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Spatial demonstratives and perceptual space: Describing and remembering object location

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ABSTRACT

Spatial demonstratives – terms including *this* and *that* – are among the most common words across all languages. Yet, there are considerable differences between languages in how demonstratives carve up space and the object characteristics they can refer to, challenging the idea that the mapping between spatial demonstratives and the vision and action systems is universal. In seven experiments we show direct parallels between spatial demonstrative usage in English and (non-linguistic) memory for object location, indicating close connections between the language of space and non-linguistic spatial representation. Spatial demonstrative choice in English and immediate memory for object location are affected by a range of parameters – distance, ownership, visibility and familiarity – that are lexicalized in the demonstrative systems of some other languages. The results support a common set of constraints on language used to talk about space and on (non-linguistic) spatial representation itself. Differences in demonstrative systems across languages may emerge from basic distinctions in the representation and memory for object location. In turn, these distinctions offer a building block from which non-spatial uses of demonstratives can develop.

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1. Introduction

The mapping between language and space has garnered much interest in the cognitive sciences. Space is regarded by many as a fundamental building block of language and cognition, and as a structuring tool for domains such as time and emotion (see for example Casasanto & Boroditsky, 2008; Lakoff, 1987; Lakoff & Johnson, 1980). Given its importance, one might expect to find considerable regularity across languages in how space is represented in language. Yet it has long been recognized that languages vary quite considerably in how they carve up space. For example, some languages have more words to describe containment and support relations than in English (e.g. Dutch), while others have less (e.g. Spanish, Indonesian; see Bowerman, 1996; Feist, 2008 for discussion). Some languages use cardinal directions to specify relations in table top space (e.g. Tzeltal), while others, English among them, prefer to use the viewpoint of the speaker or the relative positions of objects (Levinson, 2003). These (and other) differences are intriguing, and lead directly to two key questions regarding the mapping between language and space. First, do these language differences jeopardize a systematic mapping between language and the vision and action systems across speakers of languages (for different views on this, see for example Crawford, Regier, & Huttenlocher, 2000; Munnich, Landau, & Dosher, 2001)? Second, do speakers of different languages process the spatial world in different ways as a result of the language they speak (see for example Deutscher, 2010; Li, Abarbanell, Gleitman, & Papafragou, 2011)?

The main goal we have in this paper is to consider the mapping between language and space for arguably the most important spatial terms in all languages – spatial demonstratives (e.g. *this* and *that*). These terms occur in all languages, are high frequency terms within a language, and philologically emerge as the earliest traceable words in languages (Deutscher, 2005; Diessel, 1999, 2006). They are among the first words all children acquire (Clark, 1978, 2003) and are more closely associated with deictic gestures than many other linguistic items (Clark, 1996; Diessel, 2006). Yet they have been neglected from an empirical point of view. The main aim of this paper is to understand the conditions under which these essential terms are used, and how their use maps onto non-linguistic spatial representation and memory for object location. To do so, we present seven experiments demonstrating systematic overlaps between demonstrative choice and (non-linguistic) memory for object location.

The second goal we have is to consider the status of language differences across spatial demonstrative systems. The (often tacit) assumption in cross-linguistic research is that the lexicalized or overt distinctions a language makes are predictive of the distinctions speakers of that language employ when using that language. This assumption has led directly to a research industry looking at the consequences of these language differences for the mapping between language and non-linguistic systems on the one hand, and claims and tests of various forms of 'linguistic relativity' on the other (see Wolff & Holmes, 2010 for a recent overview). Our conclusion will be that more careful consideration regarding the nature of such language differences – in tandem with empirical investigation of spatial language choice and non-linguistic spatial representation together – reveals more commonality across speakers and languages than lexical distinctions might suggest.

The third goal is to consider constraints on the perceptual and mnemonic representations of space itself. The mapping between language and space is usually considered from the perspective of taking what is known about the vision and action systems and mapping that onto language. Here we also consider the reverse mapping: can distinctions in language provide clues to the nature of the mnemonic representation of space? We will conclude that distinctions in language can lead to a richer understanding of the nature of (non-linguistic) perception of space generally, and memory for object location specifically.

1.1. Spatial demonstratives across languages and perceptual space

Demonstratives occur across a range of linguistic contexts. A distinction is often made between *exophoric* use of demonstratives – where objects in the surrounding situation are referred to (Diessel, 1999; Halliday & Hassan, 1976) – and *endophoric* use, which includes demonstratives used in discourse reference, anaphoric reference and temporal reference. It is generally accepted that exophoric use of demonstratives is basic, with other uses derived from these spatial uses (see Diessel, 1999 for extensive discussion). In exophoric usage a demonstrative is taken to pick out the object being referred to in a spatial context (Enfield, 2003; Fillmore, 1982).

In a large-scale analysis of demonstrative systems across over 234 languages, Diessel (2005) found that the most basic distinction languages make is a binary distinction (54% of languages sampled; English among them). From this Diessel suggests that a proximal–distal contrast underlies demonstrative systems across languages (Diessel, 2005, 2006). However, as Enfield (2003) has noted, typologies are not based on actual studies of demonstrative use; the evidence that two-term demonstrative systems are proximal–distal is an assumption based on intuition alone. Only recently have a small number of experimental studies begun to examine the mapping between demonstratives and perceptual space.

Coventry, Valdés, Castillo, and Guijarro-Fuentes (2008) tested the mapping between perceptual space and demonstrative use using a methodology designed to elicit spatial demonstratives without speakers realizing that their language was being tested. English and Spanish-speaking participants were instructed to produce either *this* or *that* (or the Spanish equivalents: *este*, *ese*, *aquel*) to identify the position of colored geometrical shapes/disks on a table (whilst believing the experiment was about memory for object location). When the object was placed within arm's reach participants tended to use *this* (*este* in Spanish) more often than *that* (in tandem with pointing). They also used *this/este* more frequently when they had placed the object rather than when the experimenter had placed the object. Moreover an extension of the use of *this/este* to describe positions beyond arm's reach was found when participants pointed using a stick.

These and other findings (Bonfiglioli, Finocchiaro, Gesierich, Rositani, & Vescovi, 2009; Coello & Bonnotte, 2013; Maes & De Rooij, 2007; Stevens & Zhang, 2013) are consistent with work in neuroscience and neuropsychology that has identified two separate brain systems representing peripersonal (near) and extrapersonal (far) space (see for example Berti & Rizzolatti, 2002; Legrand, Brozzoli, Rossetti, & Farné, 2007; Làdavas, 2002). In particular the latter two findings in Coventry et al. mirror the results of studies on peripersonal space showing that contact with objects is important for the extension of peripersonal space, and that peripersonal space can be extended through tool use (e.g. Berti & Frassinetti, 2000; Longo & Lourenco, 2006).

While these studies suggest that spatial demonstratives do map onto perceptual space, demonstrative systems vary quite considerably across languages. Some languages have three-term demonstrative systems, which are usually regarded as distance oriented (Spanish: Kemmerer, 1999; Levinson, 2003), or person oriented (e.g., Japanese: Diessel, 2005). There are also other distinctions languages make, such as whether an object is visible or not (e.g. Tiriyó: Meira, 2003; Quileute: Diessel, 1999), whether or not an object is owned by the speaker (e.g. Supyire: Diessel, 1999), and whether the object is elevated on the vertical plan (e.g. Dyirbal, Lahu: Diessel, 1999).

Given these more 'unusual' distinctions in demonstrative systems one might think that the relationship between demonstrative systems and perceptual space – and the peripersonal versus extrapersonal distinction in particular – is in jeopardy (see for example Enfield, 2003; Kemmerer, 2006 for discussion). However, recent advances in understanding the nature of the periperpersonal–extrapersonal space distinction and findings on distance perception more broadly reveal much more richness to egocentric distance perception than an absolute near–far binary distinction suggests.

To begin with, it has been shown that near space is flexible. Not only can it be extended with tool use (Berti & Frassinetti, 2000; Holmes, Calvert, & Spence, 2004; Iriki, Tanaka, & Iwamura, 1996; Longo & Lourenco, 2006), but it can also be contracted (e.g. with the use of wrist weights; Lourenco & Longo, 2009), and the boundary from peripersonal to extrapersonal space is graded rather than absolute (Longo & Lourenco, 2006). Moreover, 'semantic' information about objects influences perception and memory for distance across a range of measures and paradigms, including memory for object location, verbal distance estimates to objects, throwing a beanbag towards an object, and visuomotor actions performed on objects. For instance desirable objects are perceived as closer than less desirable objects (Balcetis & Dunning, 2010; Valdés-Conroy, Román, Hinojosa, & Shorkey, 2012; but see Durgin, DeWald, Lechich, Li, & Ontiveros, 2011; Francis, 2012), owned object locations are remembered better (Cunningham, Turk, Macdonald, & Macrae, 2008) and are placed closer during interactions than non-owned objects (Constable, Kritikos, & Bayliss, 2011). And consistent with the findings of Longo and Lourenco (2006) on the contraction of peripersonal space, it has been shown that increased effort affects distance perception across a range of measures (see Proffitt, 2006, but also see Durgin, Klein, Spiegel, Strawser, & Williams, 2012).

These studies are among a battery of recent findings showing that the perception of space is not constrained solely by the characteristics of the physical environment, but is mediated by high-level knowledge about the objects being perceived. These advances in understanding perceptual space, we think, make some of the more 'exotic' demonstrative system contrasts across languages appear less arbitrary and much closer to grounding in non-linguistic spatial perception and memory. Moreover, if a common set of perceptual properties underlie demonstrative use, one might find that the distinctions lexicalised in some demonstrative systems are used by speakers of languages with demonstratives systems that do not make those lexical distinctions. By the same token, one should find direct parallels in performance comparing linguistic and non-linguistic tasks.

2. Overview of experiments and methods

In seven experiments we test a range of object knowledge parameters on demonstrative use in English, and on a non-linguistic version of the same tasks (immediate memory for object location). Experiments 1 (language) and 2 (memory) consider an object knowledge property which is both explicitly lexicalised in some demonstrative systems (e.g. Supyire) and has been recently shown to affect (non-linguistic) perception of object location – *ownership*. Experiments 3 and 4 take a second object knowledge property with is commonly lexicalized in Native American languages (e.g. Quileute, West Greenlandic: Diessel, 1999) and in other languages (e.g. Sinhala: Chandralal, 2010) – *visibility* – and tests whether this similarly affects demonstrative use in English (Experiment 3) and memory for object location (Experiment 4). Following on from the results of Experiments 1–4, Experiments 5 and 6 test a third object knowledge property we thought might also be a predictor of demonstrative choice and memory for object location – *familiarity*. Experiment 7 compares language and memory performance within participants to explore the direct mapping between them.

The language experiments (Experiments 1, 3, 5, 7) employed the method developed in Coventry et al. (2008) to elicit demonstrative use within a strictly controlled experimental paradigm (see Fig. 1). Participants played a 'memory game' where the goal of the game was to remember the positions of objects placed on colored dots along the midline of a large conference table. They were further informed that they were taking part in an experiment examining the effects of language on memory for object location and that they were in the 'language condition.' After each object placement, participants had to point to each object naming it using a combination of just three words: a demonstrative, an object property, and an object name (e.g., *this/that red circle; this/that pound coin*), so that everyone in the 'language condition' experienced the same level of language coding. This afforded collection of language data without participants realising that we were interested in their choice of demonstratives.

