Spatial Frames of Reference for Temporal Relations:
A Conceptual Analysis in English, German, and Tongan

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Abstract

People tend to think about time in terms of space, in some languages even with identical vocabulary. It is therefore plausible to assume that the frame of reference (FOR) preferred for spatial descriptions also helps to organize temporal descriptions. Further still: If languages differ with regard to the FORs that they prefer in the one domain—as is indeed the case—then they might also differ in the other domain. This paper presents a conceptual analysis of spatial and temporal FORs and describes how the former could be mapped onto the latter. Instances from English, German, and Tongan are provided in order to scrutinize the relationship of relevant prepositions and underlying concepts. The analysis reveals that the rare type of spatial FOR used in Tongan is indeed reflected in the temporal domain. A homology between the two domains is thus very likely.

Keywords: Time perspectives; spatial frames of reference; cross-linguistic analysis.

Introduction

When a German says "der Tag *vor* der CogSci" (the day before the CogSci), a preposition—*vor* (before)—is used to express the temporal relation. This preposition is borrowed from the domain of spatial lexemes. In fact, one would also say "der See *vor* der Stadt" (the lake in front of the city). The same is not, at least not to the same extent, valid for the opposite: The temporal relation "after" is expressed with *nach*, the spatial relation "behind" with *hinter*.

The dual meaning of *vor* in German resembles that of "before" in English, used both temporally and spatially; "in front of", on the other hand, is used only spatially. However, it is the case that in many languages the same metaphors and lexemes are used for temporal and spatial relations (e.g., Boroditsky, 2000; Gentner, 2001; Gentner, Imai & Boroditsky, 2002; Kita, Danziger & Stolz, 2001; McGlone & Harding, 1998; and references cited there). One clear example is provided by the Austronesian language spoken by about 100,000 people in the Kingdom of Tonga: In Tongan, prepositions are identical in both domains.

The extent to which spatial language is used to express temporal relations varies across languages, even between languages as closely related as German and English. This variation points towards a complex relationship between the two domains of time and space at the conceptual level.

Such a conceptual link between time and space is not only explicated in science but also in folk theories of various indigenous cultures (Ascher, 1998). In Navajo and Inuit conceptions of the universe, for instance, space and time are interwoven, with the focus of interest on motion, changes, and interrelationships (e.g., Carpenter, 1968; Pinxten, van Dooren & Harvey, 1983). The *etak* concept used by Micronesian navigators to estimate their course and progress can be interpreted both as a spatial and a temporal model (Gladwin, 1970; Hutchins, 1983, 1995). And psychological studies suggest that spatial moves affect the way in which temporal tasks are interpreted (Boroditsky & Ramscar, 2002; McGlone & Harding, 1998).

In general, it seems to be space that provides the frame for cognitions concerned with time (e.g., Casasanto & Boroditsky, 2003). Accordingly, spatial frames of reference (FORs) may be used to organise temporal orientation. With regard to spatial relationships, the use of FORs in various languages and cultures has been extensively studied (e.g., Bennardo, 2000, 2002; Haviland, 2000; Levinson, 2003; Senft, 1997; Wassmann, 1994). How much of what we know about cultural differences in spatial FORs is applicable to temporal FORs? Are the same FORs preferably used for spatial relationships also used for temporal relationships?

Mandarin speakers, who habitually use both horizontal and vertical prepositions for temporal relations, also show a tendency to "think vertically" about time (Boroditsky, 2001). English, German, and Tongan vary in terms of usage of spatial FORs, but do they vary correspondingly in their usage of temporal FORs? Or more generally: Is the conceptualization of space and spatial relationships homologous to that of time and temporal relationships?

We explore these questions by providing first of all a short overview of spatial and temporal FORs. The conceptual analysis reveals similarities and differences between the spatial domain and the temporal domain. We then look at examples of spatial prepositions used to express temporal relationships in English, German, and Tongan. Finally, we show how in Tongan a unique usage of a spatial FOR is

reflected in the temporal domain. In conclusion, we suggest that a homology between the domains of space and time is plausible.

