispheres were intact. On the other hand, the absence of performance difference between brain-damaged and normal subjects in the processing of words is not easily understandable. Since the word test requires abstract categorical processing, for which the right hemisphere is more specialized, one would normally expect a loss in this function as a result of right-hemispheric damage, which our study does not bring out. It is difficult to offer an explanation for this result. It seems to suggest that the "cortical modules" (Mountcastle, 1998; Zaborsky, 2002) show a fair degree of resilience. There is some evidence to show that concepts, which develop through experience, correspond to the activity of large assemblies of interconnected neurons in which many independent pathways can serve equivalent functions. Consequently, they are resilient to cortical damage (Hebb, 1949, 1980; Mercado, 2008).

Another intriguing finding of the study is the existence of a significant difference between the peripheral laterality of brain-damaged and normal subjects. The results show a significantly greater right-side bias in the normal than the brain-damaged group. This finding suggests two possibilities. One is that the left hemisphere of normal subjects is more lateralized than that of the brain-damaged patients. A second possibility is that the brain-damaged patients use their left and right limbs in an inconsistent manner, and thereby present evidence of low lateralization. Our data suggest the second possibility. In spite of the fact that cortical modules show a considerable degree of resilience after brain damage, as indicated earlier, the functional controls do not operate as strictly as they do in the case of normal subjects. Hence, the brain-damaged subjects demonstrate a greater switching between left and right limbs (even in the case of hands) as compared to normal subjects. However, this possibility remains to be tested in further studies by choosing unilateral tasks in more precise manners. Some of our tasks (e.g. unscrewing the lid of a jar) did not turn out to be completely unilateral.

In view of the limitations of the present study, its findings can be taken only as suggestive. In the state of almost a complete absence of studies on the relationship of the geocentric frame of reference with structural or functional aspects of the brain, however, this study does suggest some possibilities. At the functional level, the suggested trends are fairly encouraging. We see considerable support for believing geocentric language, encoding and overall efficiency in processing spatial information to be significantly linked to right-hemispheric dominance. It would be good to design a study that could demonstrate egocentric language and encoding to be linked to left-hemispheric

dominance in order to cross-validate the findings concerning right-hemispheric dominance for the use of a geocentric FoR.

In the brain-damage study, we know the regions and extent of damage, and we assume that the functioning of the concerned regions will be disrupted, but we have no reliable evidence to make a strong claim for this disruption. It is quite likely that despite injury to the brain and following surgery, some neural connections in other regions were still sufficiently functional to support the use of a geocentric spatial framework by brain-damaged subjects. The situation clearly warrants an fMRI study of brain-damaged patients during spatial task performance and the comparison of these brain records with those of normal subjects. In the absence of such a study, the conclusions about the role of brain regions in the activation of the geocentric FoR are tentative and to be taken with great caution.

To conclude this chapter, we would like to quote a question asked by Kemmerer (2006, p. 1619): "Would research on the neural substrates of spatial representation be substantially different if the dominant language in the world were, say, Tzeltal [or Hindi] instead of English?"

14 Geocentric dead reckoning

A person using the geocentric frame is able to carry large-scale dimensions of space even into small-scale environments (e.g. inside a building or room), and apply them with reference to objects even in places like on a table top. The ability to do so requires constant updating of one's position according to cardinal directions during movements in familiar or unfamiliar places. Thus, holding cardinal directions in mind during movements and judging one's position in relation to them all the time appears to be a required feature of using a geocentric frame of orientation. The process through which people constantly update their spatial position in the environment is called "dead reckoning." This process differs from that of "tracking" in which people constantly engage in some sort of computation while walking in an unfamiliar space. In this process, each movement is consciously attended, counted and linked to the final position.

Closely related to the process of dead reckoning is path integration. Mittelstaedt and Mittelstaedt (1982) suggest that it is possible to compute a location by integrating directed velocity over time. A navigator may sense it by several means, such as the flow of visual patterns, the feel of the wind, the fading of sounds, or other means. When the information is derived from the internal sensation of movements (i.e. proprioception), the process is called "inertial path integration." When the information comes from changes in the flow of external events (e.g. textures), the process is called "non-inertial path integration." A key feature of path integration is that calibration in relation to external landmarks does not occur continuously, but after significant events along a path. In dead reckoning also, although calibration usually occurs at significant path nodes, the process is retrospective in nature, implying certain processes that depend on representations of previous segments of the path. Cornell and Heth (2004) point out that, since people produce organized memories of their travel, human navigation seems to fit with the models of dead reckoning.

In most descriptions of dead reckoning or "inertial navigation" (Newcombe & Huttenlocher, 2006), one gets the impression that it is necessarily an egocentric

This chapter is based on Mishra, Singh, and Dasen (2009).

process based on tracking of one's own body movements and their deviation from an initially set position. However, this may be an ethnocentric bias, all studies being carried out with speakers of European languages. Similarly, when Klatzky (1998, p. 9) concludes that "on the whole, the literature is suggestive of a more accurate representation of egocentric parameters than allocentric parameters," she does not take into account the fact that the literature she reviewed is entirely Euro-American.

When people walk, their distances and directions relative to objects in their surroundings change. The ability to keep track of such changes requires some sort of coordination of actions with the locations of objects in the surroundings. Walking without vision is of course particularly challenging. The accuracy with which young children and adults view their surroundings and keep up to date in their spatial orientation while walking without vision or other forms of environmental information has been examined in some studies. Comparing children allowed to walk with those not allowed to walk provides a means of assessing the degree to which spatial orientation in the absence of vision is mediated by visual flow and landmark information on the one hand, and by non-visual information associated with the biomechanical act of walking on the other.

It is generally found that adults are capable of navigation with respect to remembered objects when walking without vision, although the precision of their spatial orientation in such situations depends much on how much they translate and rotate during the walk (Rieser, Guth, & Weatherford, 1987). Can young children engage in this kind of activity?

Rieser and Rider (1991) examined 4 year olds and adults concerning their spatial orientation while walking without vision. The subjects viewed one or more targets. Then they were blindfolded and guided to a new point of observation where they were asked to aim a pointer at the target(s). Spatial orientation was assessed as a function of the number of target objects (one, three or five), the complexity of the route walked and the time delay between target viewing and responding. The findings revealed that the number of targets did not influence accuracy. The responses of young children showed a larger directional bias than those of adults, and the responses from the novel position showed a larger directional bias than those from the study position. No systematic effects of route complexity or of environmental complexity on the magnitude of constant errors for children or adults were noted. There was also no difference between delay and no-delay conditions, for either adults or children.

Experimental studies of dead reckoning

Centuries ago when explorers like Columbus sailed across the Atlantic in search of the New World, they managed navigation through the open sea

without the help of the navigational technology that is available to us today. They managed to do so by the process of dead reckoning. Given an initial course, navigators continually integrate their estimates of speed and deviations from that course in order to guess at the current location. Historical records show that Columbus's guesses were often way off reality. Very sophisticated navigation techniques were also devised by Micronesian navigators (Gladwin, 1970; Hutchins, 1983), who used a "stellar compass" based on the observed rise and set of stars. They kept track of their course by imagining the movement of a virtual island in relation to this compass. Despite its level of abstraction and precision, this scheme was based on dead reckoning, meaning that navigators had to keep constant track of a multitude of factors. They could never go to sleep, because then they could not communicate the vast number of inputs to a shipmate.

The psychological processes in navigational schemes have been subjected to some laboratory research in recent years. For example, in an experimental study Simmering and Spencer (2007) tested the ability of subjects to remember the location of a ship on a table top, and to estimate its location after a 10-second delay relative to some visible dots (called real island condition) and then in the absence of those dots (called virtual island condition). It was found that in the latter condition, the subjects behaved as if the dots had never been there. In interviews, however, the subjects indicated that they were able to impose the dots mentally, and they overestimated their mental ability to do so. The researchers used these findings to support the notion of "embodied cognition," which implies that people do have abstract abilities, but those abilities are fundamentally connected to their sensory experiences of the real world. Based on this experiment, they argued that all navigation involves reliance on certain perceptual cues, and strongly claimed that even people like Micronesian seamen must rely on sensory cues derived from the motion of their body for successful navigation. However, it may be noted that their study neither probed into the use of mentally imposed reference points, nor did it focus on the processes involved in the sea navigation skill that develops over a long period of time in the face of several risks and challenges at sea.

In contrast to the claim for a physical cue-based navigation process, some research shows that people's movement on the ground is represented cognitively like a survey of the territory as seen from above. This may happen more often when people cannot see the environment while walking (e.g. in a blindfold condition). In such situations, they may be preoccupied with representing their internal sensations of movement with reference to a mental map. In a theoretical paper, Rieser (1999) argues that these imagined events serve as powerful frames of reference to draw inferences about one's own location, or the location of other objects or landmarks in the space.

Greidanus (2002, summarized in Cornell & Heth, 2004), blindfolded university students and led them walking along a path in an unfamiliar suburban neighborhood. During the walk, the blindfold was removed periodically and the students were asked to choose a line drawing that best represented an overhead view of their paths. Blindfolded students chose the correct representation of the path with 29 percent accuracy, while sighted students did it with 43 percent accuracy. All students generally took some time to eliminate the wrong path drawings using their memories of particular path segments and turns. It was also noted that students whose vision was restricted to the view of the path within one meter of their feet performed as well as did the sighted subjects. Accurate encoding of movements in this case was considered to indicate the importance of optic flow, since the students were not able to see the landmarks that might be useful at the point where they had to identify the configuration of their paths.

Dead reckoning as a process of understanding one's position in space has also drawn some interest in studies that focus on memories of travel. In these cases, sensations of movement need to be monitored for long periods without calibrations against known landmarks. According to Burch (1986) dead reckoning requires that the navigator must not only be able to calculate speed, time and direction of travel, but also estimate the error associated with each of these. The latter is especially important, because navigation by dead reckoning is inherently error prone, and hence it requires appropriate recalibration. Estimates of positional error guide the navigator to determine the point when other means are necessary to fix a location, or when other heuristics must be used in order to reach the goal. Viewed from this perspective, dead-reckoning skill consists not only of procedural expertise, but also of judgment concerning errors (Cornell & Heth, 2004). In some situations these errors may be quite problematic. For example, in sea navigation, error of a single degree will take the navigator far from the target, because the small deviation will become large with distance.

Geocentric dead reckoning

Some evidence suggests that dead reckoning can be carried out in a geocentric manner. Many people can carry geocentric references wherever they go, and can relate themselves to them in all situations. Support for this can be derived from some informal studies (see Levinson, 2003) in which people were transported to unfamiliar locations, made to walk through bushes or stay in a room without windows, and asked to point to near and far-away locations. The accuracy of their pointing was analyzed in terms of their deviations from the point of reference. The findings revealed that if the participants were predominantly geocentric-language speakers, their judgments of direction

and distance were remarkably accurate in all situations. In fact, the Guugu Yimithirr and Hai//om samples (both geocentric-language speakers, respectively Australian Aborigines and Kalahari San) were even more accurate than homing pigeons, while Dutch and English subjects, even though experienced bushwalkers (called "woodsy"), were notoriously poor.

According to Levinson (2003), these findings suggest that geocentric-language speakers "have in constant play a rather precise mental dead reckoning system," and that "absolute [geocentric] language speakers are much better dead reckoners than our 'relative' [egocentric] language speakers" (p. 241).

> In order to speak a language that encodes angles on the horizontal in absolute coordinates, an individual will need to be constantly oriented (know where the local "North" or "South" is), and moreover will need to know where he or she is with respect to other places that may need to be referred to. The system can never go "on holiday", since one never knows what experiences or directions one may need to talk about. Such languages, I have argued, *force* dead reckoning on a more or less constant basis. Speaking such a language is thus a *sufficient*, although not necessary, condition of being a good dead reckoner. (Levinson, 2003, p. 243)

While Levinson suggests the possibility of strong dead reckoning among geocentric-language speakers, he also warns against considering these findings "to hold up worldwide," and searching for a "direct causal connection between dead reckoning abilities and language" (p. 241). He indicates that no simple ecological explanation of dead reckoning is likely to succeed, but that, "finer-grained cultural factors may indeed be closely correlated with good dead reckoning skills" (Levinson, 2003, p. 243).

Cottereau-Reiss (1999) used a blindfold situation for language elicitation with a few Paicî Kanak children of New Caledonia. Children played this game in groups of three; one was blindfolded and the other two had to guide him or her to find an object placed somewhere in the room. They were not allowed to move themselves during this procedure. What happened was that the two guides used geocentric language (notably "upstream" and "to the sea"), and conventional or situational landmarks as if their blindfolded peer could actually see. There is anecdotal evidence (Cottereau-Reiss, personal communication) that the children could actually follow these directions despite being blindfolded, which implies that they could keep track of their movements within a space for which they must have kept a largely geocentric representation.

In her detailed study of Marquesan spatial language, Cablitz (2006) included a section on children's learning of the local geocentric spatial system. She found that, while even very young children could use the system accurately in familiar surroundings, they could not do so when taken to an unfamiliar setting.

The purpose of this study is to understand how children who encode spatial arrays predominantly in a geocentric frame carry directional information to other places with them, and how well they can keep track of orientation inside a house even under reduced environmental cues, and to document how they do it.

Dead reckoning inside a building is of course quite different from navigation in open spaces, because it involves keeping track of mainly 90° turns. In this, one can see the advantage of having a geocentric spatial representation which allows one to map these turns onto a grid with 90° angles, in the case of cardinal directions, or even 45° angles, if there are ten named directions (eight with precise angles) instead of four. The latter is the case in the Sanskrit spatial cosmology that was described in chapters 3 and 6.

Sample and design

The study was carried out in the city of Varanasi (India) with twenty-four Sanskrit-school and twenty-seven Hindi-school children of 11–15 years of age. While the Sanskrit-school sample consisted of boys only, the Hindi-school sample comprised twenty-five girls and two boys. They were known from our main study to use a geocentric frame of reference in language and cognition. In particular, the selected children knew the four cardinal directions not only outside in open space, but inside the room in which they were tested.

We had initially intended to include a sample of children from the Hindi-medium school who used predominantly egocentric language and encoding, but this proved to be difficult, if not impossible, because these children would fail our procedure systematically, and became extremely frustrated. Hence the study does not include such a control group.

Procedure

Children were taken individually to a room on their school compound which was unfamiliar to them, and which had no windows. They were asked to indicate the four cardinal directions (i.e. east, west, north, and south), first with their eyes open, then with their eyes blindfolded and after being spun around three and a quarter times (so that they did not face the initial direction). Then they were helped to walk blindfolded to another room. Movement between the two places required several turns. In the new room, they were again spun around three and a quarter times, and asked again to tell the four cardinal directions (eyes still blindfolded). While spinning on both occasions, care was taken that 1) the children did not end up facing the same direction they were facing prior to spinning, and 2) while spinning children and asking about directions, the researcher did not stand at the same point.

Table 14.1. *Distribution of different levels of experts in Sanskrit and Hindi schools*

	Level 1 experts	Level 2 experts	Level 3 experts	Total
Sanskrit	2	4	18	24
Hindi	7	10	10	27
Total	9	14	28	51

Then (blindfold removed), the children were given the Route task with a pathway laid out on the ground (see Figure 2.3). The experimenter moved along the path with blindfolded eyes, and the children had to guide her verbally on how to proceed on the path.

Immediately after this procedure, the children were interviewed (in Hindi) with the help of a 22-item questionnaire. It focused mainly on how children had kept track of directions during the blindfold experiment as well as how they acquired the knowledge of directions, how they carried it with them, and how they were able to use their knowledge in new and unfamiliar places and situations where no external cues are available.

Results and analysis

The initial analysis focused on the accuracy of children's responses pertaining to cardinal directions in different test situations. Using the degree of accuracy of directions, children were categorized as "level 1 experts" (all directions correct with open eyes, but not with blindfold, nor in the second room), "level 2 experts" (all directions correct with open eyes and blindfold, but not in the second room) and "level 3 experts" (all directions correct in all three situations). The distribution of different levels of experts in the two types of schools is given in Table 14.1.

The overall performance of these children indicated that 82 percent could tell cardinal directions with perfect accuracy, despite being blindfolded, in the first room (at least level 2), and 56 percent could also do it when turned around and led to another room (level 3). A significant difference in the level of expertise between the Sanskrit- and Hindi-school children was noted (chi square = 6.97, $p < .01$), although both groups were mainly geocentric in their language and encoding.