The memory experiments (Experiments 2, 4, 6, 7) utilized the same physical set up as the language experiments, but with some differences (see Fig. 2). The experiments were presented as memory for object location experiments (with no mention of language). For these experiments participants had to instruct the experimenter to move a stick (using the commands 'closer', 'further') to the location where an object had just been placed. This allowed a comparison of the estimated distance to the actual distance from the participant the object had been placed.

3. Experiment 1 – Ownership and demonstrative choice

The main goal of this Experiment was to examine the possible effect of ownership on demonstrative choice (*this* versus *that*) in English. Ownership provides an explicit structuring tool for some demonstratives systems (e.g. Supyire: Diessel, 1999), and may also be manifest in person-centred demonstrative contrasts common in languages that have more than two demonstratives (e.g. Japanese: Diessel, 1999; near the speaker, near the hearer, far from either). More generally, the concept of ownership appears to be universal across cultures (Brown, 1991), and ownership gives an object an enhanced status (Beggan, 1992).

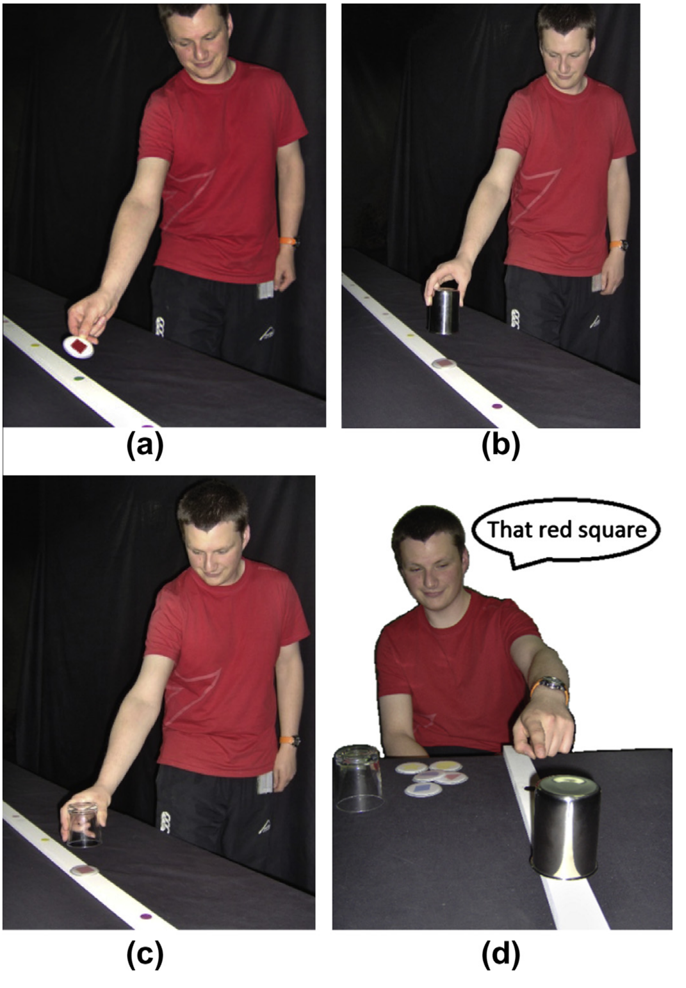

Fig. 1. Examples of object placements in the memory game. (a) –(c) Show the visibility conditions in Experiment 3 (where the participant placed the objects). (d) Shows a participant describing in the no visibility condition.

The experiment also tested two further variables that have been previously found to affect demonstrative choice; the (egocentric) distance of the object from the participant (with more frequent use of *this* in peripersonal space than in extrapersonal space) and who places the object (Coventry et al., 2008). The latter variable – who places an object – was of particular interest given the possible role of ownership as an explanation of its influence. Coventry et al. (2008) found that when the participant placed an object the use of *this* was more probable than when the experimenter placed the same object, and they interpret the effect in terms of peripersonal space: when a participant places an object it has been in his/her peripersonal space, hence the increased use of *this* following participant placements. However, an alternative – and equally plausible – explanation is that contacting an object instills a sense of object ownership, which may in turn inculcate a mapping between *this*-mine and *that*-yours. In the previous experiments ownership was not explicitly marked, and under such circumstances contacting an object may provide a marker of ownership (consistent with first possessor accounts of ownership – see for example Friedman & Neary, 2008). If this ownership account of 'who places' is correct, one would expect to find that making ownership clear would eliminate the

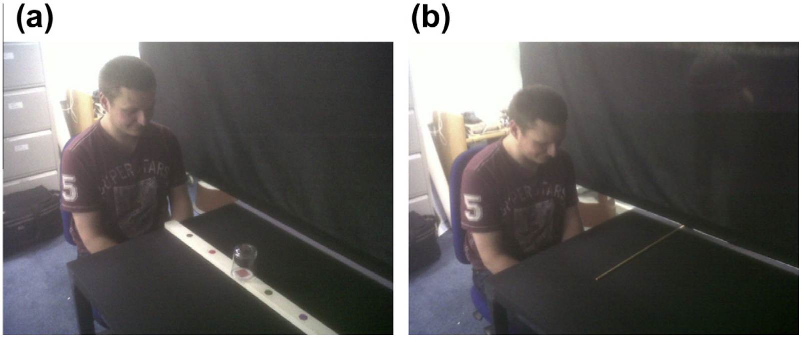

Fig. 2. Example of the setup in the memory experiments (Experiments 2, 4, 6, 7). (a) Shows the visible cover condition in Experiment 4. (b) Shows the stick position: the stick moved either towards or away from the participant according to the participant's instructions ('closer', 'further') until it was aligned with where the participant thought the object had been located (when they said 'stop').

'who places' effect. Alternatively, if the 'who places' effect has to do with contact in peripersonal space, one should find an effect of who places even in the face of explicit ownership demarcation. (Note that this latter interpretation is consistent with a recent philosophical account of demonstratives involving 'control' proposed by Brovold and Grush (2012)).

The experiment employed a 2 (ownership) × 2 (who places) × 9 (object distance) design.

3.1. Method

3.1.1. Participants

Twenty-five participants (4 male) were recruited from the student and local community populations. Their average age was 22 years (range 18–28 years), and all were monolingual native speakers of English. Participants took part for (nominal) payment.

3.1.2. Procedure

Participants were seated at a large conference table (75 cm wide and 320 cm long) on which 9 colored dots (each a different color) were placed at 25 cm intervals down the midline directly in front of participants, starting at 25 cm from the end of the table where they were seated. They played a 'memory game' where the goal of the game was to remember the positions of coins (see Fig. 1) placed on the dots.

At the start of the experiment participants were informed that they were taking part in an experiment examining the effects of language on memory for object location and that they were in the 'language condition.' They were first told that cards would be read out with a placement instruction (e.g., "You place your/my OBJECT NAME on red dot" or "I place your/my OBJECT NAME on red dot" – always read by the experimenter). Although some of the locations were well within the participants' and experimenters' reach, they were instructed that on every trial on which they were asked to place, they should stand up and walk to the side of the table to place the object. Following placement, participants were instructed to return to their seat and to point to each object naming it using a combination of just three words: a demonstrative, an object property, and an object name (e.g., *this/that red circle; this/that pound coin*), so that everyone in the 'language condition' experienced the same level of language coding. After verbal description, the object was retrieved by the person who placed it, and the next card was read out. Participants were told that they would be asked questions at the end of the game about where objects had been placed.

In this Experiment the participant and experimenter placed coins onto the colored dots. The manipulations were the distance the object was placed from the participant (9 distances), who placed the object to be described (2 placers), and the new manipulation of object ownership (owned by participants, owned by experimenter). In order to instill a sense of ownership over the placed objects, participants were given financial reward for taking part in the experiment (£4) in the form of a £2 coin, a £1 coin and two 50p pieces. They were paid at the beginning of the experiment and told that the coins would be used as stimuli. The experimenter had her own set of coins. The coins were placed in front of the participant and the experimenter, respectively. In half of the trials the participant placed the coins and in the other half the experimenter placed the coins. Half the time the participant and the experimenter placed their own coins and in the other half they placed the other person's coins. The participant identified the denomination of the coin (e.g. *this fifty pence coin*, *that one pound coin*) in every trial (including those where the experimenter placed).

There were 36 trials (fully randomized); the participant (and experimenter) placed their own and the experimenter's coins once on each of the nine locations.

At the end of the experiment (and at the end of the other experiments also), reaching distances were measured to ensure that the physical boundary between peripersonal space and extrapersonal was as expected (between locations 3 and 4 dots away from participants). This was confirmed. Moreover, in this experiment (and all the other experiments reported below) all participants used either *this* or *that* on all trials as the first term in their utterances as instructed, and on debrief no participants reported the use of the expressions feeling unnatural to them or inappropriate. This was important to note given some previous findings (Bangerter, 2004) that participants point less frequently at far distances when using verbal deixis than for near distances (at least in a task that involves picking out objects from among a large array of objects).

3.2. Results and discussion

Following Coventry et al. (2008), we calculated the percentage use of *this* for each participant for three regions of the table (see Table 1); the region in peripersonal space (the first three locations were reachable by all participants), the next three locations (in extrapersonal space), and the last three more distal locations. There were main effects of distance, $F(2,48) = 30.40$, $p < .0001$, partial $\eta^2 = .559$, and who placed the object, $F(1,24) = 5.79$, $p = .02$, partial $\eta^2 = .194$; participants used *this* most in peripersonal space ($M = 63\%$), less in extrapersonal space ($M = 32\%$), and least in the furthest locations ($M = 15\%$), and *this* was used more for objects placed by participants ($M = 40\%$) than when the objects were placed by the experimenter ($M = 30\%$). Of most interest was a main effect of ownership, $F(1,24) = 7.44$, $p = .01$, partial $\eta^2 = .237$ (Fig. 3). *This* was used more for the participant-owned objects ($M = 41\%$) than for the experimenter-owned objects ($M = 32\%$), regardless of who placed them (Fig. 3). None of the interactions were significant (all $F < 1.3$).

These data replicate the results of Coventry et al. (2008), showing that the use of *this* and *that* map onto the peripersonal–extrapersonal space distinction, and also that participant placement of an object results in a greater use of *this* compared to experimenter placements of those same objects. The results are also informative regarding the nature of the 'who places' effect. This effect is interpreted in

Table 1
Percentage of "THIS" responses in each condition across the three regions in Experiments 1, 3 and 5.