Frames of Reference (FORs)

When describing relations between and movements of objects or events, we inevitably have to take perspective and choose one particular FOR. In order to obtain coherence, the description needs to stick to this FOR, and in order to enable communication within a group, conventions are required with regard to which FOR should be preferred. These options and preferences have been extensively studied for both the spatial and the temporal domain, albeit applying different categorizations and terminology. Our attempt here is to relate the two domains more closely to each other.

Spatial FORs

A spatial FOR is a set of coordinates (three intersecting axes: vertical, sagittal, and transversal) used to construct an oriented space within which spatial relationships among objects are identified. The three types encompass an absolute, an intrinsic, and a relative FOR (see Levinson, 2003, for a typology of FOR, and Bennardo, 2004, for a revision of that typology).

An *absolute* FOR uses fixed points of reference chosen within the speaker's field, as in "The town is south of the river." These points are socially agreed upon and culturally handed down. Good examples are the well-known cardinal points (north, south, east, west), but also the sea, sacred mountains, or sacred cities like Mecca. In Oceania, a single-axis (land-sea) subtype of the absolute FOR is frequently used (Bennardo, 2002). Tongan employs a radial subtype of the absolute FOR that uses only one fixed point of reference. Movement or location of objects are established by means of centripetal or centrifugal expressions (Bennardo, 2002).

An *intrinsic* FOR is centered on an object and remains so when the speaker or the object moves, as in: "The ball is in front of the car." In the intrinsic FOR, the oriented field is thus independent from the field of the speaker—it is a new field.

A *relative* FOR is centered on a speaker and remains so when the speaker moves, as in: "The ball is in front of me." This type of relative FOR provides the 'basic' subtype (cf. Figure 1a).

The presence of a second object in the speaker's field creates the alternatives of treating both objects in direct relationship with the speaker, thus continuing to center the axes on the speaker, or of relating one object to the other. In the latter case, orienting axes can be assigned to one object (now the "reference object"). The reference object assumes the same function that the speaker had hitherto performed. In a conservative fashion, the axes mapped onto this object are exactly the same as the ones that the speaker had mapped onto him or herself.

In dividing the speaker's front or 'away' axis in two parts by the remaining (or target) object, a new possibility is created. This object's front-back axis may keep exactly the orientation of the speaker's field, thus yielding the *translation* subtype of the relative FOR: A ball positioned beyond a tree
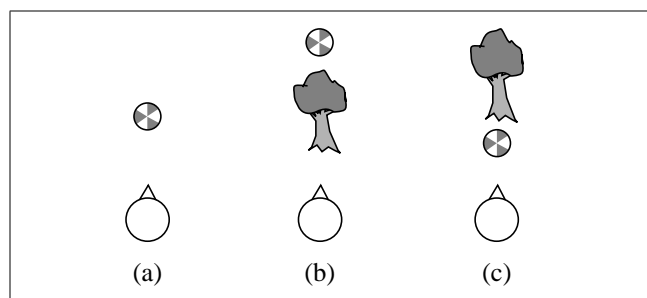
Figure 1: "The ball is in front of me / of the tree" in the three subtypes of the relative FOR: (a) basic, (b) translation, and (c) reflection.

that is in front of the speaker is considered "in front of" the tree (cf. Figure 1b). Or the front and back assignment can be flipped so that the front of the oriented object faces the speaker, thus yielding the *reflection* subtype of the relative FOR: A ball between the speaker and a tree is considered "in front of" the tree (cf. Figure 1c). In both subtypes, the assignments of the left and right sides are perfectly congruent with those of the speaker. In other words, the oriented object is not yet considered as having an oriented field of its own; rather, it is still tied to the field of the speaker.

Both English and German speakers are habitual and preferential users of the relative FOR, specifically the basic and the reflection subtypes (see Levinson, 2003). Tongan speakers represent a more complex scenario, and both relative and absolute FOR are habitually used. In addition, Tongan speakers constitute one of the only two documented cases—the first is Hausa (Hill, 1982)—of frequent users of the translation subtype of the relative FOR (Bennardo, 2000).

Temporal Perspectives

How far can we go in a comparison of spatial and temporal systems? What do they have in common, and where are crucial differences?

Basing our analysis on the Western conceptualization of time, we start with a description of time as 'something' that flows in one direction; it is extended in one dimension, it can be intersected, and events can be 'localized' on this dimension. One important difference is that time extends in one dimension only, while space has three. A second difference is that time has a direction, which is not reversible.