Sanskrit- and Hindi-school children were interviewed about the strategies they used in holding on to directions in the blindfold condition. Since there were only two "level 1 experts" in the Sanskrit school, we decided to combine levels 1 and 2 for this group. The results are presented in Table 14.2. We have organized the findings of the interview on the basis of four important features: process of

Table 14.2. *Interviews on processes in keeping track of directions in Sanskrit- and Hindi-school children with varying degrees of expertise: percentage of children giving various categories of answers*

	Sanskrit school		Hindi school		
Levels of expertise	Level 3 (N=18)	Levels 1 + 2 (N=6)	Level 3 (N=10)	Level 2 (N=10)	Level 1 (N=7)
Process					
Andaaz (reckoning)	50	67	30	0	0
Prior knowledge	28	17	40	60	29
Tracking	61	17	70	30	43
Body movements	72	100	30	30	14
Awareness					
Sun	44	83	90	100	100
Other	28	17	10	0	0
Sources of knowledge					
Teacher	50	83	20	30	0
Mother	33	33	80	70	57
Father	67	50	80	50	86
Brother/sister	22	0	10	0	0
Books	28	0	0	0	0
Experiences	28	0	0	0	0
Salience of directions in daily life					
Eating	100	100	60	60	43
Sleeping	72	100	70	80	43
Worshipping	94	100	70	90	57

knowing, basis of awareness, sources of directional knowledge, and salience of directions in daily life.

The analysis revealed a number of similarities and differences both within and across the school groups.

Process One process of interest, mentioned by many Sanskrit-school children and some of the level 3 experts in the Hindi school, was *andaaz*, which indicates a process of making fine judgments based on habitual experience of the given situation. Since the process is brought into use in day-to-day life, it functions almost in an automatic manner. The children who used *andaaz* seemed to "just know" the directions: they did not have to make any special effort. This also means that, in fact, they find it difficult to provide much detailed introspection into how they succeeded. Some children expressed this general, rather undifferentiated process of dead reckoning as "prior knowledge": they already knew and remembered the directions.

But most of the children, and in particular level 3 experts, do analyze the processes they use in somewhat more detail. They say that they do some "tracking" that involves some sort of computation while walking or being spun around. Attending to each movement (for example, counting complete turns) and linking it to the final position is a chief feature of this process. Close to this is the category of "body movements," referring most directly to proprioceptive cues (akin to inertial path integration).

Basis of awareness about directions When asked "how did you know that east was that side?" most children indicated the "sun" as the primary source of awareness of east and hence other directions. Since the source of light was not perceptible in the room without windows, and even less so when blindfolded, this either means that they took this cue ahead of time, before entering the building, or just that this is what they usually did under normal circumstances. Some level 3 experts in the Sanskrit school said that they relied on other means, like the use of locally salient environmental cues (e.g. sounds), illustrating the fact that using the sun was not in fact possible with our procedure.

Sources of directional knowledge When asked "how did you get knowledge about directions?" children indicated a number of persons who served as sources or agents of knowledge. This indicates that the knowledge of cardinal directions is indeed an important part of overt socialization, both in the family and at school. Sanskrit-school pupils indicated "teachers" more often than Hindi-school pupils, which is in line with that school's curriculum. The mother and especially the father are important sources of knowledge, indicating that this socialization occurs both at home and at school. Books and personal experiences also served as sources to shape the knowledge of directions for some Sanskrit-school level 3 experts.

Salience of directions in daily life With regard to the salience of directions in daily life, the findings suggest that knowledge of directions is somewhat more common for Sanskrit- than Hindi- school children for organizing activities like eating, worshipping and sleeping (particularly to avoid facing south). We have already examined the importance of cardinal directions in the life of Sanskrit-school children (see chapters 3 and 6), which is again confirmed from the interview data.

Beyond the categories listed in Table 14.2, some other striking differences between Sanskrit- and Hindi-school children were evident in the interview. When asked, "if you were taken to an unknown place, would you be able to find out directions the way you have done here?" a majority of Hindi-school children answered "yes," indicating that they were quite confident of doing so. In the Sanskrit school the number of children showing confidence in the transfer

Table 14.3. *Language used on Route task by experts of different levels in Sanskrit and Hindi schools*

		Level 1 experts	Level 2 experts	Level 3 experts	Total
Sanskrit school	G+	2	4	18	24
Hindi school	G+	5	5	6	16
	G-	1	4	2	7
	E	1	1	2	4

G+ Correct geocentric, G- Incorrect geocentric, E Egocentric.

of their knowledge was relatively smaller. On the other hand, when children were asked, "will you be able to find out directions in a dark night?" not a single child in the Hindi school indicated being able to do so, whereas in the Sanskrit school a fairly large number of children did. Also when asked, "have you ever played any game in which knowledge of direction was essentially required?" a majority of Sanskrit-school children answered "yes," whereas a majority of Hindi-school children answered "no."

The results of the language elicitation task (Route) presented in the second room (blindfold removed) are presented in Table 14.3. They are classified into G+ (all or all but one of the segments are described correctly with geocentric language), G- (geocentric language is used, but incorrectly for more than one segment), and E (egocentric language). It should be noted that all participants had used G+ language on previous tests, so any change in language reflects the impact of the disorienting procedure.

The findings reveal that all Sanskrit-school children continue to use correct geocentric language at the end of the procedure, as well as more than half of the Hindi-school children. However, seven of the latter (26 percent) do get disoriented and hence get the directions of the path segments wrong. This includes two of the level 3 experts, who seemingly had carried directions all the way into the second room; possibly they had just been lucky in guessing the correct directions when still blindfolded. Four of the children (15 percent) change to egocentric language, which is an easy way out of the conundrum, or, in other words, a smart choice for someone who has both frames of reference at her/his disposal.

Discussion

This study certainly has some limitations, notably linked to quasi-experimental research, i.e. working with socio-cultural facts that cannot be produced

experimentally. For example, there is a confound between the two types of schools and gender, with boys only in the Sanskrit school and mostly girls in the Hindi-medium school. While this bias also exists in our main study (chapter 6) it is more pronounced in this study, since we do not have data from a Sanskrit school for girls. However, our analyses indicated that gender is not an important variable in this context, although there are differences in socialization practices that could be relevant, for example the kind of games that are played. Another aspect that was difficult to control was the possibility that additional cues may occasionally have been available; since the study was carried out in schools and not in the laboratory, some noise did occasionally come from neighboring classrooms. Also, keeping track of the position of the experimenters may have helped in updating information about orientation. However, we have found that it is those who are already expert in dead reckoning who are able to take these additional cues into account. So we believe that such minor experimental defects do not threaten our conclusions. In (cross-)cultural psychology, there is always a trade-off between control and cultural validity (Mishra & Dasen, 2007).

The findings of the study indicate that almost all children tended to count turns and mentally keep track of directions. They generally did not use external cues other than the sun (before entering the building), and usually agreed that their previous experience with sunrise (i.e. locating east) was helpful in judging directions. Mothers, fathers and teachers were the major sources of knowledge about directions for almost all of them, showing that this knowledge is actively transmitted in both formal and informal education. While all children have this general experience, the level 3 experts tended to use a kind of active dynamic process to keep directions in mind (reckoning and tracking), while the experts of other levels seemed to rely on a more passive knowledge base.

Evidence for specific experience and training in dead reckoning can be found in many Sanskrit-school children who described the process called *andaaz* to keep track of directions in the blindfold condition. It is difficult to provide an exact translation of this concept in English. As we have indicated earlier, it refers to a process of making fine and accurate judgments. Although *andaaz* develops on the basis of one's habitual experiences of a given situation, in its mature form the process becomes automatic, and is carried out almost unconsciously. In this sense, *andaaz* represents a cognitive process which can be considered as synonymous with "reckoning." The children who use *andaaz* live with directions, move with them, and can "just tell" them any time, without making any special effort. These children also seem to be highly sensitive to salient cues to guard against errors in the judgment of directions. We have noted that some level 3 experts in the Sanskrit school indicated using more varied sources of knowledge about directions than other children. This aspect

was also evident in the salience of directions when engaging in other activities (e.g. eating, sleeping and worship).

It appears that certain activities and routines encourage the development of the dead-reckoning process. Sanskrit-medium school children's reliance on dead reckoning in judging accurate directions under blindfold conditions of the study might be attributed to the fact that they regularly participate in activities that call upon the use of dead reckoning. As a result of the specific demands of their daily life, they seem to develop cognitive characteristics which are less likely in children (e.g. of the Hindi school) who negotiate life in a slightly different setting, even if both are versed in geocentric language use. When asked how they could sense the direction even with blindfolded eyes, the Sanskrit-school children generally referred to a game that they sometimes played at home. In this game, a child gets blindfolded, his or her hands are filled with sand or dust, and a small stick is placed vertically on it. Then s/he is carried by another child quite a bit away from the starting place. The child's journey involves several turns before reaching a point where the sand is poured on the floor and the little stick is hidden in it. Then the child is carried back to the initial place through a new route, again with several turns. On reaching the starting point of the initial journey, the blindfold is removed, and the child is asked to search out the place where the sand and the stick were hidden. Sanskrit-school children played this game (and some others in which directions had to be located while blindfolded) at school fairly regularly. While many children in the Hindi school were also aware of these games (and some had actually played them when younger), they did not remember participating in such activities for several years.

We indicated earlier that dead reckoning involves keeping track of orientation by integrating information concerning movement without needing a reference to recognized features. Hence, this process is likely to be influenced by the "attention demands" of the situation. It may be noted that relatively automatic skills (e.g. movement in familiar environments) do not demand much attention, whereas skills requiring control and effort (e.g. finding one's way in unfamiliar environments) demand a great deal of attention. Keeping track of direction when blindfolded may partly involve reliance on calibration of body movements, but this strategy is more likely to work in situations when the movements are simple and easy to code in left and right turns. When the movements involve a complex pattern, body-based information does not seem to be adequate for keeping track of directions. Sanskrit-school children, who have access to ten cardinal directions (eight of them with precise angles) are likely to manipulate directions mentally in more efficient ways than those whose spatial knowledge is organized in egocentric terms mainly with reference to left and right.

In recent years, the notion of "embodied cognition" (Lakoff & Núñes, 2000) has been used in relation to the process of dead reckoning. It involves the idea

that cognitive processes develop through real-time, goal-directed interactions between individuals and their environment, that sensory and motor experiences form the basis of cognition, and that mind, body and the world mutually interact and influence one another to promote an organism's adaptive success. The embodied cognition theorists try to link the abstract mental abilities to people's fundamental sensory and motor experiences in the real world. In our study we find evidence to suggest that dead reckoning has a basis in the day-to-day experiences of children. While lesser experts may rely on a number of physical external cues (e.g. sun, street noise) to find out directions, the real experts can do it in a more automatic manner even in the absence of apparent physical cues in the situation.

Taken as a whole, the level of children's performance from both categories of schools is quite impressive, since they could solve the blindfold situation not only inside a room, but many could also do it after moving to another room. They could all be labeled as "good dead reckoners." In our study with children in Geneva (see chapter 9), only two could tell cardinal directions correctly.

However, the inability of some children to hold on to directions accurately in the blindfold condition in the other room raises doubt about the strong claim that the use of a geocentric frame of reference is the only factor associated with dead reckoning. The findings of the present study show that "dead reckoning" is not a process automatically available with geocentric-language speakers. In other words, speaking a geocentric language is not a sufficient condition for good dead reckoning, and there are more individual differences than we might have expected from Levinson's (2003) theory.

One difference between the examples mentioned by Levinson and our situation is that Hindi has the particularity of providing all three frames of reference, and even if the geocentric one is favored through cultural, and particularly religious, norms and practices, the egocentric frame remains there as an option. We are facing a cognitive style in which individuals have all the linguistic and cognitive processes at their disposal, but make some choices according to circumstances. These choices may not always be conscious, and they are heavily influenced by ecological and cultural factors (as other parts of our research demonstrate).

Now that we have presented all the results, those of the main study in Part II and those of additional studies in Part III, how does it all fit together? In chapter 15, we are going to summarize these findings, add some discussions and information coming from recent published literature, and draw some overall conclusions.

Part IV

Conclusions

15 Discussion and conclusions

Geocentric FoR as a cognitive style

After collecting all the information presented in the preceding chapters, what arguments do we have for presenting the geocentric FoR as a cognitive style? The question is indeed debatable. In those locations where the egocentric and geocentric frames clearly coexist, in Bali, Varanasi and Kathmandu, our answer is clear: "Yes"; the choice between the two frames is akin to a cognitive style. People have, as it were, the "choice," insofar as they have at their disposal, at the linguistic and the cognitive levels, both of the frames, and, depending on the situation, they activate one or the other. Sometimes they even activate one, but explain it by the other, for example, when an item on an encoding task such as Animals produces an egocentric alignment, which is then explained in geocentric language. Most of the time, however, there is indeed coherence between the linguistic and the cognitive "choice." The term does need to be put in quotation marks, because the decision is rarely conscious. Otherwise, the above-mentioned incoherent matches would not occur at all, or at least be exceptional, possibly as a result of distraction.

So, what we mean by "choice" is that individuals have in their possession the basic processes needed for either frame, in the same way as basic cognitive processes have been found to be universal in comparative cross-cultural psychology, as reviewed in chapter 1. Activating one process rather than the other is akin to a cognitive style. And which one is chosen more frequently, or even predominantly, may be due either to individual differences (akin to personality), to task demands (illustrated by the generally more egocentric encoding on Steve's Maze) or to a large variety of ecological and socio-cultural factors that we will review shortly.

The possible limits to a cognitive style interpretation are reached, however, in some locations of our research program. In the villages, Roopchandpur (India), Dolhaka (Nepal) and Sambangan (Bali), egocentric language is almost never used to describe spatial layouts of the kind used in our research; if the description is not clearly geocentric, it is at least non-egocentric, using references such as situational or conventional landmarks, or, for the younger children, intrinsic

or deictic language. There is, however, some egocentric encoding, more particularly in the younger children, and on some tasks more than on others. This is why, for these locations, we maintain that a cognitive style interpretation still applies. There is a "choice," even if heavily biased in favor of a geocentric FoR.

The utmost limit is reached, however, in our Western sample, Geneva, where the egocentric frame is the only option. Again, if the language used is not always egocentric, it is at least never geocentric, and in terms of encoding, the few items on which a geocentric encoding does occur (about 10 percent) can be attributed to a hidden intrinsic frame, and it disappears when the tasks are made more stringent in measuring truly geocentric answers. We have here one of the rare cases of a seemingly complete absence of a cognitive process, which would argue for its non-universality. Hence we could no longer speak of a cognitive style, but we would have to conclude that there is a real cultural difference in the availability of cognitive processes.

This absence is, of course, reflected in the current state of the research literature on spatial cognition, in which a geocentric FoR is never considered in mainstream developmental or experimental psychology, nor in cognitive science. These disciplines are so heavily marked by their Western enculturation that a geocentric FoR is simply not considered as an option!

Why do we maintain a cognitive-style interpretation, even for our rural samples, and for Geneva (and the rest of the Western world)? Firstly, because a geocentric FoR is used also in the Western world, although only for travel (large-scale space), or in small-scale space for map reading, even if it is never used for describing table-top space inside a room. As Gallistel (2002a, p. 504) remarks, "It would take more than another experiment to convince me that Dutch mariners are so conceptually imprisoned by their frequent use of egocentric spatial locutions that they cannot orient their ship in an absolute frame of reference." And relativists would agree. "What Levinson *et al.* have shown is that languages differ in the way that they categorize the spatial domain. They do not claim that speakers could not use other ways of categorizing space; it is just that, habitually, they do not" (Majid, 2002, p. 405).

What we are dealing with is a difference in the content or the situation in which a cognitive process is applied, in the same way as illiterate informants in Scribner's (1979) research did not apply syllogistic reasoning to theoretical content, or Schliemann and Acioly's (1989) illiterate bookmakers would not transfer their combinatorial skills from numbers to letters. Hence, just as we have interpreted Scribner's empiric mode as a cognitive style in which cognitive processes are applied only to socially relevant content, so the geocentric FoR is a cognitive style applied only to large-scale space in the Western world, but also to table-top space in the locations of our study other than Geneva.