Experiment	Condition		Region 1 (25–75 cm)		Region 2 (100–150 cm)		Region 3 (175–225 cm)	
			Mean	SEM	Mean	SEM	Mean	SEM
1-Ownership	Participant Placed	Participant's Coins	68.00	6.52	48.00	6.69	18.67	5.80
		Experimenter's Coins	62.67	8.01	28.00	6.85	13.33	5.77
	Experimenter Placed	Participant's Coins	64.00	7.68	29.33	6.75	17.33	5.81
		Experimenter's Coins	56.00	7.87	24.00	5.62	9.33	4.52
3-Visibility	Metal (Occluded)		41.18	7.84	15.69	7.07	3.92	2.68
	Glass (visible but not touchable)		50.98	8.14	27.45	9.58	5.88	4.27
	No cover (visible and touchable)		60.78	7.69	21.57	6.35	9.80	4.75
5-Familiarity	Familiar Shapes		50.76	6.53	39.39	6.06	31.82	5.90
	Unfamiliar Shapes		33.33	6.39	28.03	5.94	33.33	6.30

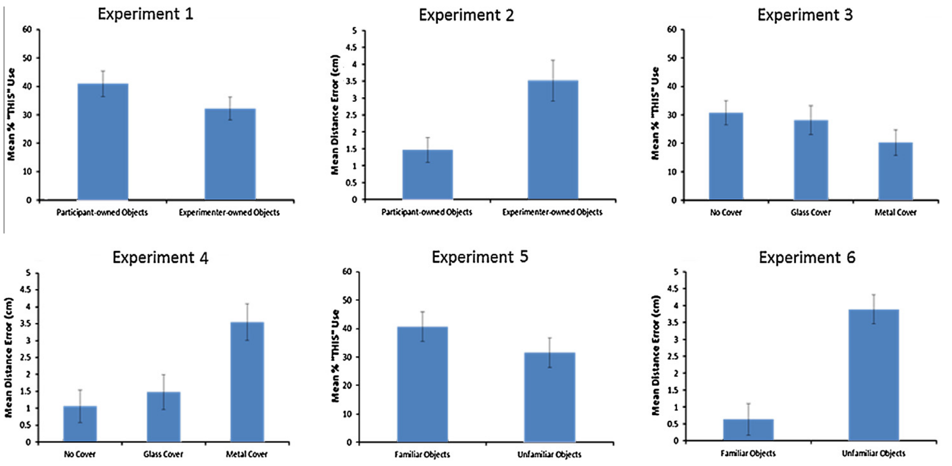

Fig. 3. Main effects of object knowledge found across Experiments 1–6. The top panel shows the results of the demonstrative experiments (mean percentage use of *this* by condition), and the bottom panel shows the memory results (mean signed distance errors: note that a positive value indicates remembering an object as being further away than it actually was). Error bars represent standard errors of the mean.

Coventry et al. in terms of contact with an object (in peripersonal space). We offered the alternative possibility that the 'who places' effect might be a result of contact and agency instilling a sense of ownership of the object. We have shown that ownership is indeed an important influence of the choice of *this* or *that* in English. However, the presence of a 'who places' effect even when ownership is explicitly indicated militates against the explanation that the 'who places' effect is about ownership.

4. Experiment 2 – Ownership and memory for object location

The goal of this experiment was to investigate the influence of ownership on immediate memory for object location. It has been argued that object location memory involves multiple components, including remembering objects, remembering locations, and the binding of objects to locations (Postma & De Haan, 1996). There is some evidence for the distinctiveness of these processes with respect to multiple object spatial arrays (see Postma, Izendoorn, & De Haan, 1998 for discussion), but little is known about the object to location binding process. One might think that location memory is all that is required when remembering the location of a single object, and that information about the object may be secondary. For example, Jiang, Olson, and Chun (2000) have suggested that location may act as an anchor for the features of an object to be bound to, and that as a consequence, object location memory is unaffected by object characteristics. Yet there is some reason to believe that object knowledge might affect memory for location.

It is well established that people exhibit memory errors for the last seen position of a moving object, misremembering the last position as further on in its projected path ('representational momentum'; Freyd, 1983; see Hubbard, 2005 for a recent review). Reed and Vinson (1996) found that representational momentum effects are mediated by knowledge of the object that is seen moving. For example, labeling the same object in different ways (e.g. a 'rocket' versus a 'cathedral') affects memory for the last position of that object when it is seen moving along its (expected) path. There is also some evidence that the gender stereotyping of an object affects memory for location (Cherney & Ryalls, 1999; Gallagher, Neave, Hamilton, & Gray, 2006). Hence, we thought it possible that other object knowledge properties also affect memory for static object location – with implications for accounts of object location memory.

Ownership as an object knowledge property is important for both memory for objects and words, and how people naturally interact with objects. Cunningham et al. (2008) had participants move cards into their own shopping basket or someone else's. Memory for the cards placed in their own basket was better than for those placed in someone else's basket. These results can be interpreted as an effect of ownership on memory. Interestingly, they found no effect of whether the object was moved by the participant or a conspecific, suggesting that ownership effects on memory are not the same as agency effects (further supporting our interpretation of the 'who places' effect found in Experiment 1).

Using a different method, Shi, Zhou, Han, and Liu (2011); see also Walla, Greiner, Duregger, Deecke, & Thurner, 2007) examined the effect of possessive pronouns (my/his Chinese equivalents) on reaction times to identify the color of the font nouns were written in. Participants were quicker to react to the nouns when the noun was proceeded by *my*. Moreover, in a surprise memory task nouns in the *my* condition were remembered better than those in the *his* condition.

Constable et al. (2011) provide direct evidence that ownership affects visuomotor interactions with objects. In one experiment, participants were instructed to reach and replace mugs either owned by them, the experimenter, or with ownership unmarked. Constable et al. found that movement patterns, including maximum acceleration of the arm during movement and lateral and dorsal distances traversed, were affected by ownership. In particular, objects owned were moved closer to the body than objects either owned by the experimenter, or unmarked for ownership.

Building on these earlier results we wanted to test whether ownership affects memory for object location when objects are presented in space at varying distances from the perceiver – and of course if effects of ownership and distance parallel the effects we have found for language in Experiment 1. In order to retain equivalence for the language experiments, we tested memory for coin locations placed on the dot locations used in Experiment 1, but we included additional locations so that dots were spaced at 12.5 cm distances (while also omitting some of the distances in extrapersonal space furthest away from participants).

The experiment employed a 2 (ownership) $\times$ 9 (distance) design.

4.1. Method

4.1.1. Participants

Twenty-two participants (4 male) were recruited from the student and local community populations. Their average age was 20 years (range 18–39 years), and all were monolingual native speakers of English. Participants took part for (nominal) payment.

4.1.2. Procedure

Participants were seated at the same table used in Experiment 1 (and in all the experiments), on which 9 colored dots (each a different color) were placed at 12.5 cm intervals down the midline directly in front of participants, starting at 25 cm from the end of the table where they were seated.

Participants were told that they were taking part in an experiment on memory for object location (language was not mentioned at all). They were then given their participation payment in the form of coins (as in Experiment 1), and were told that their coins would be used as stimuli in the experiment. On each trial participants watched the experimenter place either one of her own coins, or one of the participants' (which took 2 s) on one of the colored dots. This was done to match the experimenter places condition in the demonstrative experiment. Once placed, participants had 10 s to view the coin before being asked to close their eyes for 20 s. This gave the experimenter time to remove the dots and coin, and to get behind a screen (to avoid distracting the participant) and to position a measuring stick across the table. The stick was half the width of the table (attached to a set square for precision) and was placed at a set distance (10 cm or 20 cm) further away/nearer the participant than where the object had appeared. Two distances were used to prevent the stick placement becoming a cue for the object location. When the participant opened his/her eyes again, he/she indicated to the experimenter how the stick should be moved to be aligned with the near edge of the object (where it had been placed) using the commands 'closer', 'further', and 'stop'. On debrief participants did not spot any systematic stick placements (borne out in the memory data). At the beginning of the experiment participants were given 6 practice trials.

An important difference between this experiment (memory) and the language method (Experiment 1) was the absence of pointing in this experiment. The goal of this and the other memory experiments reported below was to investigate the influence of object knowledge properties on memory for object location. If participants pointed at an object while it was visible, this would have matched the method in the language experiments, but it may also have introduced a confound in a memory context. Pointing at an object when it is present provides an additional distance cue for recall. For that reason, participants kept their arms by their side in the present experiment (but see Experiment 7).

4.2. Results and discussion

The accuracy for object memory location was calculated by subtracting the actual distance of the object from the distance estimate (i.e. final position of the stick); positive numbers (in cm) indicate an object remembered as being further away from the participant than it actually was. The mean distance estimates are displayed in Table 2. These data were submitted to a 2(ownership) × 9(distance) ANOVA. There was a main effect of ownership, $F(1,21) = 25.26$, $p < .0001$, partial $\eta^2 = .546$. While generally there was a tendency to misremember objects as further away from participants than they actually were, estimates were more accurate for objects owned by the participants ($M = 1.46$) than for objects owned by the experimenter ($M = 3.52$). There was also a main effect of distance, $F(8,168) = 5.58$, $p < .0001$, partial $\eta^2 = .210$ (Table 2). The furthest three distances (in extrapersonal space) were associated with significantly further distance estimates relative to the actual distances than the nearest three locations (all $p < .05$). The interaction between distance and ownership was not reliable ($F < 1.5$).

Overall, participants were quite accurate in their memory for object locations (with a distance error of 3% on average), which suggests that guesses were minimal, and that the task was at the right level of difficulty. The effect of distance mirrors the effect found for Experiment 1. Distances unambiguously in extra-personal space were associated with remembering objects further away than they actually were compared to distances unambiguously in peripersonal space.

The effect of ownership found here is consistent both with the results of Cunningham et al. (2008) and Constable et al. (2011). The improved accuracy for objects owned by participants over objects owned by someone else mirrors the effect reported by Cunningham et al. (2008), but in the case of the present study objects were placed in the dorsal plane, and the memory measure was for object location rather than memory for objects. The data are also consistent with the direct object placements data found in Constable et al. (2011). In their case participants placed an object closer to themselves when they owned that object; in the present Experiment the object was remembered as being closer when it was owned by participants rather than owned by the experimenter.

More generally, the effect of ownership on object location memory is informative for theories of object location memory. In order to perform the task, participants could have ignored the object

Table 2
Absolute memory errors (cm) in each condition by distance in Experiments 2, 4 and 6.

Experiment	Condition	25 cm Mean (SEM)	37.5 cm Mean (SEM)	50 cm Mean (SEM)	62.5 cm Mean (SEM)	75 cm Mean (SEM)	87.5 cm Mean (SEM)	100 cm Mean (SEM)	112.5 cm Mean (SEM)	125 cm Mean (SEM)
2-Ownership	Participant's Coins	0.42 (0.54)	0.36 (0.45)	0.76 (0.58)	0.69 (0.6)	1.68 (0.49)	1.50 (0.7)	1.89 (0.69)	2.48 (0.72)	3.38 (1.15)
	Experimenter's Coins	0.35 (0.67)	0.94 (0.48)	2.83 (0.93)	2.60 (0.88)	3.03 (0.86)	3.91 (0.97)	6.74 (2.43)	5.11 (0.95)	6.14 (1.24)
4-Visibility	Metal (Occluded)	2.91 (2.09)	1.96 (0.55)	2.79 (0.7)	3.55 (1.02)	2.17 (1.07)	3.50 (0.71)	3.38 (0.76)	5.28 (1.02)	6.39 (1.08)
	Glass (visible but not touchable)	1.37 (0.42)	1.67 (0.82)	1.03 (1.13)	0.95 (1.07)	0.43 (0.99)	1.85 (0.76)	1.97 (0.99)	0.61 (1.17)	3.45 (1.00)
	No cover(visible and touchable)	−0.09 (0.29)	−0.65 (1.02)	0.52 (0.57)	−0.08 (0.73)	1.40 (0.93)	1.78 (0.52)	2.08 (0.97)	1.35 (0.91)	3.24 (0.92)
6-Familiarity	Familiar shapes	0.26 (0.47)	−0.24 (0.48)	−0.12 (0.56)	0.03 (0.8)	0.03 (0.59)	0.97 (1.09)	1.62 (1.10)	0.95 (1.26)	2.22 (0.94)
	Unfamiliar shapes	2.04 (0.44)	2.42 (0.76)	2.70 (0.69)	3.26 (0.83)	5.09 (1.00)	4.88 (0.87)	4.48 (0.78)	4.59 (0.67)	5.49 (0.85)

(who owns it), and could have focused on the location alone. The present data hint at the automaticity of object knowledge access in object location memory – a point we will return to later.