With regard to the direction of time, it is possible to take two contrary perspectives. For the sake of simplicity, let us assume that time were like a river (for a similar distinction with different terms see Boroditsky & Ramscar, 2002; McGlone & Harding, 1998). If we take the perspective of the water running down from the spring to the sea, everything passed by is regarded as back or past or temporally "after", while everything that lies ahead is regarded as future or front or "before" (cf. Figure 2a). However, a quick look into everyday use of the prepositions reveals that this is not the perspective typically taken in English or German. The day "before" today is yesterday, the day "after" today is tomorrow, and not vice versa.

If we take instead the perspective of a fish heading upstream (as most fish are), the water that is still to come
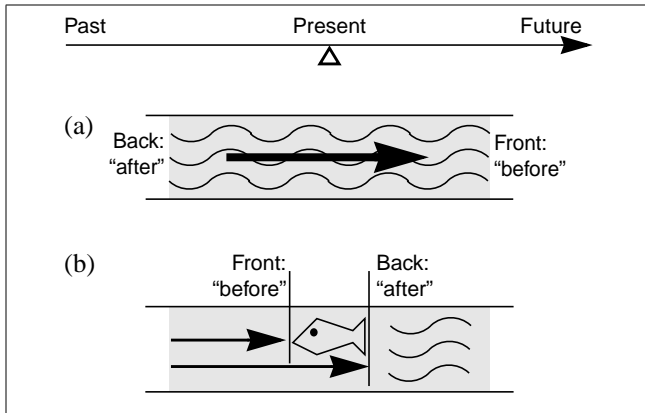
Figure 2: (a) "Water perspective": The time that lies ahead is considered the front. (b) "Fish perspective": The time that is yet to be confronted is regarded as the front.

Figure 3: (a) The *translation* subtype of a relative FOR. (b) The *reflection* subtype of a relative FOR. (PoR stands for "point of reference".)

would be the part that is the front or the future and thus "before", while the waves that have already passed by are the back or past and therefore "after" (cf. Figure 2b). Accordingly, the perspective taken in English and German prepositions is the fish perspective rather than the water perspective.

While the flow of time can be conceived from these two perspectives, events cannot. They have an intrinsic beginning and end, symbolized by the fish's head and tail respectively. A single point in time, like a gunshot or a crash, can be regarded as an extremely condensed event with zero extension, yet retaining direction.

Mapping Spatial FORs onto Temporal Perspectives

Given these substantial differences between temporal and spatial characteristics, are spatial FORs applicable for temporal relations? We propose that it is possible to map the former entirely onto the latter because the directionality of time, allowing for two perspectives, compensates for the deficiency in dimensions.

The *absolute* FOR for spatial relations localizes an object independent of its own character or the observer's position, for instance by using cardinal points or landside vs. seaside (e.g., Bennardo, 2000; Levinson, 2003). An equivalent absolute determination of events is given by a calendar. This is not an absolute positioning in universal terms as it is still relying on cultural conventions, but the same is true for the spatial "absolute" FOR (e.g., use of local geographical features such as mountains, sea, etc.).

The *intrinsic* FOR depends on the shape or function of the object concerned. If it has an intrinsic front and back—like a dog, a car, or a TV—then prepositions will most likely be used with regard to this front or back (e.g., Bennardo, 2000; Levinson, 2003). A similar notion can be attached to events. Without exception they have an intrinsic beginning and end. In a language that applies the intrinsic FOR, the time beyond the beginning should thus be referred to with "before", and the time beyond the end with "after". As all events have such an intrinsic beginning and end, it might even seem 'natural' to apply this FOR for temporal relations.
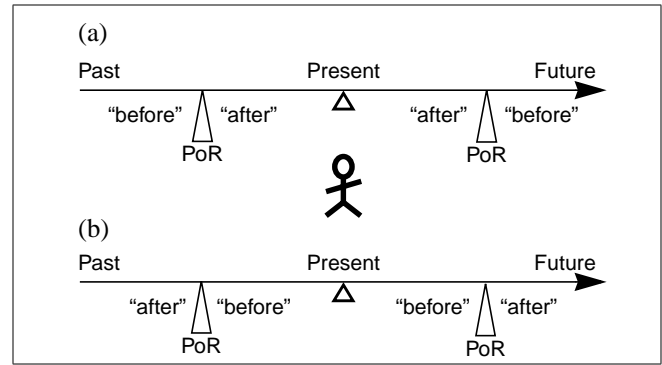
The mapping done so far leaves the "water perspective" of time as an equivalent to the (basic) *relative* FOR, and indeed, it resembles its main characteristics. In this system, it is not beginnings and endings of events that determine which part of time is perceived as front and back, but rather the position of the observer: The time that still lies ahead is regarded as the front, and the time that lies behind as the back. Since, worldwide, the relative FOR is the most commonly used to express spatial relationships, we feel justified in assuming that some languages might have adopted the relative FOR instead of the intrinsic one to express temporal relations.