Our second reason is the likelihood that even children in Geneva could learn to use a geocentric FoR, although we did not submit this hypothesis to empirical test, and the results of experiments carried out by other researchers are not very clear. Haun *et al.* (2006) found that they could train young German children to use allocentric encoding, but we are not convinced that the underlying frame was geocentric and not intrinsic. Troadec (2009) carried out a similar experiment with eighty-three French children aged 3 to 6 years. An object was hidden under one of three cups, and the child had to search for it on a second table after a 180° rotation. Troadec did not use Haun's non-verbal concept learning paradigm, but divided the sample into three experimental conditions by varying the linguistic induction in the instructions: a control group with no induction, egocentric induction ("I am hiding the biscuit under the cup to your left"), and an induction centered on the environment ("I am hiding it under the cup which is towards the school yard").[1] There was no significant age or training effect. All the children preferred egocentric encoding, and the only statistically significant result was paradoxical: the verbal induction on the environmental reference produced in fact more homogeneous egocentric answers.

The results are more convincing in another experiment on the effects of verbal induction using the Chips task with two groups of French children (forty-five aged 6–7 and forty-two aged 10–11) and a maze task (Eric's Maze; see Levinson, 2003, pp. 160–162) with seventy-two French students (Troadec, 2009). On two of the five test items, the experimenter also used a counter-suggestion (i.e. the question "Could we also do it the other way?"), to test flexibility of thinking. While, again, the spontaneous preference was for almost exclusive egocentric encoding in all three age groups in the control and egocentric induction conditions, environment-centered verbal induction did have the effect of producing 40 percent geocentric encoding at age 6–7, 72 percent at 10–11 and 25 percent with adults. Troadec (2009, p. 66) concludes: "This shows that participants of French language and culture may, to some extent and under certain conditions, implement a geocentric FoR, that is *a priori* not coherent with their culture."

In this experiment, the acceptance of counter-suggestions increased with age in the environment-centered induction condition: 6–7 year old children refused them systematically, while 36 percent of the older children[2] and 71 percent of the adults accepted them. The latter were able to express the cultural norm clearly. Some said: "It is possible, but it is not what one should

[1] These references are akin to conventional landmarks (CL), and it is debatable whether they are truly geocentric or not.

[2] For the 10–11 year old children, this acceptance rate might reflect either increasing flexibility of thinking or the effect of schooling, where pupils learn to accept what teachers say, or at least to pretend that they do.

do," or "It is possible, but it is wrong, one has to use left and right" (Troadec, 2009, pp. 67–68).

Haun, Rapold, Janzen, and Levinson (in prep.) also performed a training experiment, where Dutch children (8–9 years) were trained to use geocentric references (cardinal directions) on an Animals in a Row task (six animals, 90° rotation) and Hai//om children (7–11 years) were trained to use egocentric references. Using the non-preferred FoR proved difficult for both groups. Only one-fifth of them successfully changed to the dispreferred strategy, and attempts to do so decreased their performance significantly. The authors therefore conclude that "cross-cultural preferences are not easily overcome" (p. 16 of draft).

According to Li, Abarbanell, and Papafragou (2005; reported by Papafragou, 2008), there are also indications that people who strongly prefer a geocentric FoR, such as the Tzeltal speakers of Mexico (who use an "uphill/downhill" and "across" system without any reference to right and left), can be induced by experimental conditions to use egocentric encoding. For example, two of the encoding tasks (Chips and Eric's Maze) were used in two different conditions, an egocentric condition (EC) where the participants carried the stimulus display (hidden away) with them during their 180° rotation to the second table, and a geocentric condition (GC) where the display was moved without rotation. The scores apparently took into account the accuracy of reproduction. In the Maze task, adult Tzeltal speakers performed better in the EC than the GC condition (92 vs. 62 percent of paths were traced correctly, respectively). As path complexity was increased across trials, the Tzeltal speakers' success in the EC condition remained relatively stable (100, 96, and 80 percent in one-, two- and three-leg paths), while in the GC condition it declined (92, 60 and 35 percent, respectively). The author concludes: "These data show convincingly that Tseltal speakers can and do use egocentric coordinates to solve spatial tasks" (p. 285), and further:

> Overall, these studies show that Tseltal speakers, when given implicit cues that body-centered (left-right) distinctions are needed to solve a spatial task, use these distinctions without problems. On certain tasks, performance with such body-centered distinctions is better than performance with absolute systems of orientation that correspond more closely to the preferred linguistic systems of encoding space in Tseltal. Tseltal speakers' switch to egocentric reasoning seems to happen flexibly and without much training, despite what one might expect on the basis of language-specific frame-of-reference choices or prior empirical results. We take this as another demonstration of the independence of spatial reasoning from linguistic encoding preferences. (Papafragou, 2008, p. 286)

While this last conclusion will not be shared by everyone, there seems to be consensus on the compromise that all three FoR are at least potentially available everywhere. For example, Widlok (2007, pp. 274–275) writes: "Clearly,

all humans are potentially able to develop relative and absolute orientation strategies to some degree. But the embodied skill and disposition to use these systems are only acquired under specific conditions of development."

Universality or cultural specificity?

If we follow a cognitive-style interpretation of cultural differences, it means that the basic processes underlying spatial language and cognition, whichever frames are chosen to express it, are universal, at least at the "deep" level of competence if not at the surface level of actualized performance. We think they are. And hence, the outcome of this research does support our general conclusion about culture and cognition.

Against this background of commonality, it is the cultural differences in the way these basic processes are instantiated that are of interest. When we delve into the details of the geocentric FoR, almost completely ignored by Western mainstream psychology (with the slight exception of Piaget and Inhelder's Euclidean space), we are indeed close to cultural specificity. The claim for cultural specificity can easily be rather ethnocentric, if it just means that it is different from the Western "norm." In fact, the formerly unknown linguistic and psychological process may be quite widespread, and we are reminded of Kagitçibasi's (2007) concept of "majority world" to designate what is non-Western.

So, how widespread is the use of a geocentric FoR really? In our research, we have documented it in Indonesia (Bali), India and Nepal, which is in itself quite a widespread area, but has a common element of Hindu religion. This is no doubt a limitation to our research, and even in the same countries, we could have included other parts of the population, for example Muslims. Cardinal directions are also very important in Islam, and are taught in Urdu schools (see an example in Appendix 3). Indeed, Mishra and Jha (2006) found that Urdu-school children did not differ from Sanskrit-school children in the use of geocentric and egocentric language, while Hindi-school pupils used more E language than these two groups, but less G language. A similar pattern was found for spatial memory encoding on the task devised by Niraula and Mishra (2001b).

Linguistic research by Levinson (2003) and his group shows that the phenomenon is quite widespread, and examples can be found on most continents except Europe. It occurs in Austronesian languages (i.e. in Oceania), and the developmental psychological research in New Caledonia (Cottereau-Reiss, 1999, 2001), the Marquesas (Cablitz, 2006) and Tahiti (Troadec, 2007, 2009) indicates that, at least in locations where the traditional language and culture have been somewhat preserved, we are likely to find the same developmental patterns. Furthermore, an even more exclusive use of a geocentric FoR seems

to be found in several hunting and gathering societies (in particular Australian Aborigines and the San in the Kalahari desert); unfortunately, our efforts to include such a group in India have not been successful, despite the extensive experience R. C. Mishra has with research among so-called tribal populations in India. In any case, with the geocentric FoR, we seem to be somewhere in between a localized cultural specificity and a "majority world" phenomenon: it is widespread, but still rather unusual.

Among the several locations in which we have carried out this research, with the notable exception of Geneva, we find many similarities, but also some differences. For example, there is quite a striking similarity in the factorial structure when our tasks are submitted to Princals optimal scaling. This is illustrated in Figure 15.1, which extracts the results for the three encoding tasks from each of the relevant chapters.

In each case, Animals and Chips load similarly on dimension 1 to the order of about .80, while Steve's Maze is opposed to these two measures on dimension 2. In Bali and Varanasi, it does contribute partly to the first dimension, while that is not the case in Panditpur and Kathmandu, but that seems to be a minor difference compared to the overall similarity of structure. Having demonstrated structural identity, we would feel confident in using object scores on dimension 1 in quantitative cross-cultural comparisons between the four sites, on the grounds that they do measure the same functional process. We actually have functional, conceptual and metric equivalence for this measure, which meets the basic requirements for cross-cultural comparability (Berry & Dasen, 1974). We actually don't do this because the research was not set up as a cross-cultural comparison in these terms, our hypotheses being formulated not as differences between these locations, but in terms of relationships within each of these (or sub-group differences in particular locations).

Linguistic relativism at the individual level

A fundamental issue of our research is linguistic relativism, i.e. the hypothesis that language determines cognition. What we find is "moderate linguistic relativism," insofar as the hypothesis holds up quite well at the group level, but only partly at the individual one. In Geneva, French (or any other of the dozen first languages spoken by the children in our sample) does not foster the use of a geocentric FoR, and indeed, it is never used by children for spatial encoding. Balinese, on the other hand, makes a normative use of a geocentric orientation system, and indeed, many Balinese (particularly in the traditional, rural segment of the population) use geocentric encoding almost exclusively, and start doing so at a very young age. This is what we mean when we speak of a confirmation at the group level, that of overarching cross-cultural comparisons.

However, in most of our samples (Geneva being the utmost exception), the children use both geocentric language and other forms (even if egocentric language is almost nonexistent in some locations, such as the villages of Roopchandpur in India and Sambangan in Bali), and they mix geocentric and egocentric encoding. Hence, for the psychologist, the question of individual differences arises. Do some individuals use more geocentric language than others? If so, do the same individuals also use more geocentric encoding? This is what we mean by the individual level. The statistical test that answers this question is the correlation coefficient between language use and encoding (using partial correlations to control for age).

In our first study, we were surprised by the rather low and unsystematic correlations (the highest partial correlation was .30** with Chips in Dolakha). In the main study, we now get positive, and even some statistically significant, partial correlations in Bali (.38**) and Varanasi (.33*), but not in Kathmandu or in Panditpur with children. However, the coefficients are generally speaking quite low: a correlation of about .33 may be statistically significant, but it only explains 10 percent of the common variance. Two points of discussion are in order. First, it is interesting to note that we found the highest correlation in the only group of adults we included in this research: .67** in Panditpur explains almost 50 percent of the variance. This indicates that the relationship between language and encoding may be stronger in adults than in children, because the choice of frames may have become more stabilized. Second, correlations are, of course, sensitive to the existence of sufficient variation; if a sample is too homogeneous (e.g. uses only G and no E language), we are unlikely to find high correlations. This may explain why in Bali, the correlations are higher in the city (.28**) than in the village (.22*), and highest when the whole sample is considered (.38**).

Correlation coefficients only indicate that there is a relationship between two variables, they do not imply causality. A significant coefficient between two measured variables could be due to a third variable (that is not measured or may even be unknown). So, a further indication we need to look at is the path diagrams (Amos) that we were able to produce for some of the locations. These indicate that language use and encoding can be similarly predicted from a series of antecedent variables (to be discussed in more detail below), but that no common variance is left once these predictors have been taken into account. So, in fact, a zero correlation between language and encoding is what leads to the best fit in these models: on this ground, we might reject a linguistic relativism hypothesis completely! However, we will not go that far. The best choice is no doubt a "moderate linguistic relativism."

Another way to look at the hypothesis at the individual level is an even more "micro" approach, which consists of looking at individual items on a task. On items 4 and 5 of the encoding tasks, when we ask the child to explain "how he

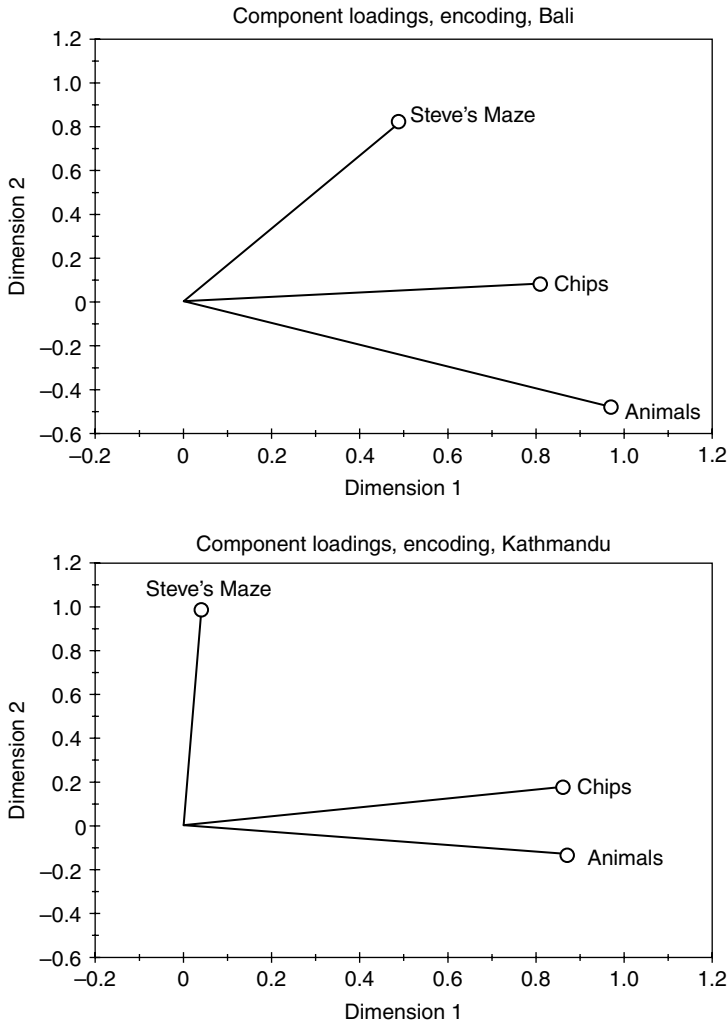
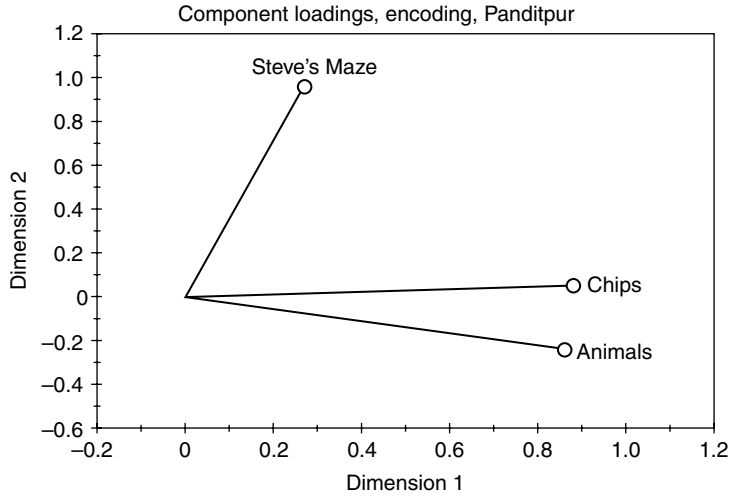


Figure 15.1 Princals factorial space for non-verbal encoding tasks in four locations

remembered," does the language used fit the encoding? Here again, we found that the answer is "yes," for a majority of items, but there is also a good proportion of mismatch. This we have found quite systematically in all locations, starting with our first study in Bali in 1994. Even then, we were puzzled by those informants who occasionally produced an egocentric encoding, but explained it in geocentric terms. Indeed, if there is a mismatch, it is usually in the direction of a non-dominant choice of encoding explained by normative language.



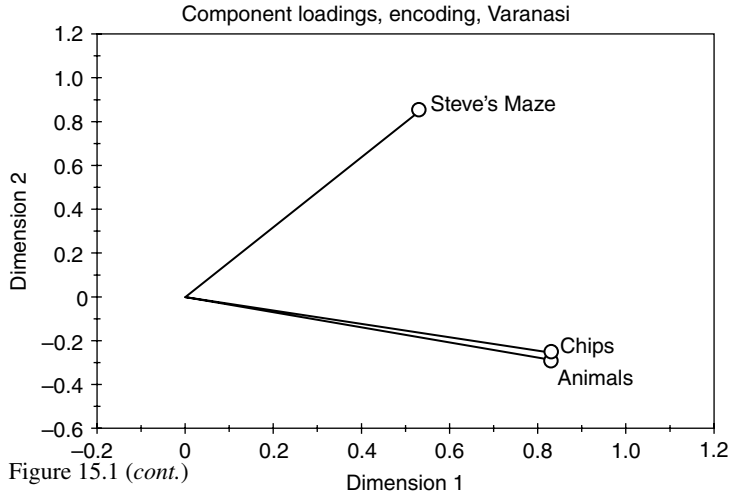


Figure 15.1 (*cont.*)

What we can conclude from these findings is that language is more likely to fit the social norm than encoding; in other words, language is more situated at the group level, and encoding is more at the individual level. Encoding is more likely to go against the social norm than language use.