5. Experiment 3 – Visibility and demonstrative choice

In this experiment we examined the possible influence on English demonstrative choice of a second distinction that is commonly lexicalized across languages (Chandralal, 2010; Diessel, 1999) – visibility. To do so, the objects to be described were either uncovered, or covered with a metal (opaque) container or covered with a glass (clear) container of the same size. We included both visible and invisible covered conditions to control for physical accessibility (Enfield, 2003; Piwek, Beun, & Cremers, 2008); a covered (invisible) object is both invisible and inaccessible while a glass cover is visible but inaccessible. If visibility is important for demonstrative choice we expected that the use of *this* should be less frequent in the metal cover condition compared with the other two conditions. Note that such a result would be consistent with recent work on peripersonal space showing that visibility, not accessibility, affects reaching trajectories to objects following the observation of a conspecific (Griffiths & Tipper, 2009). If, on the other hand, physical accessibility is important, then there should be differences in demonstrative choice comparing both the covered conditions to the uncovered (control) condition.

5.1. Method

The method was the same as for Experiment 1, with three differences. First, the participant always placed the objects. Second, the objects to be placed were colored shapes on plastic disks 6.5 cm in diameter (as used in Coventry et al., 2008). Third, the visibility of the placed objects was manipulated. On placing the disks, participants either left them uncovered, or placed them and covered them with a glass or a metal container (8 cm in diameter and 9 cm high) – see Fig. 1.

5.1.1. Participants

Seventeen participants (5 male) were recruited from the student and local community populations. Their average age was 23 years (range 19–40 years), and they were all monolingual native speakers of English. Participants took part for (nominal) payment or course credit.

5.1.2. Procedure

The procedure was the same as that used in Experiment 1. The experimenter read out instruction cards indicating which disk to place on which uniquely colored dot, and whether or not the object was to be covered with the glass, metal container, or left uncovered. The experimenter read out the instruction of the form OBJECT NAME, DOT COLOR, COVER (e.g. “red square, blue dot, metal”).

5.2. Results and discussion

As in Experiment 1, we calculated the percentage use of *this* for each participant for the three regions of the table (displayed in Table 1). There was a main effect of distance, $F(2,32) = 22.24$, $p < .0001$, partial $\eta^2 = .582$, mirroring the effect found in Experiment 1. There was also a main effect of visibility, $F(2,32) = 8.24$, $p = .0001$, partial $\eta^2 = .340$. *This* was used less when the objects were covered with the metal container ($M = 20\%$) compared to either the glass cover condition ($M = 28\%$, $p = .02$) or the no cover condition ($M = 30\%$, $p = .001$). There was no difference between the uncovered and glass cover conditions ($p = .60$). The interaction between location and visibility was not reliable ($F = 1.2$).

The results of the covering manipulation favor an explanation based on visibility rather than physical accessibility. The absence of a difference between the glass cover condition and the no cover condition shows that preventing contact with an object does not affect demonstrative choice – it is whether the object is visible or not that matters. This does not rule out some notion of ‘mental’ accessibility as important for demonstrative choice (Piwek et al., 2008), but of course that begs the question as to what ‘mental’ accessibility actually is (something we discuss later). Moreover, if accessibility is generated in some way from a more basic spatial ‘physical’ accessibility or ‘control’ (see Brovold &

Grush, 2012; Maes, 2007), then the absence of an interaction between distance and the visibility manipulation is telling.

6. Experiment 4 – Visibility and memory for object location

Visibility is explicit in the demonstrative systems of some languages, and the previous experiment has shown that visibility matters for demonstrative choice in English. If the influence of visibility on demonstratives emerges from some non-linguistic perceptual impact of visibility, then one should find that visibility affects memory for/perception of object location. That was the goal of this experiment.

6.1. Method

6.1.1. Participants

Twelve participants (4 male) were recruited from the student and local community populations. Their average age was 29 years (range 19–57 years), and they were all monolingual native speakers of English. Participants took part for (nominal) payment or course credit.

6.1.2. Procedure

The procedure was the same as in Experiment 2, with one difference. The experimenter placed the colored disk for two seconds uncovered, and then either covered it or not and left it for a further 10 s (covered in the metal and glass conditions). The covers were always placed with the edge of the cover touching the near edge of the object (so that distances were equivalent in all conditions).

6.2. Results and discussion

The mean distance error estimates are displayed in Table 2. These data were submitted to a 3(visibility) × 9(distance) ANOVA. There was a main effect of visibility, $F(2,22) = 17.51$, $p < .0001$, partial $\eta^2 = .614$. While generally there was a tendency to misremember objects as further away from participants than they actually were, estimates were significantly further away relative to actual distance when the object was covered with the metal container ($M = 3.546$) than for either the objects covered with the glass ($M = 1.481$) or uncovered objects ($M = 1.061$)(both $p < .001$). There was no difference between the glass cover and uncovered conditions ($p > .05$). There was also a main effect of distance, $F(8,88) = 6.65$, $p < .005$, partial $\eta^2 = .249$. The distance estimates (relative to actual distances) for positions in extrapersonal space were higher than those in peripersonal space (see Table 2), but the only distance reliably greater than those in peripersonal space was the furthest distance (all $p < .001$). The interaction between distance and visibility was not reliable (both $F < 1$).

The influence of visibility on memory for object location mirrors directly the effect of visibility on demonstrative choice. Objects that are covered and not visible are recalled as further away than the same objects that were either covered with a glass (hence, still visible) or uncovered. Visibility affects memory for object location just as it affects how one talks about objects that are still co-present.

7. Experiment 5 – Familiarity and demonstrative choice

In this experiment we considered a further variable that had yet to be tested with respect to influence on demonstrative choice or distance perception/memory – familiarity. The motivation to consider familiarity was as follows.

Objects owned by a person are more likely to occur closer to a person (the owner) than objects that are not owned. Objects that are visible are more likely to be located near a person than objects that are not visible. By the same token, objects that are familiar to a person are more likely to occur near a person than objects that are unfamiliar. If this (simple) account of these effects is correct (and we elaborate on that account later), then familiarity should affect demonstrative choice and memory for object location.

A second motivation for testing familiarity (as we shall argue later, not unrelated to the account we have just given) comes from work on 'mental' accessibility. In the broader context of demonstrative use in discourse settings, (mental) accessibility is glossed as the ease with which particular mental entities/objects come to mind (Piwek et al., 2008). It is plausible that familiar objects may be more mentally accessible than unfamiliar objects with consequences for demonstrative choice (see Curby & Gauthier, 2009, for a related account of expertise and object categorization).

The (related) notions of learned associations between objects and locations, and mental accessibility of objects, were the motivation to test the possible impact of object familiarity on the use of *this* and *that*. It was predicted that *this* would be used more for familiar objects (e.g. red square, yellow circle) as compared with unfamiliar objects (e.g. viridian nonagon, cerulean ranunculoid).

7.1. Method

7.1.1. Participants

Twenty-two participants (3 male) were recruited from the student and local community populations. Their average age was 20 years (range 18–42 years), and they were all monolingual native speakers of English. Participants took part for (nominal) payment or course credit.

7.1.2. Procedure

The procedure was the same as in Experiment 3. After the general procedure of the experiment was explained participants were introduced to the shapes. For the unfamiliar shapes, participants were given time to practice pronunciation and recall of the names and colors of the shapes, so that they would then be able to correctly select the color/shape for placement and description. The training was successful as no participants failed to select the correct disk to place on any trial, and they were all correctly named when describing.

7.2. Results and discussion

Again, we computed the percentage use of *this* for each participant for each of the three regions (see Table 1). There was a main effect of familiarity, $F(1,21) = 7.40$, $p = .01$, partial $\eta^2 = .261$. Overall, *this* was used more frequently for familiar objects ($M = 41\%$) than for unfamiliar objects ($M = 32\%$). The effect of object location was not reliable, $F(2,42) = 2.20$, $p = .12$, partial $\eta^2 = .095$, though the direction was consistent with the data from Experiments 1 and 3. However, the interaction between familiarity and location was reliable, $F(2,42) = 4.59$, $p = .02$, partial $\eta^2 = .180$. The effect of location was present for familiar, $F(2,42) = 5.31$, $p = .009$, partial $\eta^2 = .202$, but not for unfamiliar objects, $F(2,42) = 0.54$, $p = .59$, partial $\eta^2 = .025$. *That* was used predominately for unfamiliar objects irrespective of location.

The main effect of object familiarity on demonstrative choice in English supports the idea that objects that are unfamiliar are expected to be further away than they are and/or the notion that familiar objects are more mentally accessible, with consequences for demonstrative choice. The absence of a main effect of distance in this experiment was driven by the lack of distance effect for unfamiliar objects. Consistent with the results of Experiments 1 and 3, the use of familiar objects produced an effect of distance. In contrast, when the objects were unfamiliar the use of *that* approached ceiling even in peripersonal space. The next experiment examines this influence of familiarity on memory for object location.

8. Experiment 6 – Familiarity and memory for object location

Object familiarity has been shown to affect demonstrative choice in the previous experiment. If the influence of familiarity on demonstratives emerges from some non-linguistic perceptual impact of familiarity, then one should find that familiarity should also affect memory for/perception of object location.

The role of familiarity has been considered extensively within a perceptual context where it has been shown that familiar objects are associated with improvement in short term visual memory capacity (e.g. Anaki & Bentin, 2009; Curby & Gauthier, 2009; Curby, Glazek, & Gauthier, 2009) and with increased ease of object tracking as a familiar object moves (Pinto, Howe, Cohen, & Horowitz, 2010). However, there is a paucity of research that looks at the impact of familiarity on memory for object location. Given the findings of the above experiments (and Experiment 5 in particular), we suspected that familiarity might also affect memory for object location.

8.1. Method

8.1.1. Participants

Nineteen participants (6 male) were recruited from the student and local community populations. Their average age was 28 years (range 19–47 years), and they were all monolingual native speakers of English. Participants took part for (nominal) payment or course credit.

8.1.2. Procedure

The procedure was same as in Experiment 4, with the addition of the same introduction to the familiar/unfamiliar objects as used as in Experiment 5.