As we have seen, the relative FOR used for spatial relationships has three subtypes: the basic subtype, the reflection one, and the translation one. The latter two require the introduction of an additional object (or event) as point of reference, and even these can be identified in the one-dimensionality of temporal relationships.

In a *translation* subtype, we expect the observer to transfer his or her own position into the point of reference and thus to 'translate' this perspective (cf. Figure 3a). Accordingly, "after" should be used for events that fall between the speaker and the point of reference (irrespective of where in time the point of reference itself is), while "before" should refer to events beyond. When applying the *reflection* subtype, the observer's perspective is reflected and the prepositions are swapped (cf. Figure 3b). In this case, "before" should be used for events that fall between the speaker and the point of reference, while "after" should refer to events beyond.

With these definitions in mind, we can now unambiguously determine which FOR is applied with regard to temporal relations in the languages in question. Apart from the absolute system, which does not require prepositions, the remaining FORs are characterized by specific and distinct patterns (cf. Table 1).

Indicators of Temporal FORs in English, German, and Tongan

The usage of prepositions is taken as the main indicator of a particular FOR. Prepositions explicate not only relations but also movements. And particularly in Tongan, directionals are

Table 1: Prepositional pattern for the intrinsic and relative FORs.

Type of FOR	Past		Future	
Intrinsic	before		after	
Relative				
• Basic	after		before	
• Translation	before	after	after	before
• Reflection	after	before	before	after

habitually used to emphasize direction both in spatial and temporal expressions. The two directionals relevant here are *mai* ("towards the speaker") and *atu* ("away from the speaker") (Bennardo, 1999, 2002; Broschart, 1995, 1997).

We assume that movements are expressed in a way that reflects the preferred temporal FOR. If, for instance, in an intrinsic FOR we refer to the time before an event as its "front", the move towards the present will make use of the same vocabulary: From "Next Wednesday's meeting will be moved *forward* two days", we should therefore conclude that it will be moved to Monday. Although theoretically conclusive, this link is empirically questioned, at least for English (e.g. Boroditsky & Ramscar, 2002; McGlone & Harding, 1998). A closer look at formulation preferences for temporal movements will therefore have to complement our analysis of FORs.

Prepositions for Temporal Constellations

For the description of spatial relations, both English and German speakers can choose from all three basic types of FOR. Except for objects with strong intrinsic front and back, which call for the intrinsic FOR, however, the relative FOR (and in particular the reflection subtype) is usually preferred and cognitively dominant (cf. Majid et al., 2004).

English. For temporal relations, the system applied in English is the "fish perspective" or the intrinsic FOR. Prepositions are referring to the intrinsic beginning or end of an event and the imaginary beginning or end of a point in time:

(1)   The time *before* now is the past,
      the time *after* now is the future.

(2)   The day *before* today is yesterday,
      the day *after* today is tomorrow.

Or, to pick up the example chosen in the introduction,

(3)   The day *before* the CogSci is the day
      before the beginning of the CogSci,
      the day *after* the CogSci is the day
      after the end of the CogSci.

German. The same is true for German speakers, who also typically adopt the intrinsic FOR. Due to the partial overlap in lexemes, the resemblance of temporal and spatial prepositions is even stronger in German than in English (the following examples are equivalent to (1)–(3)).

(4)   Die Zeit *vor* jetzt ist die Vergangenheit,
      die Zeit *nach* jetzt ist die Zukunft.