Within language use itself, we have found that hypotheses derived from strong linguistic relativism are not always fully confirmed. In our "rotation

around a display" experiment, for example, it was found to be true that those who use geocentric language are more likely to give the same description from different positions, especially if they use the "quadrant" scheme to organize the display (see chapter 13). But this is only a trend, it is only a possibility, of which they make use sometimes but not always. While an egocentric description of a display necessarily changes when the speaker turns around it, a geocentric description may be the same, but it does not have to be the same.

Task specificity is another phenomenon to which our research points systematically ever since our initial project in Bali. Quite systematically, in every location (except, again, Geneva), Steve's Maze elicits more egocentric encoding than Animals and Chips. When analyzing the task demands, this is not really surprising. The latter two tasks can easily be remembered linguistically, one sentence is enough ("the blue square is uphill"; "the three animals look west and the fourth one south"), while the complicated path on Steve's Maze is more easily remembered as a shape, or as a series of movements, both of which require an egocentric FoR. A cursory reading of the way these encoding tasks were presented by the team who invented them (Danziger, 1993; Levinson, 2003) may have led to the expectation that all the tasks (and there are more than the three we used ourselves) were measuring the same process, and would hence lead to the same results.

Task specificity plays an important role in the interpretation of our findings in terms of cognitive style, although this will be no surprise for psychologists. Indeed, it reinforces the idea that the individual has the "choice" to deal with one situation differently from others. If the reactions of an individual were systematically the same for all tasks, it would mean that using a given FoR is a defining part of that individual, an aspect of "personality" that is sufficiently stable to generalize across all situations. Some of our subjects were indeed more likely than others to use one frame systematically, which is what prompted us to try to select sub-groups of systematic G and E speakers and G and E encoders, for example in Varanasi and in Kathmandu. However, this proved more difficult than expected. In fact, it was impossible to find systematically egocentric persons, and while the geocentric ones were more numerous, often they were systematic for language or for encoding, but not for both. So, while our effort to maximize differences by selecting a sub-sample was not successful, this very fact confirmed that any individual may "choose" one frame or another, for at least some situations and under certain circumstances.

This is true at least of the groups we have been studying, where the language does allow the use of all three frames of reference. According to Levinson (2003, p. 93 and p. 182), there are languages that do not allow for the egocentric FoR at all, such as Guugu Yimithirr and Arrernte (Australian Aborigines), or Hai//om (Khoisan). Unfortunately, we do not know of any psychological research on the issue with speakers of those languages. No doubt the situation

would be akin, although in reverse, to that of French speakers in Geneva (or of Dutch or Japanese in Levinson's list in Table 1.3).

A cognitive-style interpretation means that individuals usually have a preference, that they are more likely to use one style rather than the other. For field dependence/independence, while Witkin and Goodenough (1981) did mention the possibility that some individuals are flexible enough to use either a field-dependent or a field-independent style in any given social situation, and saw this flexibility as a possible great advantage, this option was never fully investigated, and seemed to be restricted to a minority of people. Most individuals do react according to one style more or less systematically, depending on a variety of factors such as their childhood socialization, or indeed, their group membership (e.g. hunter-gatherer vs. agriculturalist). Hence it becomes important, for research, to find out which ecological, socio-cultural or acculturation factors favor which style.

And so it goes for the cognitive style of using a geocentric or an egocentric FoR: there seem to be a large number of factors, or variables, that determine which frame is more likely to be used. Our research has explored quite a number of these that we shall now review. One characteristic of cognitive styles is that they are adaptive to the eco-cultural demands, they are functional. It is therefore not surprising that we find a strong ecological component.

Ecology

Eco-cultural adaptation of geocentric orientation systems

One of the key variables is no doubt ecology. First of all, there is the overall correspondence between the geographical layout and the spatial orientation system that is current. On an island such as Bali, it makes sense to use "to the mountain/to the sea," in the Himalayas "up/down," but in the flat Ganges plains sunrise and sunset and the concomitant system of cardinal directions. This variety of orientation systems, and their functionality in terms of landscape, is an interesting anthropological fact by itself. But like most anthropological findings, it suffers exceptions. Levinson (2003, p. 189) points out that there are several examples of societies living in similar ecological surroundings, yet preferring different FoRs in their language, and Majid *et al.* (2004) show that none of the ecological variables they have examined, except possibly the urban/rural contrast, is able to explain all their findings. Granted! Geography alone is certainly not a single determining factor.

On the other hand, it is rather strange that Levinson (2003, pp. 189–191) uses Pederson's (1993) research among rural and urban Tamil-speaking groups to argue in favor of a linguistic determination and against an ecological one. It will be recalled that rural Tamil speakers were using predominantly geocentric

descriptions, while urban ones were using egocentric ones more often (and some situational landmarks). As to encoding, no significant difference was found between the two groups on the Animals task, but the rural group did use significantly more absolute encoding on a task of transitive inference. Levinson attributes the findings to a "dialect difference" (p. 189), and argues against an ecological factor: "I conclude that there is distinct evidence from … this Tamil case … that ecological factors, or factors to do with material culture, or indeed religion or other cultural variables, do not seem to have a decisive role to play in non-verbal coding" (pp. 190–191).

We will come back to religion and other cultural variables shortly, but as far as ecology is concerned, we see the Tamil study as convincing evidence that a geocentric FoR is more functional in a rural setting, and an egocentric one in the city. In a previous publication on our first study (Mishra *et al.*, 2003), focusing on ecological differences, we remained quite cautious: "It is difficult to say with certainty whether the use of relative terms is linked to the topological features of the city (it certainly makes more sense to turn left and right in a city, whether driving or walking, than in either open countryside or on mountain paths)" (p. 376), and further: "The ecology of the city is more varied, and the processes involved would no doubt warrant a more detailed study" (p. 379).

While our analysis of what it means to live in a city, in terms of using spatial frames, remains impressionistic, we are reinforced by our consistent findings in our belief that the rural/urban ecological contrast is a fundamental factor.

Urban/rural difference within the same language: Bali, India, Nepal

Just like the difference Pederson found between rural and urban Tamil speakers, we found such a difference between Hindi speakers of Roopchandpur and Varanasi (see chapter 4). The difference in language use was quite striking: no egocentric language at all was used in the village, while some was used, increasingly with age, in the city. In terms of encoding, the average R-A gradients were also systematically lower in the city than in the village, in each age group.

The same difference was found once again in the second study in Bali, between Sambangan and Singaraja (chapter 5), and in Nepal if we compare the village and a city group (Table 7.4). The findings are extremely consistent, and the urban/rural difference remains constant over age.

Of course, such an ecological variable never stands alone. City people are not only likely to move about differently, between buildings rather than rice fields, they are also likely to have a higher SES (both in terms of education/occupation and affluence), which is why, in Bali, we computed our SES scores

separately for each location. However, if some covariance can be teased out statistically, other variables no doubt remain confounded. City dwellers, for example, have an easier access to media, and are possibly more likely to hear foreign languages. Hence, we would not claim that the ecological factor is pure, or indeed that any of the factors we are considering are pure: they are always part of an eco-cultural web that works as a system rather than as an addition of separate variables.

Migration from rural areas in Varanasi

How is it, then, that urban people do not systematically use egocentric language in the cities of Varanasi, Kathmandu and Singaraja? This fact no doubt shows the limits of a purely ecological interpretation. If the language, and the culture, and the belief system, all favor a geocentric system, the simple functionality of the egocentric system is not sufficient to impose itself completely.

And what happens when village people move to the city? The migration histories obtained through home interviews with a sub-sample of sixty-six families in Varanasi allow us to answer this question. It seems that the geocentric system is maintained at least for some time, and transmitted to the children. At least, there were statistically significant correlations between migration history and the use of G language (.58**) and encoding (.39**). Note that this finding was confirmed in Kathmandu only for G language (.28**) but not for encoding.

Challenging the ecological hypothesis in Panditpur

While we maintain that the urban/rural ecological dimension is very important in all three settings of our research program, we do not claim that it could not suffer exceptions. This is why we were quite interested when we were told about the village of Panditpur where egocentric language was reported to be the norm, and we found it to be an interesting potential challenge to our ecological hypothesis. As will be remembered from the short chapter on this location (chapter 8), what we found through more careful data collection was, in the end, a strong confirmation of geocentric language use, with children and particularly with adults, as well as geocentric encoding, although it does decrease in children after grade 5.

Cultural belief systems

The second important set of variables to be discussed here has to do with cultural belief systems, and in the case of our research locations, the Hindu religion in particular. Far from being secondary to language, the cultural belief

system is an overwhelming part of life in all three of our locations, and is strongly linked to the way space is conceptualized. In several chapters, we have shown how the geocentric orientation system, be it "to the mountain/to the sea" in Bali, or cardinal directions in rural and urban India and in Kathmandu, is directly linked to religious beliefs.[3] This is important because the belief system reinforces a geocentric FoR in two ways: it provides symbolic meaning to geocentric dimensions, such as considering *kaja* as the pure, holy direction in Bali, with "east" holding the same significance in Hinduist India. And linked to this, it provides continuous experience with taking these directions into account in daily life, be it during religious rituals themselves, or in connected customs, such as respect for the proper orientation for eating or sleeping.

True, left and right are also marked symbolically in a similar way, which leads to an early learning of the distinction on the body, and particularly the right and left hands. But this distinction becomes almost insignificant when compared to the overwhelming importance of the geocentric orientation system. While this is pervasive in the daily lives of everybody in the locations used for our study, it is, of course, even more important for those who practice spatially oriented religious rituals as part of their training. Hence, our study compared children from Sanskrit and Hindi schools in Varanasi (chapter 6).

It will be recalled from our detailed data analysis as well as from the summary path model, that school type in Varanasi turns out to be a major variable that predicts the whole complex of geocentric spatial knowledge, language and encoding, and is also linked to other spatial skills (for example, with SPEFT). Of course, in this type of quasi-experimental cross-cultural research, variables are never pure. Just like the rural/urban contrast, school type is linked to other socio-cultural aspects. It reflects the actual differential experience of training in Sanskrit vs. standard Hindi schooling, but goes with a variety of other variables. For example, the families of Sanskrit-school pupils have more contact with rural life, and some even live in villages, while they have sent their child to school in the city. In our study, there was also a sampling bias in favor of boys in the Sanskrit and girls in the Hindi schools, but a careful analysis of the data showed that gender is a secondary variable in this case.

One limitation of our research is that we have dealt only with the Hindu cultural belief system, even though it is quite different in Bali than in India and Nepal. According to the information we have collected (and presented in chapter 3 and Appendix 3), cardinal directions are also quite important in Muslim and in Buddhist rituals, and it would be interesting to carry out further research in this respect.

[3] In Dolhaka village in Nepal, the "upstream/downstream" system is somewhat of an exception, being possibly more linked to the daily experience of walking in the mountains, although there are also holy dimensions to the peaks of the Himalayas.

Acculturation (bilingualism, SES and various socio-cultural factors)

As a third set of factors, we shall consider various socio-economic and socio-cultural variables, that we can group together as reflecting some kind of acculturation, i.e. a possible departure from the local traditional culture that emphasizes the use of a geocentric FoR. Central in this discussion will be bilingualism with a language that uses predominantly egocentric references.

An interesting aspect of this discussion is that we seem to encounter the same variables in Bali and in Kathmandu, but they function rather differently. In Bali, the central influential variable could be called "traditional culture," which comprises the knowledge of the Balinese orientation system, and the use of Balinese language (both in the home, and on our tasks) rather than Indonesian. The maintenance of this traditional culture is of course strongly linked to the ecological variable: it is much stronger in the village than in the city, and within each location, it is linked to SES: the families with higher SES tend to be more "acculturated," i.e. less linked to traditional culture. Hence, if we look at the Bali summary model, we see that both G language and G encoding are predicted separately (respectively at .51 and .42) by this virtual variable.

The whole pattern of results in Bali is coherent with this interpretation. It explains why we have found more G encoding in the most remote village of Bunutan, and why this may have been even more the case in 1994 than in 2002. However, the levels of G language use and G encoding are really quite high even in the city, and starting at a very early age, so that we may conclude that "traditional culture" is still holding its own in Bali (or, at least, in the north of Bali where our study was carried out).

In Kathmandu, on the other hand, we find that the use of English does not at all have the impact that would be expected by progressive socialization in a language that uses only (or at least mainly) an egocentric FoR. While G language use was found to be slightly higher in the Nepali school, especially in the case of older children, this was not found to be the case for G encoding, which is higher in the English group.

How could it be that using English on a daily basis, exclusively for several hours a day, and over a period of up to eight years, has no impact? We did not expect this finding, and only have post hoc speculations to explain it. However, it does make sense: it is of course not the language per se that matters, but language use in a given speech community. And it seems that in Kathmandu, the English school community is using English, at least partly, with a geocentric frame.

Thus, in Kathmandu, like in Bali, the "traditional" cultural model (that carries with it the use of the NSEW system), seems to remain very strong.

The geocentric frame is transmitted both through the official curriculum (see Appendix 3) and through the "hidden curriculum," because the teachers are all Nepalese and themselves have English as a second language. In English schools in Kathmandu, English seems to be used like Nepali as far as spatial FoRs are concerned, in the same way as our anecdotal observations in Bali showed that some teachers were using the traditional Balinese orientation system, instead of cardinal directions, in Indonesian. This conclusion, of course, reinforces the fact that language use is only one part (even if an important one) of the complex eco-cultural system.

In Kathmandu, like in our other locations, this traditional cultural model is also linked to the religious belief system. However, it seems that the higher SES families are likely to keep up religious practices even more than less affluent families. Hence, we get quite a different impact of bilingualism and SES in Kathmandu and Bali, but probably for the same reason, namely the underlying variable of respect or even reaffirmation of traditional culture.

While we have attempted to separate the ecological conditions, cultural belief systems and acculturation variables in order to discuss them separately, we see that this is, of course, quite impossible because they form, in fact, an eco-cultural system in which all of these components are linked. Language, and in particular G language use, is a coherent part of this system, but it should now be obvious that it cannot be singled out as a putative unique causal factor determining cognition, as extreme linguistic relativism would have it.

In fact, our summary path models suggest that G language and G encoding are both predicted from the other variables, in particular traditional culture and its linked features, as well as age, but that a direct causal link between language and cognition is not necessary for a good statistical fit of the models. In the Kathmandu model, there is a slight link between the two variables (.16), but the model does not allow us to distinguish between a causal link from language to encoding or the reverse. This could lead to an outward rejection of any direct role of language in cognition, a step we are not willing to take when considering several other aspects of our analyses. It is, however, another clue in favor of only a very moderate form of the linguistic relativism hypothesis.

Links to the theoretical framework

Having now examined three major eco-cultural variables, we are reminded of the integrated eco-cultural theoretical framework presented in chapter 1 (see Figure 1.1).

What we have discussed so far are the variables in the macrosystem, namely culture as interacting with and adapting to the ecological and socio-cultural contexts, and among other cultural aspects, the cultural belief systems of cosmology and religion. We have also mentioned the processes, in the mesosystem,

of ecological influences and acculturation. We now have to turn more specifically to the main process of interest, cultural transmission (enculturation and socialization), and to how these components impact on the developmental niche and on the ontogenetic development of children. This is the topic of our next section, under the heading of human development.

Human development

Reversal of stages vs. different eco-cultural pathways to human development

On the basis of the results obtained with the first study in Bali, we entertained for some time the idea that we might be witnessing a reversal of the stages of development described by Piaget and Inhelder (and other developmental psychologists) for Western children. In other words, while the intrinsic FoR (topological space) would be universal and acquired first everywhere, in Bali we would then witness the development of the geocentric FoR (Euclidean space), gradually followed by the egocentric one (projective space). It is the order between Euclidean and projective that would have illustrated the reversal.