8.2. Results

The mean distance error estimates were submitted to a 2(familiarity) × 9(distance) ANOVA. There was a main effect of familiarity, $F(1,18) = 82.25$, $p < .00001$, partial $\eta^2 = .820$. While generally there was a tendency to misremember objects as further away from participants than they actually were, estimates were more accurate for familiar objects ($M = 0.634$) than for unfamiliar objects ($M = 3.883$). The main effect of distance was also reliable, $F(8,44) = 4.46$, $p < .005$, partial $\eta^2 = .161$. The furthest four locations were associated with greater distance errors than for the nearest four locations (all $p < .05$). No other contrasts were reliable. The interaction between familiarity and distance was not reliable ($F < 1$).

These results show that object familiarity affects object location memory. We can consider possible explanations as to why this might be the case. One might think that unfamiliar object names may create greater memory load, resulting in poorer memory performance, but this was not the case – memory for object location for unfamiliar objects was similar to memory for familiar objects overall, and the direction of the errors were systematic rather than arbitrary. Consistent with the influence of object familiarity on choice of demonstratives (Experiment 5), the general tendency to misremember unfamiliar objects as further away than they actually were can be accounted for based on either some effort-based/accessibility-based parameter, where more effort to remember is associated with increased distance. Alternatively, the expectation that familiar objects are generally closer than unfamiliar objects may also account for this finding. As we argue below, consideration of the experimental results on balance militates in favor of an expectation-based account of both memory for object location, and choice of language to describe object location.

9. Experiment 7

Experiments 1–6 show parallels between spatial demonstrative choice to describe object location and memory for the distance an object is placed. But what is the nature of this relationship? There are several possible positions on the relation between spatial language and non-linguistic spatial representation, helpfully enumerated in discussions of the mapping between spatial adpositions and spatial representation by a range of authors (see Crawford et al., 2000; Landau & Hoffman, 2005; Munnich et al., 2001, for discussion). First, many have claimed that language is parasitic on non-linguistic spatial perception and memory, with language reflecting universal representations of space (Clark, 1973; Jackendoff, 1983; Landau & Jackendoff, 1993; Mandler, 1996; Talmy, 1983). More broadly, such a view is consistent with recent ‘embodied’ approaches to cognition, with language directly grounded in non-linguistic vision and action processes (see for example Barsalou, 2008 for a recent review). Second, it has been claimed by some that spatial categories themselves are shaped by language (Bowerman, 1996; Brown & Levinson, 1993; Levinson, 2003; Majid, Bowerman, Kita, Haun, & Levinson, 2004; Pederson et al., 1998). Therefore the specific language one speaks impacts upon the (non-linguistic) spatial categories one has – and this is most clearly the case when one can use language at encoding during a (supposed) non-linguistic task (for discussion see Li et al., 2011; Frank, Everett, Fedorenko, & Gibson, 2008). Third, some have argued that there may be a common set of constraints underlying both language and perception, and specifically that language and memory might both independently draw on the same set of spatial properties (Crawford et al., 2000).

The main goal of this experiment was to begin to unpack the relationship between demonstrative use and non-linguistic perception. To do so we first introduced a new condition into the memory paradigm, a verbal interference condition (modeled on Trueswell & Papafragou, 2010), where participants repeated phonemes out loud during exposure to the object in the memory game. If language is used as a tool to remember object location (Li et al., 2011; see also Frank et al., 2008), then the verbal interference condition should eliminate object knowledge effects. In contrast, if the object knowledge effects remain under conditions of verbal interference, one can assume that object knowledge effects either have to do with language drawing on non-linguistic spatial perception and memory, or that both the language of space and non-linguistic memory for object location are both affected by the same underlying processes.

The second goal of this experiment was to examine the relationship between object knowledge effects in language and memory for space directly by testing individual participants across both paradigms. If language is parasitic on memory for object location, then one should find that the people who exhibit the biggest effects of object knowledge on demonstrative choice should also show the biggest effects of object knowledge on memory for object location. In this Experiment we used a within participants design to test this hypothesis; each participant first took part in the memory experiment without verbal interference, with verbal interference, followed later by the language experiment.

The third goal was to iron out differences in the previous language and memory paradigms by using the same locations across all conditions and by getting participants to point during encoding in the memory conditions, thus making the language and memory paradigms identical. We chose familiarity as the object manipulation, given the interaction between familiarity and distance in Experiment 5 (the only interaction in any of the experiments), and the absence of this interaction in Experiment 6. Also, as a consequence of opportunity sampling in the previous experiments the majority of participants were female, leaving open the possibility that our results could be skewed given some previous findings of sex differences in memory for objects and object location (see Voyer, Postma, Brake, & Imperato-McGinley, 2007 for a review). Therefore we tested an equal number of male and female participants in this experiment.

The experiment employed a 2 (gender) $\times$ 2 (object familiarity) $\times$ 3 (task; memory without verbal interference, memory with verbal interference, language) $\times$ 6 (location) mixed design.

9.1. Method

9.1.1. Participants

Thirty-two participants (16 male) were recruited from the student and local community populations. Their average age was 23 years (range 19–38 years), and all were monolingual native speakers of English. Participants took part for (nominal) payment.

9.1.2. Procedure

The table set-up was the same as in the previous experiments. Nine colored dots were placed at 25 cm intervals down the midline directly in front of participants, starting at 25 cm from the end of the table where they were seated. But this time for both language and memory paradigms objects were presented at only the first 6 locations;3 in peripersonal space and 3 in extrapersonal space (to make the whole experiment a manageable length for participants).

The experiment was divided into three parts, presented in the same order for each participant. The first part examined memory for object location for familiar and unfamiliar objects, without verbal interference, using the methodology and colored shapes on plastic disks from Experiments 5 and 6.

One difference in this experiment, however, was that participants were additionally asked to point at the disks while viewing them in all conditions. There were 24 randomized trials, prior to which participants were given 6 practice trials.

Part two of the experiment was identical to part one expect that participants were asked to carry out an articulatory suppression task whilst viewing the disks. They were asked to repeat the sounds *Ba Be Bi Bo Bu* in a loop. This task was chosen as it has previously been used for spatial tasks (Garden, Cornoldi, & Logie, 2002), and is similar to the suppression procedure used by Trueswell and Papafragou (2010).

Part three of the study used the memory game methodology from Experiment 5 to tap demonstrative choice. Participants remained seated whilst the disks were placed by the experimenter. Participants were given 6 practice trials and 24 randomized trials.

9.2. Results and discussion

The data are displayed in Table 3. First we considered the language data. We computed the percentage use of *this* for each participant in peripersonal versus extrapersonal space. The data were analysed using a 2(gender) × 2(familiarity) × 2(location) mixed ANOVA. There was a main effect of familiarity, $F(1,30) = 13.04$, $p < .005$, partial $\eta^2 = .303$. Participants used *this* more for familiar objects ($M = 50\%$) than for unfamiliar objects ($M = 39\%$). There was also a main effect of object location, $F(1,30) = 12.29$, $p < .005$, partial $\eta^2 = .291$. Participants used *this* more for near locations ($M = 55\%$) than for far locations ($M = 33\%$). There was also a main effect of gender, $F(1,30) = 6.49$, $p < .05$, partial $\eta^2 = .178$. Overall women used *this* ($M = 52\%$) more than men ($M = 36\%$). None of the interactions were reliable.

These data replicate the effect of familiarity on demonstrative choice found in Experiment 5, but the interaction between familiarity and distance has been replaced here by a main effect of distance alone, consistent with the results of the previous experiments manipulating other object parameters. The main effect of gender found here on demonstrative choice suggests that future studies would do well to consider spatial language gender differences more comprehensively, but the absence of any interactions of the variables of interest with gender indicate that the results are robust across both men and women.

We next considered the memory conditions. The errors were analysed using a 2(gender) × 2(memory condition: no interference, interference) × 2(object familiarity) × 6(object location) mixed ANOVA. The results produced a main effect of object familiarity, $F(1,30) = 42.67$, $p < .0001$, partial $\eta^2 = .587$. Participants were more accurate for familiar objects ($M = 2.113$) than for unfamiliar objects ($M = 3.864$). There was also a main effect of object location, $F(5,150) = 20.42$, $p < .0001$, partial

Table 3
Language and memory data by object and distance in Experiment 7.

		25 cm Mean (SEM)	50 cm Mean (SEM)	75 cm Mean (SEM)	100 cm Mean (SEM)	125 cm Mean (SEM)	150 cm Mean (SEM)
Memory* (without interference)	Familiar shapes	0.74 (0.41)	0.73 (0.51)	1.18 (0.87)	2.17 (0.77)	3.42 (0.83)	4.73 (0.90)
	Unfamiliar shapes	1.53 (0.47)	1.68 (0.52)	3.92 (0.68)	3.37 (0.69)	5.31 (0.87)	7.68 (1.07)
Memory* (with interference)	Familiar shapes	0.93 (0.52)	1.48 (0.77)	1.92 (0.64)	1.82 (0.71)	2.31 (0.87)	3.91 (0.87)
	Unfamiliar shapes	2.41 (0.45)	2.37 (0.54)	4.02 (0.60)	3.89 (0.79)	4.07 (0.83)	6.13 (0.72)
Language**	Familiar shapes	68.75 (7.36)	57.81 (7.48)	48.44 (6.54)	46.88 (7.42)	39.06 (5.83)	37.50 (7.10)
	Unfamiliar shapes	57.81	51.56	48.44	23.44	32.81	18.75

* Absolute error (cm).
** Percentage use of “THIS”.

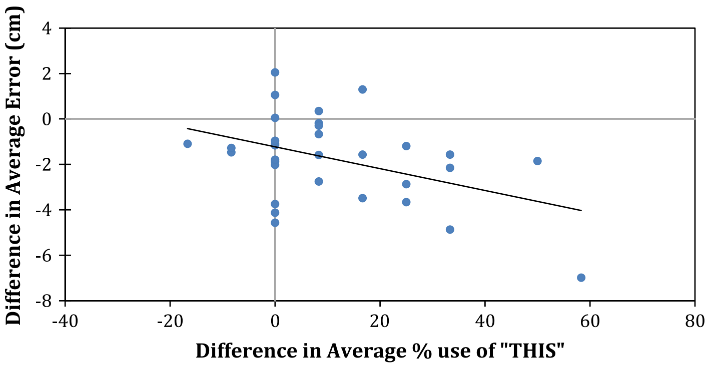

Fig. 4. Scatterplot showing the difference in average percentage use of "THIS" between familiar and unfamiliar conditions against the difference in average error between familiar and unfamiliar conditions.

$\eta^2 = .405$. The locations in extrapersonal space were associated with increased distance migration compared to the first three locations (all $p < .05$). None of the other main effects or interactions were reliable (all $F < 1.9$).

These results reveal that memory for object location is unaffected by verbal interference during the task; there were no interactions between condition and any of the variables of interest. So we can discount the possibility that participants in the memory tasks used language as a tool with which to aid their memory performance (see Frank et al., 2008; Li et al., 2011). We also failed to find any gender differences in object location memory, ameliorating possible concerns that the effects found in the previous experiments may be a consequence of the majority of participants being female.