(5)   Der Tag *vor* heute ist gestern,
      der Tag *nach* heute ist morgen.

Note that the day before yesterday is even termed *vorgestern*. And the last instance, with an additional point of reference:

(6)   Der Tag *vor* der CogSci ist der Tag
      vor Beginn der CogSci,
      der Tag *nach* der CogSci ist der Tag
      nach Ende der CogSci.

Tongan. When phrasing spatial relationships, Tongans prevalently use the relative FOR in small-scale space (small objects very close to the speaker), but prefer the absolute FOR to refer to large-scale space (objects of any size at some distance from the speaker). Tongan speakers are also frequent users of the translation subtype of the relative FOR in both types of space (Bennardo, 2000)—a unique feature.

With regard to temporal relations, a first analysis seems to suggest that the intrinsic FOR is preferred in simple settings:

(7)   Ko e taimi ki *mu'a* 'i he taimi ni ko e taimi kuo 'osi.
      (lit. 'The time before / to the front of now is the time that is over / the past.')

(8)   Ko e taimi ki *mui* 'i he taimi ni ko e taimi kaha'u.
      (lit. 'The time after / to the back of now is the time that is still to come / the future.')

(9)   'Aneafi ko e 'aho ki *mu'a* he 'aho ni.
      ('Yesterday is the day before today.')

(10) 'Apongipongi ko e 'aho ki *mui* he 'aho ni.
      ('Tomorrow is the day after today.')

However, if we look at expressions that require an additional point of reference, we find these patterns:

(11) Ko e Falaite Lelei na'e hoko 'i he 'aho 'e ua ki *mu'a*
      'i he 'Aho Sāpate Toetu'u.
      ('Good Friday happened two days before Easter Sunday.')

(12) 'E 'alu 'eku faiako 'i he 'aho 'e tolu ki *mu'a* 'apongipongi.
      ('My teacher will go three days after tomorrow.')

Note that in both sentences the same preposition, *mu'a* ("to the front"), is used for each time beyond the point of reference, just as was predicted for the translation subtype.

Prepositions and Directionals for Temporal Movements

With regard to the lexemes used for movements in time, the findings are somehow puzzling, even for closely related English and German.

English and German. In spite of the fact that English speakers apply the intrinsic FOR when talking about something "before" an event, they seem to have no such preference with regard to a sentence like "The meeting will be moved *forward* two days" (Boroditsky & Ramscar, 2002; McGlone & Harding, 1998).

The same does not hold for German speakers. In a replication[1] of Experiment 1 from Boroditsky and Ramscar (2002), inducing either a time-moving or an ego-moving perspective did *not* affect the preference for the intrinsic FOR. Across all

three conditions convergence was close to total, with 95 % preference for the option with intrinsic FOR (the relative one was chosen in *no* case).

Tongan. In Tongan, we also find some variance in sentences that relate to movements in time. The Tongan verbs used to express temporal motion are *matolo* ("to move or be moved along or back or forward [from where it was] in place or time") and *toloi* ("to put off, postpone, defer, adjourn").

When we check the Tongan dictionary (Churchward, 1959) and grammar (Churchward, 1953), we find at least some indicators for a similar perspective. Both sources state that the preposition *mu'a* not only means spatially "in front", "first" in a row, and temporal "before", but also the time that is yet to come. The opposite preposition *mui* correspondingly indicates both "behind" and "after", but also the times gone. Further still, with regard to moves in time, the grammar suggests a switch in meaning for the prepositions/nouns.

(13) Kuo matolo *atu* ki *mu'a*.
    (lit. 'It has been moved away from me to the front.'
    dict. 'It has been put off to a later date.')

(14) Kuo matolo *mai* ki *mui*.
    (lit. 'It has been moved towards me to the back.'
    dict. 'It has been moved to an earlier date.')

This seems to be a clear indication of the switch from an intrinsic FOR to a relative FOR, and this relative perspective is even emphasized by the directionals *mai* (towards the speaker) and *atu* (away from the speaker).

However, some of our informants did not apply this perspective but used the spatial nouns the other way around. They did not even consider the translation suggested by Churchward as valid but phrased his sentences instead as:

(15) Kuo matolo *atu* ki *mui*.
    (lit. 'It has been moved away from me to the back.'
    i.e., 'It has been put off to a later date.')