While such a reversal would have represented a "first" in cross-cultural cognitive psychology, and was thus an exciting prospect, further data collection did not confirm the hypothesis. In fact, our linking the geocentric FoR to Euclidean space too directly was at fault. It is true that using an orientation like cardinal directions is akin to imposing a grid upon spatial representation, but other aspects of Euclidean space, such as taking measured distance into account, are not necessarily included in the geocentric FoR. Also, if we look at what Western children do, for example those we tested in Geneva, they may well develop Euclidean space, but they still do not use a geocentric FoR, at least not by our definition (using it inside, for small-scale space, etc.).

As to the Balinese, Indian and Nepali children, they do not move from using a geocentric FoR early on to an egocentric one later with age, but instead move from an early geocentric frame to an even more systematic use of the geocentric frame later. In other words, what we are witnessing is a different path of development, from geocentric to more geocentric, with the egocentric FoR as a secondary possibility throughout. This is also why an interpretation in terms of cognitive styles seems more appropriate: the dominant style is geocentric, but under some circumstances (for younger children, for some older children in Varanasi, for Steve's Maze rather than Animals or Chips, etc.), the egocentric style may take over.

This is particularly true if we look at encoding. If we consider spatial language, the developmental shift is certainly not from egocentric to geocentric, since egocentric language is hardly ever used. Note that in Bali, G language is

used (and even correctly used) from age 4 onwards, with some E and I. Bali seems to be the extreme case of early development of the geocentric FoR. In Kathmandu, the younger children tend to use deictic (D) descriptors, and some situational landmarks (SL). It is true that this already reflects a movement away from the display, even if it is limited to directions inside the room. This is, of course, even more marked when conventional landmarks (CL) replace SL, but that was found only in the village locations in India and Nepal.

Learning to use a geocentric orientation system correctly is a difficult process. We witness a first use of G language at about age 6 in Kathmandu, but it takes some years before this is used correctly in a systematic fashion. There again, individual differences as well as socio-cultural factors intervene. As we have seen in chapter 6, Sanskrit-school children use geocentric language correctly without fail by age 11 or 12 at the latest, while this is not the case for all Hindi-school children. The contrast is even stronger in Bali, where Balinese-speaking children as young as age 4 use G language correctly, while those who mix in Indonesian don't.

Knowledge of the G orientation system outside/inside

Obviously, correct G language cannot be used without the knowledge of the orientation system, so we assessed this separately, with the added question of whether the children would be able to use the system inside a room as well as outside the school building. In Bali, this knowledge was found to be acquired as early as age 4, at least among the Balinese-speaking children, and they knew both axes correctly, and used the directions as well inside as outside. This precocious knowledge of the system in Bali is quite astounding. In Kathmandu, in the youngest age group, almost none of the children know the directions (even though they use wide, geocentric gestures; see chapter 11), while starting at age 7 to 9, about half of the children do. Some of the children get one axis correct but not the other one. In Varanasi, where this was tested only with older children, the knowledge is almost perfect in Sanskrit-school children, but builds up progressively in Hindi-school children between age 11 and 14 (and does not reach 100 percent).

Mothers' spatial language use

It is obvious that the geocentric spatial language, like any other language, is acquired by learning it from adults and possibly from peers, but it was still a surprise for us to find that cardinal directions are sometimes used by mothers with children as young as 1 year of age (see chapter 10). At least, this was the case in our study in Roopchandpur, the village setting in India, but some early use of "up/down" was also found in the village in Nepal.

We can conclude that parents just use with their young children the language they are used to, without considering that it is impossible for babies to understand a geocentric orientation system. They do show some adaptation of their language by using deictic references in Nepal, and intrinsic in India, but the absence of egocentric language, and importance of geocentric references, are the striking findings in the mothers' spatial language use.

Precocity of the geocentric FoR

The way geocentric language is used by adults with very young children seems to allow them to build up a geocentric FoR also very early. Exactly at what age is difficult to tell. From our data, we see that in Bali, at least in the village settings, the G frame seems to be already well established by age 4, which is the youngest age we were able to test (and not without some difficulties, and certainly with a lot of patience). It would be challenging to devise some tasks or experimental situations that could be used with children before the age of 4, like the concept formation learning tasks of Haun *et al.* (2006) or Troadec's (2009) induction tasks, in a version that would allow us to distinguish the geocentric from the more general allocentric frame.

In Kathmandu, our study using gestures also leads to the conclusion that a geocentric FoR exists as early as age 4, even before any geocentric language is used. That is, of course, an exciting prospect, arguing for the precedence of cognition over language. Certainly, it is an experiment that needs to be replicated, possibly in another location. Indeed, we happened to have video recordings available in Kathmandu, and checking up on gestures actually came as an afterthought. According to the rest of our data, on language and encoding, Kathmandu is not the location in which one would have expected to find such precocity, as compared to Bali or village settings in India or Nepal. What is most likely is that these young children imitate the dominant cultural model without actually mastering it fully.

Effects of schooling

Developmental psychologists working in the Western world always have the problem (although they mostly seem to be unaware of it) that chronological age is confounded with schooling. So, any developmental trend attributed to age could, in fact, be due to the cumulative effects of schooling. We were very pleased to be able to include, in our first study, a complete sample of unschooled children in all three locations of that research.

The results show that this effort has not really been worthwhile. Only very few differences were found between the schooled and unschooled, such as a predominant use of "up/down" by the unschooled in Dolhaka, while the

schooled children used NSEW instead. But there were hardly any other systematic effects. We can conclude that the development of a geocentric FoR in the populations of our study is independent of schooling. It occurs through enculturation, i.e. it is learned involuntarily by immersion, by observation and imitation of the spatial references used by adults and peers. It is a good example of informal education (Dasen, 2008; Trommsdorff & Dasen, 2002), and of the functioning of the developmental niche surrounding the growing child.

This does not mean that a more formal education does not contribute to the development of the geocentric FoR. First of all, in India and in Nepal and, as far as we could find out, in all types of schools (including Urdu schools in India; see Appendix 3), the orientation system with four cardinal directions is explicitly taught in grade 2, and reinforced in later years. So, in many instances, the system taught in school is congruent with the system used normatively by the adult population. In other instances, there is a discrepancy, such as in Dolhaka, where the local orientation system uses "up/down," while NSEW is taught in school. Similarly, in Bali, where teaching is done in Indonesian only, there is a discrepancy between the systems learned at home and in school.

Recall Figures 5.6 and 5.7 in the chapter on Bali, that show how the knowledge of the Balinese and Indonesian orientation systems develops with age. While the Indonesian-speaking children acquire both systems about the same time, but quite late, the Balinese-speaking children know their own system from early on, and acquire the Indonesian one later. What is interesting is to see that knowing their own system seems to help them in acquiring the Indonesian one (they are slightly in advance of their Indonesian-speaking peers, at least up to age 8, in the knowledge of the Indonesian NSEW system). The fear that they might get confused by the coexistence of two systems does not seem to be warranted.

A further example of formal transmission is our study of children in Sanskrit schools, where the Sanskrit orientation system with ten named directions is explicitly taught, and reinforced by daily routines. In this case, schooling becomes an important variable, but as a special type of schooling, and not as a variable competing with chronological age.

Experiential process variables: independent mobility

As part of the processes of informal education, we have also explored some of the daily activities that may lead to the construction of spatial skills in general, and to a geocentric FoR in particular. Based on previous research that both authors had carried out earlier, and in different settings, we hypothesized that the amount of direct experience with moving around in the neighborhood should influence the construction of these skills. In the child interviews, we asked about the frequency of various activities outside of the home, and the

distance at which they were carried out, and also how the child was moving about, i.e. walking, on a bicycle or being driven.

Deriving such information from interviews is rather awkward, and no doubt quite unreliable. We had initially planned to carry out an observational study, using the technique of so-called "spot observations," in which the researcher records the whereabouts of the individuals in the sample at random times of the day (and fills out a form on what they were doing, asks whether they were told to do so or not, etc.). This technique is relatively free from the bias of the observer's presence, and allows a quantification of spontaneous behavior if a large number of spots are recorded. However, this also means that the technique is very labor intensive.

The best location to carry out such a study, in terms of the availability of research assistants who could have been trained for this task, would have been Varanasi. However, there would have been several restrictions with our sample; for example, girls in the Sanskrit schools never leave the school compound. In any case, it was decided to leave aside this observational study, and our data are, therefore, limited to child questionnaire data.

In Varanasi, possibly because of the restricted movements of part of the sample, and also because we collected the data only with a sub-group of eighty children, the results are not impressive. The only significant correlation to be found was .36** between independent mobility and G language. At least, it is an indication that the use of geocentric language is related to moving about (and in particular, the greater distance at which activities are carried out).

More detailed results were obtained in Kathmandu, where the child questionnaire was used with the total sample of 400 children. As to the summary measures, it will be recalled from Table 7.15, that independent mobility showed systematic correlations with all the language and cognition measures, passive mobility with all but G language. The correlations are actually highest with the two measures of spatial skills, BDT and SPEFT, which shows that the experiential variables influence spatial ability in general. We logically assume that, if an egocentric frame were the norm, the same experiences would no doubt foster an egocentric frame. Hence, these variables cannot be taken as a direct causal influence on the development of the geocentric FoR, but rather as an indirect route, through the development of an overall factor of spatial ability. This is shown in the Amos path model (Figure 7.6), where both mobility variables contribute to the virtual variable of spatial ability.

The Amos summary model for Varanasi (Figure 6.18) also includes such a virtual variable of spatial ability, linked to BDT and SPEFT, and also to processing speed and hemispheric dominance. These are some links with other cognitive processes that we will discuss in the next section. Before doing so, however, we can come back briefly to our theoretical framework.

Links to the theoretical framework

We have now reviewed several aspects of cultural transmission, in terms of enculturation and socialization (or, in other words, informal and formal education), that contribute to the development of a geocentric FoR. In terms of the microsystem of the developmental niche, we have described several aspects of the physical and social settings in which this frame is just simply present to be learned. In coherence with these settings, there are child-rearing practices and daily experiences that contribute to the learning of the system, and these are, of course, coherent with parental ethnotheories. Note that the latter were not assessed directly in our project, but are subsumed in the cultural belief system that comes from the macro level.

Links of a geocentric FoR to other cognitive processes

What are the implications of using a geocentric rather than an egocentric FoR? Cognitive styles are usually thought to have far-reaching consequences on other aspects of cognitive functioning, or even personality, social skills, choice of profession, etc. (Zhang & Sternberg, 2006). Is that true also of spatial FoR? Levinson (2003) reviews a few of these possible consequences, such as dead reckoning, wayfinding and the ability to point accurately towards home from any distant location.

Dead reckoning: updating spatial orientation while blindfolded

In this research, we also explored a few links to other cognitive processes, among which the closest to previously reported research is dead reckoning in our blindfold experiment in Varanasi (chapter 14). The results showed that using a geocentric FoR is not a sufficient condition for keeping track of cardinal directions under the extreme conditions of our experiment. We agree with Widlok (2007, p. 275) when he writes: "It is much more convincing to regard language and other forms of social behaviour (including piloting and dead-reckoning) as activities that develop concurrently rather than sequentially."

Generally speaking, all our informants in each of the locations who know the orientation system outside (of the school building) can carry this inside a room. This alone is already quite an achievement, which is far from obvious to those of us who are accustomed to using an egocentric FoR.

Some of our "expert" informants could do much more, such as keeping those directions in mind while blindfolded, turned around, and led blindfolded to another room. This is a remarkable feat, even if the experimental situation was possibly not controlling for all extraneous cues. These experts were more likely to come from the Sanskrit rather than Hindi schools, had a concept for

this updating and reckoning skill (*andaaz*), and sometimes reported practicing it in games at home and in school.

Organizational schemes

While dead reckoning is a possible consequence of expertise in the geocentric FoR, we also tried to explore at a more micro level how individuals using a different FoR impose a particular organization on a display, such as the three objects in the Perspectives task (chapter 12). We found that splitting the display into quadrants (e.g. the objects are said to be east, south and west) increased with age, while splitting it into two parts (not necessarily in egocentric terms such as left and right, but for example east and west), decreased with age. In Varanasi, the former was linked to other measures of a geocentric FoR and spatial skills, and the latter was negatively linked to geocentric language, but these correlations were not confirmed in other locations. The use of quadrants also increased the likelihood of providing the same description of the display when moving around it.

Spatial ability and Piagetian concept development

The previous section raises the question of the relationship between the geocentric frame, as a cognitive style, and spatial abilities or spatial concept development more generally. To measure these, we included measures of spatial ability in our main study (BDT and SPEFT), and we used Piagetian tasks in the spatial domain in the first study. To deal with the latter first, we found that there was indeed a relationship between using G language and attaining higher stages on some Piagetian tasks, but there was no relationship to encoding. There are also some significant correlations between G language and encoding and spatial ability, but these are not as systematic or as high as one might have expected. The results are summarized in Table 15.1.

Note that, when partialed for age, the correlations are significant in both locations only between BDT and encoding, and they are quite small (.13 and .15). Even between the two measures, the correlations are not as high as one might have expected for tests supposed to represent the same dimension (.35** [.33**] in Varanasi, and .57** [.21**] in Kathmandu, for respectively Pearson and partialed coefficients).

Nevertheless, the results do not argue against the existence of a more general spatial ability, partially measured by the BDT and SPEFT tasks and also by general processing speed on the central hemispheric dominance task, and this spatial ability may influence both G language and G encoding. At least, this is the structure that is suggested by the path models obtained in Varanasi and in Kathmandu.

Table 15.1. *Pearson correlations (and partial correlations controlling for age) between language and encoding and spatial ability measures*

		Varanasi		Kathmandu	
		Pearson r	Partial	Pearson r	Partial
Language	BDT	.14**		.37**	
	SPEFT	.19**		.32**	
Encoding	BDT	.16**	.13**	.41**	.15*
	SPEFT	.21**	.19**	.24**	

Possible neurophysiological underpinnings

There are suggestions from neurophysiological research, using particularly fRMI, that there are different neurological pathways for the egocentric and the allocentric FoR. The latter, however, usually refers to using intrinsic spatial localizers, and there seems to be very little research dealing with a geocentric FoR. In our research (chapter 13), we explored possible links with peripheral lateralization (so-called handedness, but not only for hands but also feet, eye and ear), without finding any evidence. We also included an experiment designed to measure hemispheric dominance at the central level (accuracy and latency of response to stimuli presented in the right or left visual fields). Right-hemispheric dominance has been found in processing categorical information on a verbal task more than in global processing (e.g. features of male or female faces), and some authors (e.g. Taylor & Tversky, 1996) mention a possible link between right-hemispheric dominance and geocentric encoding.

Our research confirmed the effect in Varanasi, but not in Kathmandu, namely a better processing of words in terms of abstract categories (but not of faces) presented on the left linked to geocentric language and encoding. Hence, there is at least a slight indication that the geocentric FoR may be linked to right-hemispheric dominance, but the fact that the finding does not hold up in a second location keeps us from claiming any generality.

Our project also included a small study with brain-damaged patients, which showed that the latter had lower scores than a normal comparison group on measures of spatial ability (BDT, SPEFT) and knowledge of cardinal directions, but there was no difference in the use of geocentric language or encoding. The patients also showed some spatial disorientation (evident, for example, through bizarre alignments on the Animals encoding task), and greater disparity of peripheral lateralization. Overall, brain damage to the right hemisphere seemed to affect general spatial functioning rather than the geocentric FoR in particular.

Discussion

As we come to the final summing up of this project, we would like to emphasize a few points of method that we have covered in more detail elsewhere (Mishra & Dasen, 2007), in particular the constant interface between anthropology and psychology. It would have been difficult to carry out this research without a profound knowledge of the culture in each of the locations; in Bali, this was actually provided by an anthropologist, Jürg Wassmann, and his ethnographic field-work in that setting, as well as by the local research assistants. In India and in Nepal, it is the constant collaboration between an outsider (P. Dasen) and his local colleagues (R. C. Mishra, S. Niraula and their assistants) that provided the necessary linguistic and cultural knowledge to ensure – at least we strongly believe – the cultural appropriateness of the study and its tools. We used a lot of local ("emic") cultural knowledge, possibly more than becomes explicit when writing a volume such as this.