Next we wanted to establish if there is a direct relationship between object location memory on the one hand, and language on the other. To do so, for each individual participant we computed the difference between the percentage use of *this* for the familiar versus the unfamiliar objects, and also the difference in memory for distance for the familiar versus the unfamiliar objects. The relationship between these measures is shown in Fig. 4. There was a significant correlation between measures, $r(30) = -0.431$, $p = .007$ (one-tailed). As participants exhibited a greater difference between the percentage use of *this* for familiar compared to unfamiliar objects, so too did they exhibit a greater difference in location memory for the familiar versus unfamiliar objects; a higher use of *this* for familiar versus unfamiliar objects is associated with a much greater (negative) difference in memory for distance for the familiar versus unfamiliar objects. This result is informative regarding the nature of the relationship between the use of demonstratives and (non-linguistic) spatial representation – a point we consider in detail below.

10. General discussion

The choice of spatial demonstratives in English has been shown to be affected by a range of new parameters – ownership, visibility and familiarity – in addition to parameters (e.g. distance) previously identified as important for their use. And corresponding effects have been found for a non-linguistic task tapping memory for object location. We first consider the language and memory results separately, before considering exactly how they map onto one another.

10.1. Spatial demonstratives

In all the demonstrative experiments there was a clear mapping between peripersonal versus extrapersonal space and choice of demonstratives in English. As objects move outside reachable distance into extrapersonal space, there is a graded fall off in the use of *this*, consistent with previous results using the memory game method (Coventry et al., 2008) and the graded nature of the transition from peripersonal to extrapersonal space (Longo & Lourenco, 2006). Experiment 1 also further tested between two accounts of the 'who places' effect (Coventry et al., 2008) – ownership versus previous contact in peripersonal space – coming down in favor of the latter.

The main results of interest are the new findings that ownership, visibility and familiarity all affect choice of spatial demonstratives in English. These results are important for three reasons. First, the motivation for testing these parameters came in part from distinctions made in the demonstrative systems of *other* languages. If a common set of parameters affect demonstrative choice across languages, then one should find that parameters lexicalized in some languages are nevertheless important for the choice of terms in a language that does not make those explicit lexical distinctions. We have found that this is the case. Visibility and ownership, explicitly lexicalized in languages such as Sinhalese and Supyire respectively, affect the choice of *this* and *that* in English. This provides a challenge to one of the main drivers of work commonly referred to under the rubric of 'linguistic relativity'. Testing for cross-cultural differences in (non-linguistic) cognition on the basis of language differences is often based on the assumption that lexical distinctions are what is important about those terms in a language. Speakers may use distinctions in their specific language as a tool with which to remember or process spatial information (see for example Li et al., 2011; Frank et al., 2008), but those distinctions do not necessarily capture how those terms are actually used within a language, nor the mapping between that language and the perceptual systems of those speakers.

Building on the current results, it will be important to test speakers using the memory game across a range of languages employing different demonstrative systems to establish if the explicit distinctions demonstrative systems make translate into greater weighting for those parameters. For instance in a language, such as Sinhalese, which purportedly makes lexical distinctions based on object visibility, it will be informative to see whether visibility impacts upon demonstrative choice more than it does for English, which does not lexicalise visibility explicitly (but does exhibit a large visibility effect nevertheless). In that regard, it is worth noting that distance in English impacted upon demonstrative choice more than any of the object knowledge effects in the present Experiments (see Table 1), and English has been assumed by most researchers to exhibit a proximal–distal demonstrative contrast.

The second reason why these effects are informative is that they offer rare data about demonstrative usage collected in a tight experimental setting. As Enfield (2003) has noted, most work on demonstratives has been based either on intuition, or collected from (often restricted) discourse contexts where the spatial environment being referred to is not present. Under these conditions it is hard to infer anything about the mapping between spatial demonstratives and perceptual space, and indeed one might argue that assumptions about the meaning of demonstratives across languages are on shaky ground. In contrast, the memory game task setting affords experimental control while also eliciting spatial demonstratives without participants being aware that demonstrative choice is being investigated. Although not a dialogical setting, we believe that the control the method offers gives good data regarding actual demonstrative use, more than compensating for the absence of complete conversational and naturalistic authenticity.

Third, the demonstrative data on their own challenge previous accounts of the meaning of demonstratives which have attempted to reduce their meaning to a single catch-all parameter. Several accounts of demonstratives have assumed that *this* and *that* in English, when used spatially, map onto a clean binary proximal–distal contrast from which other uses originate (Diessel, 2005; Maes, 2007). Moreover, Maes (2007) has proposed that a near–far image schema also affords extension to other types of (endophoric) demonstrative use. In spite of evidence in our experiments that the peripersonal–extrapersonal distinction is important for demonstrative choice, this distinction does not account for effects of visibility, ownership and familiarity. In particular, the absence of interactions between any of these variables and distance suggests that demonstrative choice in English is affected by more than a single parameter.

Leaving aside the peripersonal–extrapersonal distinction, some have argued that more discourse-related distinctions, such as joint attention, or more abstract notions such as accessibility, may rival a spatial distinction in terms of 'basicness' underlying demonstrative use (Burenhult, 2003; Piwek et al., 2008). Diessel (2006) proposes that both the indication of location of a referent relative to the deictic centre and coordination of interlocutors' joint attention focus are the two central (and closely related) functions of demonstratives. In an interesting analysis of Lao demonstratives gleaned from real interactive settings, Enfield (2003) offers a stripped back semantics for these terms, with rich pragmatic (situational) factors fleshing out the basic semantic notions of not-here for *nan* in Lao (equivalent of *that*) and no information for *nii* (equivalent of *this*). Enfield assumes that the association of *nii* with proximal comes from rich contextual knowledge (pragmatics), rather from any core spatial knowledge associated with the semantics.

It is undeniable that demonstratives can be used in a variety of different contexts, and it has been shown convincingly that common ground plays an important role in the use of these terms in dialogical settings (Clark, 1996; Clark, Schreuder, & Buttrick, 1983). Yet acknowledging that demonstrative use is rich and varied does not undermine the idea that spatial demonstratives might also be used in systematic ways mapping onto the perception of space. In our experiments the experimenter and participant were sitting side-by-side, with equal object visibility. And the interaction between participant and experimenter was minimal, meaning that the focus was on the spatial determinants of demonstrative choice. In this context, we think it unlikely that the effects found are 'pragmatic' in the sense proposed by Enfield (2003). Moreover, there is evidence that more pragmatic determinants of demonstrative choice appear later on in development (see Küntay & Özyürek, 2006), consistent with the view that spatial demonstrative use based around a deictic centre is primary, with other uses emerging later.

Consideration of spatial demonstratives in light of research on other types of spatial language also provides a challenge to the view that a single parameter might act as a catch-all for the semantics of these terms. Reviewing a large body of experimental studies examining how the comprehension and production of spatial prepositions covaries with changes to the relative positions of objects and object properties, Coventry and Garrod (2004) conclude that words such as *in* and *over* are dependent on several interlocking parameters (geometric relations, object knowledge, and dynamic functional relations between objects). So why would one expect spatial demonstratives to only be about geometric location or object knowledge?

While consideration of the demonstrative results on their own merits attention, it is only through comparison with non-linguistic task data can one establish whether there is a mapping between language and non-linguistic spatial representation. As we argued at the outset, linguists have often used somewhat caricatured notions of the near–far space with which to argue for or against a perceptual grounding for demonstratives. Next we consider the data from the sister (non-linguistic) spatial memory experiments showing that memory for object location is affected by multiple constraints paralleling the language data.

10.2. Perception and memory for object location

Memory for object location is taken to involve memory for the location in which an object is placed, memory for the object, and a binding between object location and object (Postma & De Haan, 1996). In contrast to the view that object location is primary (Jiang et al., 2000), our results show systematic distance migrations as a function of object ownership, visibility, and familiarity.

The influence of ownership on memory for object location builds on earlier studies showing enhanced memory for objects owned than for those not owned (Cunningham et al., 2008; Shi et al., 2011). However, in contrast to previous findings our experiments reveal more accurate memory for object location (rather than for object identity) when the participant owns that object than when the object is owned by someone else (i.e. objects misremembered as being further away than they actually were).

Familiarity exhibits a similar influence to ownership on memory for object location. Objects that are less familiar to participants are remembered as being further away than where they actually were. In both the case of ownership and familiarity, one might argue that perception of distance is partly determined by a concept of mental accessibility or mental connection to objects, where objects that are effortful to process or objects with reduced desirability through being owned by another (Beggan, 1992) are perceived as being further away. Such a perspective is consistent with results from recent work on distance perception arguing that perception of the physical environment is not easily disentangled from the desires and experiences of the perceiver (Balcetis & Dunning, 2010; Proffitt, 2006). For example Balcetis and Dunning (2010; but see also Durgin et al., 2011; Francis, 2012) had participants throw a beanbag to an object as a measure of perceived distance to it, finding that participants underthrew the bean bag for a desirable object (a $25 gift card) and slightly overthrew it when it had a $0 value.

On closer inspection the results from the ownership study are not easily accounted for in terms of some mental concept of accessibility, desirability, or effort – nor in terms of physical accessibility. In Experiment 4 we manipulated both accessibility to an object (blocking access to it through the object being covered or uncovered) and visibility (using a metal cover versus a glass cover). If accessibility to the object is important, we would have expected that memory for object location would differ between the uncovered condition and the two covered conditions. In contrast, the results showed clear differences between the metal cover condition where the object was not visible (following covering) and both the covered visible and uncovered (visible) conditions. This suggests that visibility, not accessibility, is the origin of the differences. So how can this result be accommodated within a model of object location memory?

Taken together, the results can be most parsimoniously explained through a model where the distance an object is expected to be located is combined with the actual distance an object is located (with an associated estimation error) in memory, as follows:

$$M_D = f(D_a, D_{\text{exp}}, D_{\text{err}})$$

where M = signed memory error, D = distance, $_a$ = actual, $_{\text{exp}}$ = expected and $_{\text{err}}$ = estimation error.

For example, objects that are owned are expected to be nearer us than objects that are owned by someone else (and are placed nearer when we move them; Constable et al., 2011). Taking D_{exp} as the distance an object would usually be placed from a person, the M_D value is lower for the owned object than for the unowned object. (Note that M_D for the owned object is still an overestimate, which is likely to be a reflection of general estimation error, D_{err}.)

The familiarity results and the visibility results can be treated in the same manner. Objects that are not visible are expected to be on average much further away than objects that are visible. And it is also reasonable to assume that D_{exp} for objects that are unfamiliar would be much larger than D_{exp} for familiar objects. The data support this model (see Fig. 3), but further research will be required to populate the expected distance values and to assess their influence (within participants) on distance memory (M_D). .

Such a model can easily be accommodated within a memory framework. But one can also speculate regarding whether the expected location influence occurs early on in encoding of object location (i.e. during perception), or later in recall. Several studies examining perception of distance show similar results across methods varying in their susceptibility to postperceptual processes (see Balcetis & Dunning, 2010, for discussion), suggesting that the effects we have found may be perceptual rather than post-perceptual. Nevertheless, one possible way of delineating between the effects we have found for object location memory as encoding or retrieval effects is to vary the time interval between encoding and retrieval. One might expect an increasing influence of expected location the greater the time interval between encoding and retrieval if primarily postperceptual processes drive effects. This is worth testing in future studies.