(16) Kuo matolo *mai* ki *mu'a*.
    (lit. 'It has been moved towards me to the front.'
    i.e., 'It has been moved to an earlier date.')

While these informants stated that (13) and (14) are comprehensible, they interpreted them contrary to the meaning as given in the dictionary. Their interpretation of the spatial-temporal nouns (*mui* and *mu'a*) in that case even overrode the meaning of the directionals.

Contrary to this, other informants gave us the following instances:

(17) Ko e fakataha toloi mai ki *mui* mei he 9 ki he 7.
    ('The meeting was moved back from 9 to 7.')

(18) Ko e fakataha toloi mai ki *mu'a* mei he 7 ki he 9.
    ('The meeting was moved forward from 7 to 9.')

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1   44 undergraduates from the University of Freiburg participated in the experiment. The material of the original study was translated into German, using the term *vorverlegen* for "moving forward". A control condition was added in order to obtain preferences in neutral contexts, and a second question was added to obtain preferences in the past.

The pattern here basically corresponds to the one given by Churchward (cf. 13 and 14), except for the indiscriminately used directional *mai*, and reveals again a translation subtype of the relative FOR.

These informants also indicated a fundamental difference in formality between the use of *matolo* and *toloi* (both meaning "move"). The former, driving the translation relative FOR, is more formal, and the second, driving the intrinsic FOR, more informal and colloquial.

Discussion

Is it possible to map spatial FORs onto temporal relations? Our conceptual analysis suggests that it is, because the direction of time and the intrinsic character of events compensate for the deficiency in dimensions. Accordingly, we can also analyze whether a preference for spatial FORs is reflected in temporal usage.

Since speakers of all three languages may, generally speaking, choose from all three types of FOR, a clear indication is only possible with regard to the translation subtype of the relative FOR that is nearly exclusively used in Tongan. An instance of the translation FOR in temporal descriptions in Tongan would therefore provide a strong argument supporting the homology of the temporal and spatial domain.

Such an indication could not be found with constellations (except for sentence (13)), for which all three groups apply the intrinsic FOR—as they do for spatial constellations when referring to an object with intrinsic orientation.

However, with regard to movements in time, the findings are more heterogeneous. While English speakers seem to have no clear preference for either the intrinsic or relative FOR, German speakers still exclusively apply the intrinsic FOR. Tongan speakers make use of two different FORs, each depending on the verb: the intrinsic FOR is driven by *toloi*, the translational relative by *matolo*.

However, our Tongan informants did not entirely agree either with each other or with the Tongan grammar (Churchward, 1953) with regard to the correct interpretation of a sentence like (13). What could be the reason for these diverging opinions?

One reason might be that Boroditsky and Ramscar's (2002) findings for English speakers also hold for Tongan speakers: In temporal movements, the two perspectives may be used ambiguously and could be open to contextual influences as much as they are open to experimental manipulation. However, German speakers do not fall victim to this kind of influence, and whether Tongans do so, will have to be further scrutinized.

Another reason could be that Churchward was simply wrong. We cannot exclude this option, but we regard it implausible as he is usually a very reliable source and we consider it unlikely that he would have misunderstood a relation *contrary* to his own cognitive concepts.

A third explanation could be that within the last 50 years (since the publication of the Tongan grammar), linguistic conventions may have changed, probably under the influence of English school curricula. This might have resulted in more heterogeneous patterns of expressions. This hypothesis is

supported by the fact that different informants provided different (yet consistent) answers to the same question.

This hypothesis is also supported by the difference in formality between the use of *matolo* and *toloi* that corresponds to a different usage of FORs. The translation subtype of the relative FOR is used with the formal *matolo* (preferred in traditional Tongan), while the intrinsic FOR (as in English) is used with the informal *toloi*. And this is true only for educated speakers whose use of English in everyday life is very frequent.

The proportion of Tongan speakers that still applies the rare translation subtype of the relative FOR has yet to be established. However, we did find evidence that it *is* used. As this usage reflects the use of the translation subtype in spatial descriptions, we may thus conclude that habitual uses of specific FORs for spatial relationships are indeed homologous to and generative of the FORs used for temporal relationships.

Acknowledgments

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