So, is this research an example of "indigenous psychology"? Since it deals with a concept (or, as we would say, a cognitive style) that is unknown in Western developmental psychology, we might claim it to be that. However, the tasks we used, both for language elicitation and for studying spatial encoding, as well as all the additional tasks or situations in particular sub-sets of the study, are, in fact, all "imported," even though we spent a considerable amount of time and effort to make sure that they were locally appropriate. The so-called encoding tasks are a case in point, since they were invented by Levinson's team, and used in many locations world-wide. Fortunately they happen to be quite easy to implement in a variety of situations, and, for at least some of them, with children as young as age 4. Our research strategy is typically that of comparative cross-cultural psychology, with the option that Berry *et al.* (2002) have called "universalist," i.e. neither absolutist (believing that the use of standard instruments across cultures is straightforward) nor relativist (claiming that comparison is impossible).

The demonstration of a common factorial structure to the three encoding tasks, presented above (Figure 15.1), is a good illustration of the cross-cultural methodology that first seeks a common structure, and then documents the cultural variations that deviate from the commonality.

The other rule that we took from cross-cultural psychology is the selection of samples, each chosen not just out of convenience, but because the locations were known to correspond to certain eco-cultural (including linguistic) features that were important for our hypotheses. And in each of these locations, we were careful to include fairly large samples, well representative of the population, and in each location, we carried out extensive and continuous field-work.

Finally, we can easily see in this research the interest, we might say even the necessity, of carrying out comparisons, be it between different sub-groups

within a country (such as the urban/rural comparisons) or cross-culturally. This allows us to ascertain on the one hand what is common, but also what is (slightly or completely) different. For example, we see that in all of our non-Western samples, geocentric spatial language develops quite early, but much earlier in Bali than in Kathmandu. We can also take these comparisons as replication studies. For some aspects of the results, for example, we do not find the same relationships in Varanasi and in Kathmandu, which prompts us to be more careful in generalizing our conclusions.

There are, of course, also several limitations to our research. For example, we have already mentioned the need for research in other cultural belief systems (Islam, Buddhism, animism), and the need for research in languages that apparently do not allow an egocentric FoR. This would allow the limits to a cognitive-style interpretation to be tested.

Finally, we may also question the usefulness of this type of research. It is "basic" research, that seems to have no application, at least no immediate and obvious application. At a time when research, particularly in the social sciences, and even more particularly in the majority world, is supposed to answer urgent questions and problems, we have not much to show! Hopefully, however, research like this, pointing to phenomena that are unknown in the Western world, and hence simply not studied, may be useful at least in pointing to the inherent ethnocentrism of much of our social sciences. In Bali, India and Nepal, it may allow our colleagues to teach something about human development that is locally relevant, and different from what is reported in the imported textbooks. In the rest of the world, it may hopefully point to the interest of putting our theories to the test through the cross-cultural method.

Appendix 1: Summary of instructions, questionnaires and coding schemes

Instructions for task administration

For all tasks align the tables on one of the main directions (e.g. north/ south).

1. Animals in a Row

Training: Child names animals.

Put 3 animals in a row, looking left, aligned south/north.

Tell the child s/he will have to remember "just how they are standing and which way they are looking." Avoid using any spatial language.

Hide the 3 animals behind cardboard or paper, give the child another set of the same 3 animals, and ask child to place them as they were before.

If the child does not pay attention to the alignment, repeat trial item and say "They all look to the same side" but avoid any other spatial language (such as left/right, or directions).

Items 1 to 5:

For each item, place 4 animals on table 1, ask child to remember them.

The fourth animal is always placed near the first animal in the row, either to the front or back (see record sheets: Order: RB, LF, LB, RF, LB). Then cover them with folded paper.

Child moves (slowly!) to table 2, receives appropriate 3 animals in his/her hands, and is asked to place them "just as they were there."

Select different combination of animals for each trial.

For trials 4 and 5, ask child what s/he did to remember the animals, and note answer on coding sheet.

For trials 6 and 7, move the second table to the side (or use a third table), and tell the child that this table will now be used. The child is to turn by 90° (and not 270°). Order: RB, LF.

2. Chips

Training on table 1:

Display 5 cards all with same orientation. Ask for description (if necessary, give it yourself: "Big red square, small blue square." Say: "You see, all five are the same." Take one card and rotate it by 90°. "Now one card is different from the others. Can you see how that might be?" (Do not use spatial language yourself, except, if needed "The red one is on this side, the blue one on this side."

"Now I want you to remember how that card is. How it is different from the other cards. Can you remember it?"

Remove the card, and set up 4 cards in a cross pattern such that each card has a different orientation. "Now look at these 4 cards. Which card is like the one you saw before?"

Repeat until two successes (if necessary, show inspection card at the same time as target cards).

Items 1 to 5:

"This time I'll show you one card here and I want you to remember it. You then have to select it from 4 cards that I will be setting up on the other table over there."

Show card 1. Set up display on other table. Child moves (slowly) to table 2. Allow child to return to table 1 if s/he cannot remember it; also, if child chooses one of the distractors (D), the child is given a second chance.

Return to table 1, and continue for 5 items. Note that the display of 4 cards has to be changed between items, except between items 4 and 5. Order: blue bottom, top, right, left, top.

For trials 6 and 7, move the second table to the side (or use a third table), and tell the child that this table will now be used. The child is to turn by 90° (and not 270°). Order: blue bottom, right.

3. Steve's Maze

Training on table 1:

Use map 0. "Here is a path around some fields. You start off here at the house, and you go in the direction of the path, all the way around, till you get to here (trace the path with your hand). You have to get from the end of the path back to the house. You can't go through the trees, nor can you cross these stones. You've got to go here between them" (trace route with finger).

Take 3 cards, and show that cards 0.1 and 0.2 will not lead back, but that 0.3 will. Shuffle cards. "Now show me the correct one again."

Training on table 2:

"Now I am going to ask you to remember this path, and later show you the cards on the other table, and ask you to choose one."

Display cards on table 2. If child selects A or R, continue; if D, ask to take card back to table 1 to check, and repeat training step 3.

Items 1 to 5:

For each item, display appropriate map on table 1, and choice cards on table 2, following the order on scoring sheet. Each time, show the end of the path and say "From here, you have to get back to the house." Let child inspect the map as long as s/he likes, but avoid letting him/her trace the route. Avoid any spatial language. The child goes slowly to table 2. Let child return to table 1 if s/he wants to. If child chooses D, repeat the item.

For items 4 and 5, ask "How did you remember the path?" and record answer.

4. Route description

Use same route as for "memory for objects and reverse route description." The child (C) has to give the experimenter (E) instructions of how to move a toy car along the path. If the instructions are ambiguous or not clear, E asks to clarify, but without giving any hints as to spatial language.

For example: C: "Go this way." E: "Which way do you mean, I can't see."

If the instructions are wrong, move the wrong way, but slowly, so that C can change to correct instructions.

Record all language used on the outline drawing, next to each relevant segment.

5. Perspectives (3 objects description)

Ask child for description of display from position 1; then also from positions 2. Record these descriptions. (Use codes A, B, C for the three objects). If the child says nothing, ask about each object in turn.

At position 2, rotate display by 180°, and ask again for a description.

Example of coding scheme

N	Subject number by age	
Sample (school)		1 private, 2 government, 3 Sanskrit
Gender		1 boys, 2 girls
N	Subject number by age	
Age	Age, checked from date of birth X = (x-1); 6 to x+5	
Sch	Class, school (grade)	
AnG	Animals, Number of G	0 to 5
AnD	Animals, Number of D	0 to 5
GG GE EG EE	Nb of items of each type of encoding	0 to 5
An4 An5	Encoding items 4, 5	
An4L An5L	Language used on items 4 and 5	
An6 An7	Encoding items 6 and 7 (90°)	GG GE EG EE
Ch	Same scheme for Chips	+ S = shape
St	Id. Steve's Maze	
RdG	Nb of G on route description	0 to 8
RdG+	Of which, nb correct	0 to 8
RdR RdR+	Id. for Relative	0 to 8
PerG	Nb of G on Perspectives	0 to 9
PerG+	Of which, nb correct	
PerSL* PerI *PerCL	Nb of SL (to the window, etc.), Intrinsic, Conventional Landmarks	
PerE	Nb egocentric on Perspectives	0 to 9
PerE+	Of which nb correct	
same	Same description on positions 1 and 2	0 no 1 yes
sameR	Id. position 1 and rotation	Id.
Fr1	Scheme used in position 1	MV MH QV QH QC ER EL EF EB
Fr2	Id. position 2	9 = non-codable
Fr3	Id. position 2 after rotation	

Personal data questionnaire used in Bali (version reproduced here is for use in the village)

Data pribadi (desa)

No: *Nama:*

Kelamin: L P

Grade:

Tanggal lahir anak:

Lama belajar di TK: Lama belajar di SD:

Pendidikan terakhir, ayah: Ibu:

Pekerjaan, ayah: Pekerjaan, ibu:

Kasta:

Apakah anda merupakan keluarga pindahan dari kota ke desa?

Jika ya, kapan anda pindah?

Apakah ada anggota keluarga anda yang bekerja di kota?

Jika ada, siapa?

Seberapa sering anak anda pergi ke kota (Singaraja)?

Media di rumah: Surat kabar Radio TV

Bahasa yang digunakan di dalam keluarga:

Catatan:

Child questionnaire, including scoring

Date: Location:

No: Name:

School: Class:

Parents' name:

Address:

Date of birth:

Languages spoken in the home (rank order of importance):

Bhojpuri B Standard Hindi H Sanskrit S Urdu U English E

Nepali N Other (specify) O

L1 1st language

L2 2nd

L3 3rd

A. Student's own mobility

V1 Do you ride a bicycle? YES 2 NO 0 SOMETIMES 1

V2 since when? Nb years

V3 Do you ride a motorcycle? YES 2 NO 0 SOMETIMES 1

V4 since when? Nb years

V5 How far is it from home to school?

1 less than 500 m

2 between 500 m and 2 km

3 more than 2 km

How do you go to school? (multiple answers possible)

V6 – by car or bus YES NO (1, 0)

V7 – by motorbike/scooter/three wheeler YES NO (1, 0)

V8 – by rickshaw or bike YES NO (1, 0)

V9 – on own bicycle/motorbike YES NO (1, 0)

V10 – walking YES NO (1, 0)

V11a How often do you go to the local market (e.g. Lanka)?

0 never

1 less than once a month

2 once a month

3 once a week

4 several times a week

5 every day

V11b How often do you go downtown (further than local market)?

0 never

1 less than once a month

2 once a month

3 once a week

4 several times a week

5 every day

B. Family mobility in city

Does the family own:

V12 – a car YES 1 NO 0
V13 since when? Nb years
V14 – one motorbike/scooter YES 1 NO 0
V15 since when? Nb years
V16 – several motorbikes YES 1 NO 0
V17 since when? Nb years
V18 – a bicycle YES 1 NO 0
V19 since when? Nb years
V20 – several bicycles YES 1 NO 0
V21 since when? Nb years
How often is the child taken for a ride

V22 in the car:	V23 motorbike/scooter:	V24 on a bicycle:
0 never	0 never	0 never
1 once a month	1 once a month	1 once a month
2 once a week	2 once a week	2 once a week
3 several times a week	3 several times a week	3 several times a week
4 every day	4 every day	4 every day

C. Activities outside of school

Type	Specify (multiple answers possible)	How often?	Distance from home	Comments
Tutoring		V25 0 never; 1 once a year; 2 several times a year; 3 once a month; 4 more than once a month; 5 once a week; 6 more than once a week; 9 uncodable blank: activity does not apply	V26 0 at home (or never) 1 < 500 m 2 500–2000 m 3 > 2 km	
Sports		V27	V28	

Type	Specify (multiple answers possible)	How often?	Distance from home	Comments
Artistic		V29	V30	
Shopping		V31	V32	
Chores, work		V33	V34	
Activities with peers		V35	V36	
Family outings		V37	V38	
Religious activities		V39	V40	
Other		V41	V42	

D. Contact with village

V43 Does the family have relatives in a village (or in several villages)?

YES 1 NO 0

(relatives = uncle, aunt, cousins, grandparents, both maternal and paternal)

V44 How often does a member of family go for a visit there?

(family: persons living in same residence)

0 never

1 less than once a year

2 once a year

3 several times a year

4 once a month

5 more than once a month

V45 How often do you go for a visit there?

0 never

1 less than once a year

2 once a year

3 several times a year

4 once a month

5 more than once a month

V46 Do you ever stay there for more than one week? YES 1 NO 0

V47 How often does a person from the village come for a visit?

0 never

1 less than once a year

2 once a year
3 several times a year
4 once a month
5 more than once a month

Family home questionnaire, including scoring

No: Name:
School: Class:
Parents' name: Address:
Date of birth:

A. Child's migration history

CM1 Was the child born in Varanasi/Kathmandu? YES 1 NO 0
If no:
CM2 1) where was s/he born? X 1 ANOTHER CITY X 0 VILLAGE
CM3 2) when did s/he move to Varanasi/Kathmandu? (year)
Code nb of years in city
If yes:
CM4 did s/he live in Varanasi/Kathmandu all the time? YES 1 NO 0
CM5 If no, where else did s/he live (for more than one year), and for how long?
Code nb of years in a village
CM6
Code nb of years in a city

B. Family migration history

FM1 Was the **father** born in Varanasi/Kathmandu? YES 1 NO 0
If no:
FM2 1) where was he born? X 1 ANOTHER CITY X 0 VILLAGE
FM3 2) when did he move to Varanasi/Kathmandu? (year)
Code nb of years in city
If yes:
FM4 did he live in Varanasi/Kathmandu all the time? YES 1 NO 0

FM5 If no, where else did he live, and for how long?
Code nb of years in a village
FM6
Code nb of years in a city
MM1 Was the **mother** born in Varanasi/Kathmandu? YES 1 NO 0
If no:
MM2 1) where was she born? X 1 ANOTHER CITY X 0 VILLAGE
MM3 2) when did she move to Varanasi/Kathmandu? (year)
Code nb of years in city
If yes:
MM4 did she live in Varanasi/Kathmandu all the time? YES 1 NO 0
MM5 If no, where else did she live, and for how long?
Code nb of years in a village
MM6
Code nb of years in a city

C. Socio-demographic data

FED Father's education:
0 None
1 Part primary (less than 5 years)
2 Full primary (5 to 8 years)
3 High school (9, 10 y.)
4 Intermediate (11, 12 y.)
5 Professional, technical
6 University
MED Mother's education:
0 None
1 Part primary (less than 5 years)
2 Full primary (5 to 8 years)
3 High school (9, 10 y.)
4 Intermediate (11, 12 y.)
5 Professional, technical
6 University

FOC Father's occupation:

0 unemployed

1 farmer, laborer

2 seller, carpenter

3 employee, public servant

4 managerial

MOC Mother's occupation:

0 housewife

1 farmer, laborer

2 seller, carpenter

3 employee, public servant

4 managerial

Which of the following are present in the home? (0 absent 1 present)

NEWS Newspaper 0 1

BOOKS Books 0 1

RADIO Radio 0 1

TV TV 0 1

VIDEOG Video games 0 1

LANG1, LANG2, LANG3 Languages spoken in the home (rank order of importance):

(codes for up to three languages)

Bhojpuri (B) Standard Hindi (H) Sanskrit (S) Urdu (U)

Nepali (N) English (E)

Other (specify) (O)

Number of children: NBM boys (Code nb) NBF girls (Code nb)

BIRTHOR Birth order of child: (Code ordinal nb among living siblings)

GDPAR Do the grandparents live with the family?

X 0 No X Yes (code number)

RES Residence: House 1 Flat 0

ROOMS Number of rooms: (Code nb)

RESQUAL Interviewer's assessment of quality of residence:

1 minimal

2 below average

3 average

4 good

5 luxurious

AFFL Interviewer's evaluation of affluence:

1 poor

2 modest

3 average

4 good

5 high

D. Spatial language

We are interested in the language the child may hear in the home to describe routes and locations.

1. Mother – Please give a description of the route from your home to the child's school (or some other route description):

G RL (right/left) CL M/D (that way, etc.) UP Other

Code nb of items of each type, including repetitions

Variables: mlg mlrl mlcl mld mlup mlother

- Place three objects on a table (as in Perspectives task), and ask to describe their location.