The type of model we advocate here is consistent with the account of perception offered by Bar (2009), who claims that perception involves both top down prediction and bottom up sensory processing. Bar has argued persuasively that perception of the environment relies on memory as much as it does on incoming information, blurring the boundary between perception and cognition. Our data suggest that top-down expectations about objects do drive understanding of (and memory for) locational distance, consistent with prediction-driven accounts of perceptual understanding.

10.3. Demonstratives and perception in context

Across the experiments the manipulations of ownership, visibility, familiarity and distance have been found to affect both demonstrative choice and memory for object location. But what is the mapping between these results, and how do they inform understanding of demonstrative systems and perception of object location?

We delineated three possible relationships between the language of space and (nonlinguistic) spatial representation as a motivation for the design of Experiment 7. One of these possibilities – that language affects non-linguistic memory for object location – was explicitly tested with the introduction of a verbal interference condition in Experiment 7. The results showed that object familiarity effects do not diminish under conditions of articulatory suppression, thereby discounting the hypothesis, at least with respect to demonstratives, that the distinctions a language makes are used as a tool during the task to aid memory performance (Frank et al., 2008; Li et al., 2011).

This leaves us with two possible relationships between demonstratives and memory for object location. One position is that the use of language is parasitic on non-linguistic representations of space (Barsalou, 2008; Clark, 1973; Jackendoff, 1983; Landau & Jackendoff, 1993; Talmy, 1983). The other is that both the language of space and memory for object location are both subject to the same underlying constraints (Crawford et al., 2000).

In order to disentangle these two views, it is important to examine the patterning of results across the demonstratives and memory tasks. First, aside from one interaction between familiarity and distance that was not replicated in Experiment 7, the results of the demonstrative experiments and the memory experiments were strikingly similar. Distance from the participant impacts upon demonstrative choice and memory for object location the most (see Tables 1 and 2), and the effects of ownership, visibility and familiarity closely mirror each other. But the most direct relationship between them was established in Experiment 7 with a correlation between demonstrative use and memory for object location; participants showing the biggest influence of familiarity on demonstrative choice also show the biggest influence of familiarity on memory for object location. This pattern of results, in our view, strongly supports a model where the language of space is parasitic on (non-linguistic) vision and action representations. The alternative model proposed by Crawford et al. (2000) was motivated by divergence in performance on spatial language tasks (prepositions) and memory for position. In our data we find no such divergence, bypassing the need (on grounds of parsimony) for a third underlying variable to explain the relationship between our measures.

If demonstrative choice is parasitic upon the flexible perception of space, one can argue that the distinctions languages make in varied demonstrative systems may be a direct result of packaging available perceptual parameters in flexible ways also. To the peripersonal–extrapersonal space distinction we have added visibility, ownership and familiarity to the set of perceptual parameters affecting distance perception/memory for distance – but there will be others. In fact, if it is true that demonstrative distinctions come from perceptual distinctions, then the distinctions languages make in their demonstrative systems may themselves be informative regarding distinctions that are worth exploring with respects to perceptual space. For example, person-centred contrasts in demonstrative systems – my space versus your space – is a possible candidate that may affect basic perception of distance and memory for distance. In support of this, there is some evidence that people are sensitive to how another person may interact with an object from their point of view when they share space but nevertheless have a different perspective on it (Griffiths & Tipper, 2009).

The alternative interpretation of our results is that both language to describe space and perception of space are subject to the types of 'pragmatic' contextual constraints that have previously been reserved to supplement language semantics (see for example Enfield, 2003, for a pragmatic account of Lao demonstratives). This is certainly an intriguing possibility, but one that would require a radical shift in how one construes the act of perceiving. For now at least, the idea that demonstrative use in language is parasitic on non-linguistic representation of space still allows pragmatics in language to go beyond these constraints while also accounting for greater demonstrative coverage emanating from perceptual experience.

The idea that perception of distance/memory for distance are affected by a range of parameters that, in turn, affect how one talks about space, can be considered within the context of learning about and interacting with objects. Children learn associations between objects, locations, actions, and words (see Samuelson, Smith, Perry, & Spencer, 2011), and these associations affect how an event is perceived at any given moment in time. The peripersonal–extrapersonal distinction might emerge, as has been suggested by Bremner, Holmes, & Spence (2008), through experience of being able to reach and manipulate objects. Objects that can be reached and manipulated become distinguished from those that cannot be reached and manipulated. In a similar vein, objects that are owned are more likely to be nearer the owner than objects that are not owned. And objects that are visible are more likely to be nearer the viewer than objects that are not visible. Taken together, these learned associated might then lead to predictions about where an object is, conjoining the bottom up information about where the object actually is in the perception of distance (consonant with Bar, 2009).

Such a model might also give clues to patterning of demonstrative systems across languages. From a developmental perspective, the distinction between peripersonal and extrapersonal space emerges within the second 6 months of life. Experientially, this early distinction between contacting and not contacting an object can be regarded as foundational. Concepts, such as ownership, emerge much later, long after the action system is wired up (Friedman & Neary, 2008). On that basis, one might speculate that the peripersonal/extrapersonal distinction is a better candidate to provide a basic distinction for the world's demonstrative systems than ownership. This idea that the most basic vision and action processes are likely to be represented the most in spatial language across languages has a long history (see Clark, 1983), but such an approach needs to be tempered with the observation that language universals are hard to pin down (see Evans & Levinson, 2009).

While the present work supports a strong link between spatial demonstratives and perceptual space, it is important to remember that demonstratives across languages are used in a wide variety of ways, and in many non-spatial contexts. For example, demonstratives are often used contrastively ('this planet and that planet'), temporally ('this time and that time'), as well as serving many discourse (endophoric) functions (see Diessel, 1999; Piwek et al., 2008, for discussion). It is these other uses that have been taken as one of the main challenges to the idea that demonstratives are grounded in the vision and action systems (Kemmerer, 1999; Kemmerer, 2006). The inherent flexibility in both the perception of distance and the choice of language to describe object location provide a natural means from which other flexible functions of demonstratives may well originate.

11. Conclusions

There is a striking correspondence between spatial demonstrative choice to describe object location and (non-linguistic) memory for object location. Spatial demonstrative choice in English is much more similar to demonstrative contrasts in other languages than a simple binary proximal–distal contrast in English would suggest. The results reinforce the importance of the mapping between peripersonal and extrapersonal space and demonstrative choice – but with an enriched conceptualization of what memory for object location entails. Both language to talk about space and non-linguistic conceptualisation of space are influenced by a common set of high-level variables.

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Appendix A

List of objects used in Experiments.

Experiments 1 and 2 (ownership): 50p, £1, £2 coins.

Experiments 3 and 4 (visibility): red square, red triangle; blue semicircle, blue diamond, yellow heart.

Experiments 5 and 6 (familiarity): FAMILIAR OBJECTS – yellow heart, orange square, blue circle, red triangle. UNFAMILIAR OBJECTS – cerulean ranunculoid, viridian nonagon, chartreuse nephroid, aureolin undecagon.

References

Anaki, D., & Bentin, S. (1999). Familiarity effects on categorization levels of faces and objects. *Cognition, 111*, 144–149.
Balcetis, E., & Dunning, D. (2010). Wishful seeing: More desired objects are seen as closer. *Psychological Science, 21*, 147–152.

Bangerter, A. (2004). Using pointing and describing to achieve joint focus of attention in dialogue. *Psychological Science, 15*(6), 415–419.
Bar, M. (2009). The proactive brain: Memory for predictions. *Philosophical Transactions of the Royal Society of London Series B, 364*, 1235–1243.
Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology, 59*, 617–645.
Beggan, J. K. (1992). On the social nature of nonsocial perception: The mere ownership effect. *Journal of Personality and Social Psychology, 62*, 229–237.
Berti, A., & Frassinetti, F. (2000). When far becomes near: Remapping of space by tool use. *Journal of Cognitive Neuroscience, 12*, 415–420.
Berti, A., & Rizzolatti, G. (2002). Coding near and far space. In H.-O. Karnath, A. D. Milner, & G. Vallar (Eds.), *The cognitive and neural bases of spatial neglect* (pp. 119–129). New York: Oxford University Press.
Bonfiglioli, C., Finocchiaro, C., Gesierich, B., Rositani, F., & Vescovi, M. (2009). A kinematic approach to the conceptual representations of *this* and *that*. *Cognition, 111*, 270–274.
Bowerman, M. (1996). Learning how to structure space for language: A cross-linguistic perspective. In P. Bloom, M. A. Peterson, L. Nadel, & M. F. Garrett (Eds.), *Language and space* (pp. 385–436). Cambridge, MA: MIT Press.
Bremner, A. J., Holmes, N. P., & Spence, C. (2008). Infants lost in (peripersonal) space? *Trends in Cognitive Sciences, 12*(8), 298–305.
Brovold, A., & Grush, R. (2012). Towards an (improved) interdisciplinary investigation of demonstrative reference. In A. Athanassios & P. Machamer (Eds.), *Perception, realism, and the problem of reference* (pp. 11–42). Cambridge University Press.
Brown, D. E. (1991). *Human universals*. New York: McGraw-Hill.
Brown, P., & Levinson, S. C. (1993). "Uphill" and "downhill" in Tzeltal. *Journal of Linguistic Anthropology, 3*(1), 46–74.
Burenhult, N. (2003). Attention, accessibility, and the addressee: The case of the Jahai demonstrative *ton*. *Pragmatics, 13*(3), 363–379.
Casasanto, D., & Boroditsky, L. (2008). Time in the Mind: Using space to think about time. *Cognition, 106*, 579–593.
Chandralal, D. (2010). *Sinhala*. Amsterdam: John Benjamins.
Cherney, I. D., & Ryalls, B. O. (1999). Gender-linked differences in the incidental memory of children and adults. *Journal of Experimental Child Psychology, 72*, 305–328.
Clark, E. V. (1978). From gesture to word: On the natural history of deixis in language acquisition. In J. S. Bruner & A. Garton (Eds.), *Human growth and development* (pp. 85–120). Oxford: Oxford University Press.
Clark, E. V. (2003). *First language acquisition*. Cambridge: Cambridge University Press.
Clark, H. H. (1973). Space, time, semantics, and the child. In T. E. Moore (Ed.), *Cognitive development and the acquisition of language*. New York: Academic Press.
Clark, H. H. (1996). *Using language*. Cambridge: Cambridge University Press.
Clark, H. H., Schreuder, R., & Buttrick, S. (1983). Common ground and the understanding of demonstrative reference. *Journal of Verbal Learning and Verbal Behavior, 22*, 245–258.
Coello, Y., & Bonnotte, I. (2013). The mutual roles of action representations and spatial deictics in French language. *Quarterly Journal of Experimental Psychology, 66*(11), 2187–2203.
Constable, M. D., Kritikos, A., & Bayliss, P. (2011). Grasping the concept of personal property. *Cognition, 119*, 430–437.
Coventry, K. R., & Garrod, S. C. (2004). *Saying, Seeing and Acting. The psychological semantics of spatial prepositions*. Hove and New York: Psychology Press, Taylor & Francis.
Coventry, K. R., Valdés, B., Castillo, A., & Guijarro-Fuentes, P. (2008). Language within your reach: Near-far perceptual space and spatial demonstratives. *Cognition, 108*, 889–898.
Crawford, L. E., Regier, T., & Huttenlocher, J. (2000). Linguistic and non-linguistic spatial categozisation. *Cognition, 75*, 209–235.
Cunningham, S. J., Turk, D. J., Macdonald, L. M., & Macrae, C. N. (2008). Yours or mine? Ownership and memory. *Consciousness and Cognition, 17*, 312–318.
Curby, K., & Gauthier, I. (2009). The temporal advantage for individuating objects of expertise: Perceptual expertise is an early riser. *Journal of Vision, 9*(6), 1–13.
Curby, K. M., Glazek, K., & Gauthier, I. (2009). A visual short-term memory advantage for objects of expertise. *Journal of Experimental Psychology: Human Perception and Performance, 35*(1), 94–107.
Deutscher, G. (2005). *The unfolding of language: An evolutionary tour of mankind's greatest invention*. New York NY: Metropolitan Books.
Deutscher, G. (2010). *Through the language glass*. New York NY: Metropolitan Books.
Diessel, H. (1999). *Demonstratives. Form, function, and grammaticalization*. Amsterdam: John Benjamins.
Diessel, H. (2005). Distance contrasts in demonstratives. In M. Haspelmath, M. Dryer, D. Gil, & B. Comrie (Eds.), *World atlas of language structures* (pp. 170–173). Oxford: Oxford University Press.
Diessel, H. (2006). Demonstratives, joint attention, and the emergence of grammar. *Cognitive Linguistics, 17*, 463–489.
Durgin, F. H., DeWald, D., Lechich, S., Li, Z., & Ontiveros, Z. (2011). Action and motivation: Measuring perception or strategies? *Psychonomic Bulletin & Review, 18*, 1077–1082.
Durgin, F. H., Klein, B., Spiegel, A., Strawser, C. J., & Williams, M. (2012). The social psychology of perception experiments: Hills, backpacks, glucose and the problem of generalizability. *Journal of Experimental Psychology: Human Perception and Performance, 38*(6), 1582–1595.
Enfield, N. J. (2003). Demonstratives in space and interaction: Data from Lao speakers and implications for semantic analysis. *Language, 79*, 82–117.
Evans, N., & Levinson, S. C. (2009). The myth of language universals: Language diversity and its importance for cognitive science. *Behavioral and Brain Sciences, 32*, 429–492.
Feist, M. I. (2008). Space between languages. *Cognitive Science, 32*, 1177–1199.
Fillmore, C. J. (1982). Towards a descriptive framework for spatial deixis. In R. J. Jarvella & W. Klein (Eds.), *Speech, place and action* (pp. 31–59). Chichester: John Wiley.
Francis, G. (2012). The same old New Look: Publication bias in a study of wishful seeing. *I-Perception, 3*, 176–178.