2. Father Please give a description of the route from your home to the child's school (or some other route description):

G RL (right/left) CL M/D (that way, etc.) UP Other

Code nb of items of each type, including repetitions

Variables: flg flrl flcl fld flup flother

- Place three objects on a table (as in Perspectives task), and ask to describe their location.

E. Various observations during visit

Language used in the home:

Appendix 2: Examples of language in each location

We give here some language examples related to the specific tasks we used in our study, hoping to satisfy at least partly our colleagues who are linguists.

Hindi

Perspectives: G

Peelaa	uttar,	laal	dakshin	aur	haraa	poorab	hai
Yellow	north,	red	south	and	green	east	is

Yellow is north, red south, and green east

Peelaa	poorab	dakshin	ke	kone	par,	laal	poorab	uttar	ke
Yellow	east-	south	of	corner	at,	red	east-	north	of

kone	par,	haraa	uttar-	pashchim	ke	kone	par	hai
corner	at,	green	north-	west	of	corner	at	is

Yellow is at corner of south-east, red at corner of north-east, green at corner of north-west

Peelaa	uttar	hai,	laal	uttar	hai,	aur	haraa	bhee	uttar	hai
Yellow	north	is,	red	north	is,	and	green	also	north	is

Yellow is north, red is north, and green is also north

Perspectives: E

Peelaa	baayen	hai,	laal	bhee	baayen	hai,	haraa	daayen	hai
Yellow	left	is,	red	also	left	is,	green	right	is

Yellow is left, red is also left, green is right

Peelaa	baayen	men	uupar	hai,	laal	baayen	men	neeche	hai,
Yellow	left	in	upside	is,	red	left	in	downside	is,

haraa	daayen	men	neeche	hai	
green	right	in	downside	is	

Yellow is left upside, red is left downside, green is right downside

Perspective: I

Peelaa	laal	ke	aage	hai,	laal	peelaa	ke	peechhe	hai
Yellow	red	of	ahead	is,	red	yellow	of	back	is
aur	laal	haraa	ke	bagal	men	is			
and	red	green	of	side	in	is			

Yellow is in front of red, red is back of yellow, and green is to the side of red

Perspectives: CL

Peelaa	mandir	kee-ore	hai,	laal	school	kee-ore	aur	haraa	talaab	kee-ore
Yellow	temple	toward	is,	red	school	toward	and	green	pond	toward

Yellow is toward temple, red toward school and green toward pond

Perspectives: SL

Peelaa	khirakee	kee-ore	hai,	laal	kursee	kee-ore	aur	haraa	deewaal	kee-ore
Yellow	window	toward	is,	red	chair	toward	and	green	wall	toward

Yellow is toward window, red toward chair and green toward wall

Perspectives: D

Peelaa	udhar	hai,	laal	bhee	udhar	aur	haraa	idhar	hai
Yellow	that way	is,	red	also	that way	and	green	this way	is

Yellow is that way, red also that way and green is this way

Road: G

Seedhe	pashchim	chaliye,	ab	uttar	mud-kar	chaliye,	ab
Straight-ahead	west	walk,	now	north	turn-ing	walk,	now
poorab	mudiye,	phir	uttar	mud-kar	jaayiye,	ab	pashchim
east	turn,	again	north	turn-ing	go,	now	west
jaaiye,	ab	dakshin	chaliye,	ab	uttar,	ab	pashchim
go,	now	south	walk,	now	north,	now	west

Walk straight ahead west, now walk turning north, now turn east, again go turning north, now go west, now walk south, now north, now west

Road: E

Seedha	jaaiye,	daayen	modiye,	ab	baayen	modiye,	seedhe
Straight ahead	go,	right	turn,	now	left	turn,	straight
lejaaiye,	ab	baayen,	ab	daayen	se	ghoom-kar	daayen
take,	now	left,	now	right	from	turn-ing	right
hi	rakhiye,	ab	baayen,	bas	pahuncha	diya	
to	keep,	now	left,	now	reached	made	

Go straight ahead, turn right, now turn left, take straight, now left, now turning from right keep to right, now left, now you have reached.

Road: I

Gaaya	ke-paas	jaaiye,	ab	baalti	kee-ore,	ab	helicopter	kee-ore,	car
Cow	to near	go,	now	bucket	toward,	now	helicopter	toward,	car
ke-paas,	ab	kettle	ke-paas	ab	haathee	ke- paas,	ab	ped	ke-paas
to-near,	now	kettle	to-near,	now	elephant	to- near	now	tree	to-near

Go near to cow, now toward bucket, now toward helicopter, near to car, now near to kettle, now near to elephant, now near to tree (objects are on the display)

Encoding tasks

Animals: G

Ghoraa,	haathee,	mor	uttar	dishaa	men,	sher	paschim	men	hai
Horse,	elephant,	peacock	north	direction	in,	lion	west	in	is

Horse, elephant, peacock in north direction, lion is in west

Ghoraa	poorab	dekh-raha	thaa,	aur	sher,	gaaya	aur	haathee	dakshin	dekh-rahe	the
Horse	east	look-ing	was,	and	lion,	cow	and	elephant	south	look-ing	were

Horse was looking east, and lion, cow and elephant were looking south

Animals: E

Teen	mere	baayen	side	dekh-rahe	hain,	ek	saamne
Three	my	left	side	look-ing	are,	one	front

Three are looking my left side, one (to) front

Chips: G

Laal	mere	dakshin	taraf	hai,	neela	uttar	taraf	hai
Red	my	south	side	is,	blue	north	side	is
Red is on my south side, and blue is north side								

Chips: E

Laal	daayen	side	hai,	aur	neelaa	waalaa	baayen
Red	right	side	is,	and	blue	one	left
Red is right side, and blue one (to) left							

Chips: I

Laal	waalaa	aage	hai,	aur	neelaa	waalaa	laal	ke	neeche
Red	one	ahead	is,	and	blue	one	red	of	below
Red one is ahead, and blue one below of red									

Steve's Maze: G

Rastaa	pahale	poorab	gayaa,	phir	ped	se	mud-kar	dakshin	taraf	gayaa
Path	first	east	went,	then	tree	from	turn-ing	south	side	went
Path first went east, then turning from tree went south side										

Steve's Maze: E

Raastaa	seedhe	se	baayen,	phir	daayen,	phir	baayen	gayaa	thaa
Path	straight	from	left,	then	right,	then	left	gone	was
Path was gone from straight (to) left, then (to) right, then (to) left									

Steve's Maze: Shape

Raaste	kee	banawat	dhyaan	men	rakhaa
Path	of	design	mind	in	kept
Kept design of path in mind					

Some examples of language use in Nepal

Nepali

Up/down

Pahad	tira	pharkeko	hunale
Mountain	toward	faces	as
Because (it) faces toward the mountain			
Tala	tira	hereko	chha
Down	wards	looked	has
(It) has looked downwards			
Undho-gaira	heko		hunale
Down going	is		as
Because (it) is going down			
Thado	bhayeko	hunale	
Standing up	is	as	
Because (it) is standing up			

Newari monolingual examples

Up/down

Bastupisin	kobi	soye	lagine	
Animals	down	face	because	
Because animals face downwards				
Kobi	twal	khinna	soya	lagina
Down	settlement	toward	facing	because
Because (it) faces towards the settlement downwards				

Terso

Mul	terso	juye	lagina
Path	straight	as	is
Because the path is straight			
Mul	ghumauro	juye	lagina
Path	curve	as	the
Because the path is curved			

Spatial language examples in Bali

English	Balinese	Bahasa Indonesian
North / to the sea	Kelod (in Singaraja)	Utara
South / to the mountain	Kaja (in Singaraja)	Selatan
East	Kangin	Timur
West	Kauh	Barat
Right	Kenawan	Kanan
Left	Kebot	Kiri
Front	Di malu (malu = first)	Muka (di muka, depan, di depan, kemuka)
Back	Uri (durinan)	Belakang, di belakang
Up	beduur	Atas
Up (go)	Menek	Naik
Down	Beten	Bawah
Down (go)	Tuun	Turun
Straight	Leser, beneng	Lurus
Curve, curving	Lengkong, melengkung	Melengkung
Curving	Cekokan	Cekung
Flat	Asah	Datar
Sea	Pasih	Laut
To turn	Melikuk, mengkol, mebelok	Belok
To face	Miap, marep, ngarep	Hadap, ngadep
Facing	Menghadap, ngarep, marep	Hadap, menghadap
To look, facing	Meliat, mulet	Melihat
To advance, to go	Maju, terus	Maju
Side, next to, parallel	Disamping	Samping
Diagonal	Ngeseng	Serong, mereng
Next to (east) eastwards, east of something	-an (e.g. danginan, dauhan, delodan, dajanan)	Sebelah (ex. timur)
South-east		Tenggara
Location In the direction of	Be+direction (bedauhne in the west) Pak, tung	Ara
Underneath	Beten	Di bawah
Small	Cenik	Kecil
Big	Gede	Besar
Near	Paak	Dekat
Most	Paling	Paling
Zig-zag	Mengkal-mengkol	Berliku-liku
At the corner	Bucu	Pojok
Then	Mara	Lalu, kemudian
Number	Angka	Angka
The way, path, road	Lurung, jalan	Jalan
To there	Kema	Ke sana
The same	Patuh	Sama
This	Kene	Ini
That	Ento	Itu

English	Balinese	Bahasa Indonesian
Turning	Pengkolan	Belokan
Because	Kerana	Karena
Middle	Ditengah	Tengah
Look like	Cara	Seperti
Red	Barak	Merah
Blue	Pelung	Biru
Shape	Bentukne	Bentuknya
Stone	Batu	Batu
Mountain	Gunung	Gunung
Snake	Lipi, lelipi	Ular

Examples of spatial language categories in Bali

Balinese (a) and Bahasa Indonesian (b)

Animals Task (explanations on items 4 and 5)
Geocentric

1a. Balinese

Buron	buron	marep	kaja
Animals		are looking	to mountain

Animals are looking south (to the mountain)

1b. Bahasa

Binatang	binatang	menghadap	ke	selatan
Animals		are looking	to	south

Animals are looking south

2a.

Penyu	Bebek	Ajak	Kambing	ade	bedangin	Lelipi	Kelod
Turtle	duck	and	goat	are	in east	snake	to north

Turtle, duck and goat are in east, snake to north

2b.

Kura kura	Itik	Dan	Kambing	Berada	Di	Arah timur	Ular	Menghadap	utara
Turtle	duck	and	goat	are	in	east direction	snake	face to	north

Turtle, duck and goat are in east direction, snake faces north

Egocentric

3a.

Telu	Nolih	Ke	Tengebot	Tiange	Abesik	Ke	Arep
Three	are looking	to	left side	my	one	to	front

Three are looking to my left side, one to front

3b.

Tiga	menghadap	ke	sebelah	kiri	saya	satu	ke	depan
Three	are looking	to	side	left	my	one	to	front

Three are looking to my left side, one to front

Chips Task (explanations on items 4 and 5)

Geocentric

4a.

Barak	Di	sisi	kaja	Tiange	Biru	Di	sisi	kelod
Red	in	side	south	my	blue	in	side	north

Red is on my south side, blue is on north side.

4b.

Merah	Di	Selatan	Saya	Biru	Di	Utara
Red	in	south	my	blue	in	north

Red is on my south side, blue is north side

Egocentric

5a.

Barak	Di	Sebelah	Kenawan	Ajak	Biru	Di	kebot
Red	in	side	right	and	blue	in	left

Red is on right side, and blue one to left

5b.

Merah	Di	Sebelah	Kanan	Dan	Biru	Di	kiri
Red	in	side	right	and	blue	in	left

Red is on right side, and blue one to left

Intrinsic

6a.

Biru	Di	Duur	barak	Ade	Di	Beten	Biru
Blue	at	above	red	is	at	below	blue

Blue is above, red is below blue

6b.

Biru	Di	Atas	Merah	Berada	Di	Bawah	biru
Blue	at	above	red	is	at	below	blue

Blue is above, red is below blue

Steve's Maze (explanations on items 4 and 5)

Geocentric

7a.

Jalan	Ane	Simalu	Nganginang	Lantas	Belok	ngajanang
Path	of which	first	to east direction	then	turn	to south side

Path first went east, then turned to south side

7b.

Jalan	pertama	ke timur	lalu	belok	ke selatan
Path	the first	to the east	then	turn	to south

Path first went east, then turned to south side

Egocentric

8a.

Jalan	Beneng	Ke	Kebot,	Lantas	Ke	Kenawan,	Lantas	Ke	kebot
Path	straight	to	left	then	to	right side	then	to	left

Path went straight to left, then to right, then left

8b.

Jalan	Lurus	Ke	Kiri	Lalu	Ke	Kanan	Lalu	Ke	kiri
Path	straight	to	left	then	to	right	then	to	left

Path went straight to left, then to right, then left

Perspectives

Geocentric

9a.

Barak	Di	Kelod	Gadang	Kaja	Ajak	Keranjang	kauh
Red	in	north	green	in south	and	baskets	in west

Red is north, green south, and the basket west

9b.

Merah	Di	Utara	Hijau	Selatan	Dan	Keranjang	barat
Red	in	north	green	in south	and	basket	west

Red is north, green south, and the basket west

10a.

Barak	Di	Bucu	Kaja kangin	Gadang	Di	Bucu	Kelod-kangin	Keranjang	di
Red	at	corner	south east	green	at	corner	north east	basket	at

Bucu	Kelod-kauh
corner	north west

Red is at corner of south-east, green at corner of north-east, basket at corner of north-west

10b.

Merah	Di	Sudut	Tenggara	Hijau	Di	Sudut	Timur laut	Keranjang	di
Red	at	corner	east south	green	at	corner	east north	basket	at
Sudut	Barat laut								
corner	west north								

Red is at corner of south-east, green at corner of north-east, basket at corner of north-west

Egocentric

11a.

Keranjang	Di	Kenawan	Gadang	Di	Malun	Tiange	Barak	Di	kebot
Basket	at	right	green	at	front	of me	red	at	left

Basket is right, green is in front (of me), red is left

11b.

Keranjang	Di	Kanan	Hijau	Di	Depan	Saya	Merah	Di	kiri
Basket	at	right	green	at	front	me	red	at	left

Basket is right, green is in front (of me), red is left

Intrinsic

12a.

Kotak	Di	Malune	Gadang	Gadang	Di	Durine	Kotak	Barak	ajak
Box	at	ahead of	green	green	at	back of	box	red	and

Keranjang	Di	Samping	Ane	gadang
basket	at	side	that	green

Box is in front of green, green is back of red box, and basket is at the side of green

12b.

Kotak	Di	Depan	Hijau	Hijau	Di	Belakang	Kotak	Barak	dan
Box	at	front	green	green	at	back	box	red	and

Keranjang	Di	Samping	Yang	hijau
basket	at	side	that	green

Box is in front of green, green is back of red box, and basket is at the side of green

Road task
Geocentric

13a.

Jemak	Terus	lurus	Belok	Kangin	Jani	Kaja	Bin	kangin	Belok
Take	ahead	straight	turn	east	now	south	again	east	turn

Kelod	Jani	Jemak	Bucu	Kelod kauh	Jani	Kangin	Jani	Kelod
north	now	take	corner	north-west	now	east	now	north

Take straight ahead, turn east, now south, east again, turn north, now take north-west corner, now east, now north

13b.

Ambil	Terus	Jalan lurus	Belok	Timur	Sekarang	Selatan	Lagi	Timur	Belok
Take	ahead	straight	turn	east	now	south	again	east	turn
Utara	Sekarang	Ambil	Sudut	Barat-laut	Sekarang	Timur	Sekarang	utara	
north	now	take	corner	west-north	now	east	now	north	

Take straight ahead, turn east, now south, east again, turn north, now take north-west corner, now east, now north

Egocentric

14a.

Megedi	Lurus	Terus	Belok	Kenawan	Jani	Belok	Kenawan	jani	
Go	straight	ahead	turn	right	now	turn	right	now	
Belok	kebot	Jani	jemak	lurus	jani	ke	kebot	kenawan	kebot
turn	left	now	take	straight	now	towards	left	right	left

Go straight ahead, turn right, now turn right, now left, take straight, now towards left, right, left

14b.