Frank, M. C., Everett, D. L., Fedorenko, E., & Gibson, E. (2008). Number as a cognitive technology: Evidence from Pirahã language and culture. *Cognition, 108*, 819–824.

Freyd, J. J. (1983). The mental representation of movement when static stimuli are viewed. *Perception & Psychophysics, 33*, 575–581.

Friedman, O., & Neary, K. R. (2008). Determining who owns what: Do children infer ownership from first possession? *Cognition, 107*(3), 829–849.

Gallagher, P., Neave, N., Hamilton, C., & Gray, J. M. (2006). Sex differences in object location memory: Some further methodological considerations. *Learning and Individual Differences, 16*, 277–290.

Garden, S., Cornoldi, C., & Logie, R. H. (2002). Visuo-spatial working memory in navigation. *Applied Cognitive Psychology, 16*, 35–50.

Griffiths, D., & Tipper, S. P. (2009). Priming of reach trajectory when observing actions: Hand-centred effects. *Quarterly Journal of Experimental Psychology, 62*(12), 2450–2470.

Halliday, M., & Hassan, R. (1976). *Cohesion in English*. London: Longman.

Holmes, N. P., Calvert, G. A., & Spence, C. (2004). Extending or projecting peripersonal space with tools? Multisensory interactions highlight only the distal and proximal ends of tools. *Neuroscience Letters, 373*, 62–67.

Hubbard, T. L. (2005). Representational momentum and related displacements in spatial memory: A review of the findings. *Psychonomic Bulletin and Review, 12*(5), 822–851.

Iriki, A., Tanaka, M., & Iwamura, Y. (1996). Coding of modified body schema during tool use by macaque postcentral neurones. *Neuroreport, 7*, 2325–2330.

Jackendoff, R. (1983). *Semantics and cognition*. Cambridge, MA: MIT press.

Jiang, Y., Olson, I. R., & Chun, M. M. (2000). Organisation of visual short-term memory. *Journal of Experimental Psychology: Learning, Memory and Cognition, 26*, 683–702.

Kemmerer, D. (1999). "Near" and "far" in language and perception. *Cognition, 44*, 1607–1621.

Kemmerer, D. (2006). The semantics of space: Integrating linguistic typology and cognitive neuroscience. *Neuropsychologia, 44*, 1607–1621.

Küntay, A., & Özyürek, A. (2006). Learning to use demonstratives in conversation: What do language specific strategies in Turkish reveal? *Journal of Child Language, 33*, 303–320.

Làdavas, E. (2002). Functional and dynamic properties of visual peripersonal space. *Trends in Cognitive Science, 6*, 17–22.

Lakoff, G. (1987). *Women, fire, and dangerous things*. Chicago: Chicago University Press.

Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. Chicago: Chicago University Press.

Landau, B., & Hoffman, J. E. (2005). Parallels between spatial cognition and spatial language: Evidence from Williams syndrome. *Journal of Memory and Language, 53*, 163–185.

Landau, B., & Jackendoff, R. (1993). "What" and "where" in spatial language and spatial cognition. *Behavioral and Brain Sciences, 16*, 217–238.

Legrand, D., Brozzoli, C., Rossetti, Y., & Farné, A. (2007). Close to me: Multisensory space representations for action and pre-reflexive consciousness of one-self-in-the-world. *Consciousness and Cognition, 16*, 687–699.

Levinson, S. C. (2003). *Space in language and cognition: Explorations in cognitive diversity*. Cambridge: Cambridge University Press.

Li, P., Abarbanell, L., Gleitman, L., & Papafragou, A. (2011). Spatial reasoning in Tenejapan Mayans. *Cognition, 120*, 33–53.

Longo, M. R., & Lourenco, S. F. (2006). On the nature of near space: Effects of tool use and the transition to far space. *Neuropsychologia, 44*, 977–981.

Lourenco, S. F., & Longo, M. R. (2009). The plasticity of near space: Evidence for contraction. *Cognition, 112*, 451–456.

Maes, A. (2007). Spatial and conceptual demonstratives. In I. Korzen & L. Lundquist (Eds.), *Comparing anaphors – Between sentences, texts and languages* (pp. 127–144). Copenhagen: Samfundslitteratur Press.

Maes, A., & De Rooij, C. (2007). How do demonstratives code distance? In A. Branco, T. McEnery, R. Mitkov, & F. Silva (Eds.), *Proceedings of the 6th Discourse Anaphora and Anaphor Resolution Colloquium DAARC 2007* (pp. 83–89). Lagos, Pt: Centro Linguistica da Universidade do Porto.

Majid, A., Bowerman, M., Kita, S., Haun, D. B. M., & Levinson, S. C. (2004). Can language restructure cognition? The case for space. *Trends in Cognitive Sciences, 8*(3), 108–114.

Mandler, J. (1996). Preverbal representation and language. In P. Bloom, M. A. Peterson, L. Nadel, & M. F. Garrett (Eds.), *Language and space* (pp. 365–384). Cambridge, MA: MIT Press.

Meira, S. (2003). 'Addressee effects' in demonstrative systems: The cases of Tiriyó and Brazilian Portuguese. In F. Lenz (Ed.), *Deictic conceptualization of space, time and person*. Pragmatics & Beyond New Series: John Benjamins Publishing Company.

Munnich, E., Landau, B., & Dosher, B. A. (2001). Spatial language and spatial representation: A cross-linguistic comparison. *Cognition, 81*, 171–207.

Pederson, E., Danzigier, E., Wilkins, D., Levinson, S., Kita, S., & Senft, G. (1998). Semantic typology and spatial conceptualization. *Language, 74*(3), 557–589.

Pinto, Y., Howe, P. D. L., Cohen, M. A., & Horowitz, T. S. (2010). The more you see an object, the easier it becomes to track it. *Journal of Vision, 10*, 1–15.

Piwek, P., Beun, R.-J., & Cremers, A. (2008). 'Proximal' and 'distal' in language and cognition: Evidence from deictic demonstratives in Dutch. *Journal of Pragmatics, 40*, 694–718.

Postma, A., & De Haan, E. H. F. (1996). What was where? Memory for object locations. *Quarterly Journal of Experimental Psychology, 49A*(1), 178–199.

Postma, A., Izendoorn, R., & De Haan, E. H. F. (1998). Sex differences in object location memory. *Brain and Cognition, 36*, 334–345.

Proffitt, D. R. (2006). Embodied perception and the economy of action. *Perspectives on Psychological Science, 1*, 110–122.

Reed, C. L., & Vinson, N. G. (1996). Conceptual effects on representational momentum. *Journal of Experimental Psychology: Human Perception & Performance, 22*, 839–850.

Samuelson, L. K., Smith, L. B., Perry, L. K., & Spencer, J. P. (2011). Grounding word learning in space. *PLoS ONE, 6*(12), e28095.

Shi, Z., Zhou, A., Han, W., & Liu, P. (2011). Effects of ownership expressed by the first-person possessive pronoun. *Consciousness and Cognition, 20*, 951–955.

Stevens, J., & Zhang, Y. (2013). Relative distance and gaze in the use of entity-referring spatial demonstratives: An event-related potential study. *Journal of Neurolinguistics, 26*(1), 31–45.

Talmy, L. (1983). How language structures space. In H. Pick & L. Acredolo (Eds.), *Spatial Orientation: Theory, research and application* (pp. 225–282). New York: Plenum Press.

Trueswell, J., & Papafragou, A. (2010). Perceiving and remembering events cross-linguistically: Evidence from dual-task paradigms. *Journal of Memory and Language, 63*, 64–82.

Valdés-Conroy, B., Román, F. J., Hinojosa, J. A., & Shorkey, S. P. (2012). So far so good: Emotion in the peripersonal/extrapersonal space. *PLoS ONE, 7*(11), e49162.

Voyer, D., Postma, A., Brake, B., & Imperato-McGinley, J. (2007). Gender differences in object location memory: A meta-analysis. *Psychonomic Bulletin and Review, 14*(1), 23–38.

Walla, P., Greiner, K., Duregger, C., Deecke, L., & Thurner, S. (2007). Self-awareness and the subconscious effect of personal pronouns on word encoding: A magnetoencephalography study. *Neuropsychologia, 45*, 796–809.

Wolff, P., & Holmes, K. (2010). Linguistic relativity. *WIREs Cognitive Science*.