Pergi	lurus	terus	belok	kanan	sekarang	belok	kanan	sekarang	
Go	straight	ahead	turn	right	now	turn	right	now	
belok	kiri	sekarang	ambil	lurus	sekarang	ke	kiri	kanan	kiri
turn	left	now	take	straight	now	towards	left	right	left

Go straight ahead, turn right, now turn right, now left, take straight, now towards left, right, left

Appendix 3: Extracts from school manuals

Cardinal directions taught in schools: Nepal and India

After discovering that English-medium school children in Kathmandu were using geocentric language and encoding as much as Nepali-medium school children (see chapter 7), we enquired with the teachers whether the curriculum included the teaching of cardinal directions. Indeed, it does. The illustration in Figure A3.1 is from a grade 2 Nepali textbook.

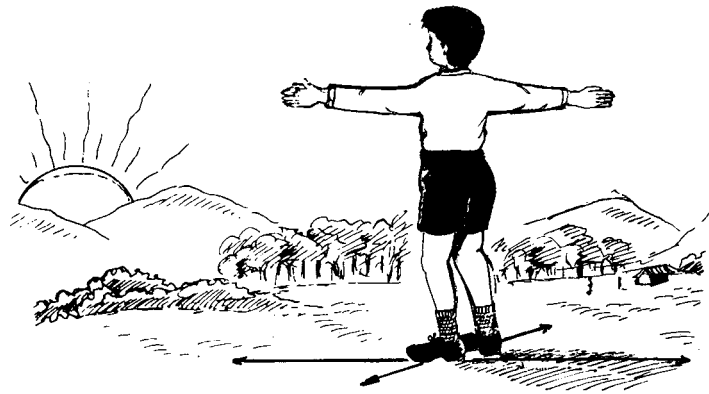
The following is a translation of the Nepali lesson.

Ways to know direction:

1. (A lady teacher is teaching class 2 students of a school. Sujan, Bina and Rena, along with many other students, are sitting on benches.)
2. Madame: Children, I am today teaching you the method to find out directions, OK!
3. Students: (with one voice) OK, Madame!
4. Bina: How to find out direction, Madame?
5. Madame: There are two ways to find out directions. First, I will teach you one of the methods. We have to go out to learn that method. Yes, let's go out! (All students move out.)
6. Madame: (Looking towards the sun at the sky) Yes, you tell me where does the sun rise in the morning?
7. Rena: (pointing at the hill toward the east) from that hill.
8. Madame: Is Rena right? You all tell (me).
9. All students: Yes, Madame.
10. OK, turn toward the place where the sun rises in the morning. (All turn and face toward the sun rising hill.)
11. Madame: (pointing to the hill with first finger) that is the east direction where you are looking at. The direction where the sun rises is the east. The sun always rises from the east. Did you understand?
12. All students: Yes, we understood, Madame. The direction toward rising sun is the east.

पाठ चौध

दिशा पत्ता लगाउने तरिका



(कुनै विद्यालयका दुई कक्षाका कोठामा गुरुआमा पढाउँदै हुनुहुन्छ। कक्षामा सुजन, बीना र रेनाका साथै अरू धेरै विद्यार्थीहरू बेन्चमा बसिराखेका छन्।)

गुरुआमा : नानीहरू हो, आज म तिमीहरूलाई दिशा पत्ता लगाउने तरिका सिकाउँछु है!

विद्यार्थीहरू : (एकै स्वरमा) हुन्छ गुरुआमा!

बीना : दिशा कसरी पत्ता लगाउने गुरुआमा!

गुरुआमा : दिशा पत्ता लगाउने दुईवटा तरिका छन्। तीमध्ये एउटा तरिका पहिले म तिमीहरूलाई सिकाउँछु। त्यो सिक्न बाहिर जानुपर्छ। ल, बाहिर हिँड त! (सबै विद्यार्थी बाहिर जान्छन्)

गुरुआमा : (अकाशको घामतिर हेर्दै) ल, तिमीहरू भन त,

Figure A3.1 Extract from grade 2 book, Nepali schools
Reproduced with permission from Awasti, M. & Bhandari, P. (2006). *Saral Nepali Srinkhala*. Kathmandu: Ekta Books (first edition 1990).

13. Madame: You have understood the way to find out the east direction. OK, listen to the other ways to find out directions, too. You are now facing toward the east where the sun rises. The place on your left hand side is the north direction. The place on your right hand side is the south direction.

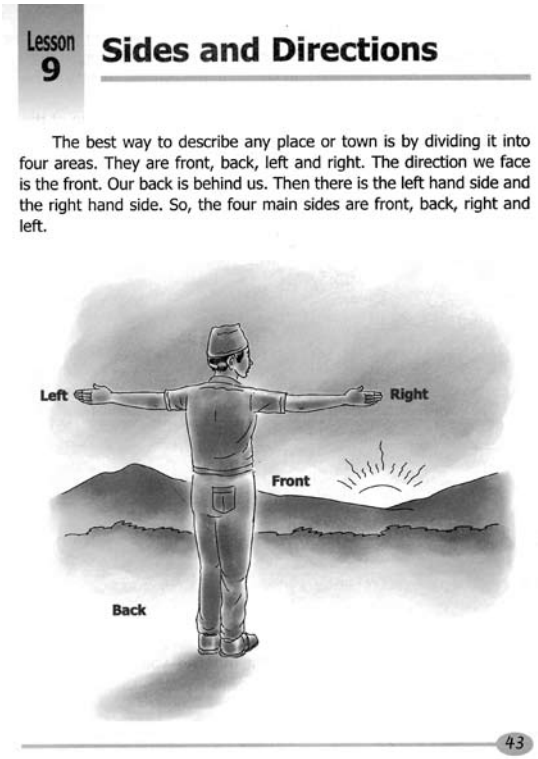


Figure A3.2 Extract from grade 2 book, English schools
Reproduced with permission from Chandra, T. (2009). *Our social studies, book 2*. Kathmandu: Ekta Books (first edition 1986).

You have understood the ways to find out the north and south. Now, the place behind you is the west direction. The sun always sets in the west. The sun setting direction is the west.

14. Sujan: Madame! Are there only four directions?
15. Madame: Yes, these are the main four directions east, north, south, and west.
16. Bina: Madame, we find out the directions by looking at the sun rising place during the day but how to find out the directions on a cloudy day and during the night?
17. Madame: You asked a right question. I had already told you there are two ways to find out the directions. I already taught you the way to find out the directions by looking at the sun. I now teach you the next way. OK, let us go to the class room. (All go to the class room.)
18. Madame: (showing the compass placed on her table) What is this? You all tell me.
19. Sujan: That looks like a clock, Madame!

We have seen the sunrise. We see it rising in the morning. It rises in the East. We have seen the Sun setting in the evening. It sets in the West.

We can take these two directions of the rising and setting of the Sun as East and West of the Earth.

When you face the rising sun in the morning, you are facing East. The rear will be West and your left hand will point North. South is the direction where your right hand points.

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Figure A3.2 (*cont.*)

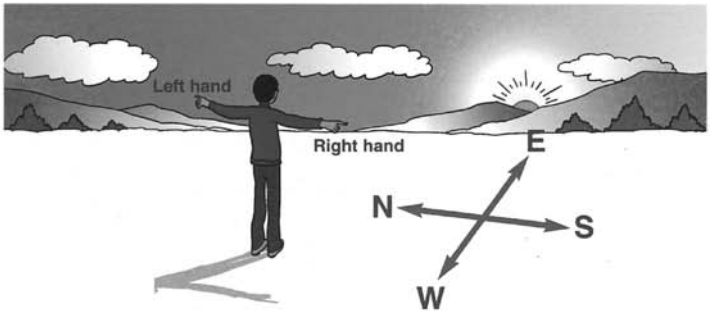
20. Madame: This is not a clock. This is a compass to find out directions. It helps us to find out directions during cloudy time and night time as well.
21. Bina: How does it find out directions, Madame?
22. Madame: (showing the compass), look; here is a needle in it. The needle always faces toward north and south. The tip of the needle always indicates toward north and the bottom toward south. The east direction lies on the right side and west direction lies on left side of this needle. You have to remember that the compass needle tip always shows the north direction. Did you understand? (The bell rings indicating the end of the class.)

Figure A3.2 is an extract from a grade 2 English book. The similarity between the pictures in the English manual and the Nepali one is quite striking, although the lesson starts more clearly with the egocentric LRFB references before moving to the cardinal directions. In previous versions of the books that we collected in 2004, the drawings looked even more similar in the two versions.

Figure A3.3 comes from a more recent book also used in the English schools in the form of test items.

Exercise 8 The Direction

A. In general there are four directions.



1. East = The sun rises in the East.
2. West = The sun sets in the West.
3. North = Our left hand-side when we face the East.
4. South = Our right hand-side when we face the East.

B. Fill in the blanks with the help of given words in the box.

1. The boy is facing _____.
2. The boy's back is facing _____.
3. The boy's right hand is pointing _____.
4. The boy's left hand is pointing _____.
5. The direction opposite East is _____.
6. The direction opposite North is _____.

West	South	North	South	East	West

Score: _____ Teacher's Signature: _____ Date: _____

Figure A3.3 Extract from grade 2 book, English schools
Reproduced with permission from Adon Rongong & Timothy Chandra (2009). *GK and IQ Test, book 2*. Kathmandu: Ekta Books (first edition 1989). p.12

Hindi school

We later enquired also in the Hindi-medium school of our study in Varanasi, and found much the same illustrations. Figure A3.4 illustrates one of these in a grade 1 book.

The poem that goes with this drawing translates as:

'Children, learn the things children should know; come let me tell you. The earth tells, the sky tells, in all there are four directions. The direction in which the sun rises in the morning, you stand facing that direction. The east direction is exactly in front of you; the back direction will be the west. To the left hand side will be north direction, and to the right will be the south. Children, there are four directions: east, west, north, south.'

In a grade 2 book, we found a similar picture with a boy, and the following text in Hindi:

With the help of the sun you can get the knowledge of directions. How?

In the morning if you stand having your face towards the rising sun, then towards your face will the east direction, towards the back the west direction, to the left hand side north direction, and to the right hand side will be the south direction. In this way, the directions are four: (1) east, (2) west, (3) north, (4) south.

Remember:

1. The sun is in the sky. In fact, it is a big ball of fire. The sun gives us heat and light.
2. In the morning the sun rises in the east, and in the evening hides (sets) in the west.
3. With the help of the sun, directions can also be known. At the time of sunrise if we stand facing towards the sun, then towards our face will the east direction, towards the back the west direction, towards the left hand the north direction, and towards the right hand will be the south direction. In this way, the directions are four:

   (1) east, (2) west, (3) north, (4) south.

Urdu school

Similarly, cardinal directions are taught in Urdu schools. Figures A3.5 and A3.6 are to be found in a grade 3 Urdu school book. The following is a translation of the Urdu lesson:

Methods of recognizing direction: after knowing the name of the directions it is necessary to recognize them so that we can read maps, get help while traveling or during dark nights. We can easily find out which direction lies where.

With the aid of the sun: At dawn, during sunrise, stand facing the sun and that becomes east, at the back of you lies west, towards your right is south and towards your left is north.

With the aid of the mosque: you will know that at the time of offering namaz, we face towards Kaaba sharif or the mosque and that is west, at the back is east, on the right is north and on the left lies south.

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दिशाएँ

बाल ज्ञान की बातें सीखो,
आओ बच्चों तुम्हें बताएँ।
धरती कहती अम्बर कहता
होती है कुल चार दिशाएँ।
सूरज उगता जिधर सबेरे
उधर खड़े हो मुँह करके तुम।
पूर्व दिशा है ठीक सामने
पीठ दिशा होगी पश्चिम।
बायें हाथ दिशा उत्तर की
दायें होगी दक्षिण।
बच्चो! चार दिशाएँ होतीं,
पूरब, पश्चिम, उत्तर, दक्षिण।

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Figure A3.4 Extract from grade 1 book, Hindi schools
Source: Rai, S.N. (n.d.). *Bhasha Manjari*. Kolkata 7: Shail Publication. Class 1. Based on National Council for Educational Research and Training (NCERT) pattern.

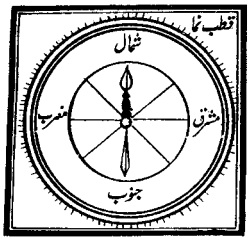
جگہ گھیرتی ہے وہ اس کا خاکہ کہلاتا ہے۔ اس سے کسی چیز کی جسامت۔
کا پتہ لگتا ہے کہ وہ گول ہے یا چوکور۔

سمت :-

تم اکثر کہتے ہوگے کہ فلاں مقام مشرق سمت ہے یا اللہ کا گھر
کعبہ شریف مغرب سمت ہے یا ہمارا مدرسہ شمال سمت ہے پس اسی
کو سمت کہا جاتا ہے یعنی سمت "معنی طرف"۔ یعنی ہم مشرق یا مغرب
طرف بھی کہہ سکتے ہیں۔ پورب پچھم، اتر، دکھن یہی چار سمتیں ہیں
جنھیں مشرق، مغرب، شمال، جنوب بھی کہتے ہیں۔ یعنی
پورب کو مشرق پچھم کو مغرب اتر کو شمال، دکھن کو جنوب۔

سمتیں پہچاننے کے طریقے :- سمتوں کا نام جاننے کے بعد
یہ ضروری ہے کہ انھیں پہچاننا بھی سیکھ لو تاکہ نقشہ دیکھنے کے
علاوہ سفر یا اندھیری رات میں تم آسانی سے پتہ لگا سکو کہ اس
طرف فلاں سمت ہے۔

سُورج کے ذریعہ :- سویرے سورج نکلتے وقت اس کی
طرف رُخ کر کے کھڑے ہو جاؤ تو ہمیشہ تمھارے سامنے مشرق یعنی پورب
پیچھے کی طرف مغرب یعنی پچھم، داہنی طرف جنوب یعنی دکھن اور بائیں



چمکتا ہوا نظر آئے گا۔ اس کے اردگرد سات تارے چکر لگا رہے ہوں گے
اس کو قطب تارہ دھرو تارہ کہتے ہیں۔ یہ تارہ ہمیشہ شمال کی طرف
نکلتا ہے۔ اس کے سامنے منہ کر کے کھڑے ہو جائیں تو سامنے شمال
پیچھے جنوب داہنی طرف مشرق اور بائیں طرف مغرب ہوگا۔

قطب نما کے ذریعہ :- سمت معلوم کرنے کا سب سے آسان
طریقہ قطب نما ہے۔ رات ہو یا دن ہم ہر جگہ اور ہر موقع پر اس
کے ذریعہ سمت کا پتہ لگا سکتے ہیں۔

پیتل کی چھوٹی سی ڈبیہ ہوتی ہے جس کے اندر لگی ہوئی سوئی کا

طرف شمال یعنی اُتر ہوگا۔

مسجد کے ذریعہ :- تمھیں معلوم ہوگا کہ نماز میں ہمارا رخ کعبہ
شریف کی طرف رہتا ہے۔ اس طرح کعبہ شریف یا مسجد کی طرف
رخ کر کے کھڑے ہو جائیں تو سامنے مغرب پیچھے مشرق دائیں ہاتھ
کی طرف شمال اور بائیں ہاتھ کی طرف جنوب ہوگا۔

قطب تارے کے ذریعہ :- سورج یا سایہ کے ذریعہ ہم اس
وقت سمت معلوم کر سکتے ہیں جبکہ دن ہو لیکن اگر ہم تاروں کی چھاؤں
میں پڑے ہوں تو پھر قطب تارہ ہی مددگار ثابت ہوگا۔

رات کے وقت شمال کی طرف دیکھو تو ایک تیز روشنی والا تارہ

Figure A3.5 Extract from grade 3 book, Urdu school
Source: Naasir (1989). *Istalahat geographiya*. Faizabad, UP: Danish book dipo Tanda. Lesson "simt" (directions).

With the aid of the Pole Star (North Star): with the help of the sun or shadows it is easy to locate directions in day time. But during night time the only help we can get is from the North Star. At night if we look northwards at the sky we can see a bright shining star and nearby are seven stars circling it. This is called the North Star or the Pole Star. It always appears in the northern sky. If we face it, then it is north, at our back is south, in the right hand we have east and at the left is west.

With the aid of a compass: the easiest way of locating directions, whether it be day time or night time, at every place and on every occasion is the compass. In a small copper box lies a needle of the compass which always points northwards and the opposite direction is south.

In Geneva, the teaching of cardinal directions is not in the curriculum and does not appear in any textbook or teaching manual. It is left to the initiative of the individual teacher.

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