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Eric Pederson; Eve Danziger; David Wilkins; Stephen Levinson; Sotaro Kita; Gunter Senft

Language, Vol. 74, No. 3 (Sep., 1998), 557-589.

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SEMANTIC TYPOLOGY AND SPATIAL CONCEPTUALIZATION

ERIC PEDERSON

University of Oregon

EVE DANZIGER

University of Virginia

DAVID WILKINS

*Max Planck Institute for
Psycholinguistics*

STEPHEN LEVINSON

*Max Planck Institute for
Psycholinguistics*

SOTARO KITA

*Max Planck Institute for
Psycholinguistics*

GUNTER SENFT

*Max Planck Institute for
Psycholinguistics*

This project collected linguistic data for spatial relations across a typologically and genetically varied set of languages. In the linguistic analysis, we focus on the ways in which propositions may be functionally equivalent across the linguistic communities while nonetheless representing semantically quite distinctive frames of reference. Running nonlinguistic experiments on subjects from these language communities, we find that a population's cognitive frame of reference correlates with the linguistic frame of reference within the same referential domain.*

INTRODUCTION. This study examines the relationship between language and cognition through a crosslinguistic and crosscultural study of spatial reference. Beginning with a crosslinguistic survey of spatial reference in language use, we find systematic variation that contradicts usual assumptions about what must be universal. However, the available number of general spatial systems for describing spatial arrays can be sorted into a few distinctive frames of reference. We focus on two frames of reference: the ABSOLUTE, based on fixed bearings such as north and south, and the RELATIVE, based on projections from the human body such as 'in front (of me)', 'to the left'.

In assessing language use, it is not enough to rely on descriptions of languages that are based on conventional elicitation techniques as these may not fully reflect actual socially anchored conventions. We have developed and used director/matcher language games which facilitate interactive discourse between native speakers about spatial relations in tabletop space. The standardized nature of these games allows more exact comparison across languages than is usually possible with conventionally collected discourse.

Having observed the variation of language use across communities, we further ask whether there is corresponding conceptual variation—the question of the linguistic relativity of thought. For this, we developed nonlinguistic experiments to determine the speaker's cognitive representations independently of the linguistic data collection. The findings from these experiments clearly demonstrate that a community's use of linguistic coding reliably correlates with the way the individual conceptualizes and memorizes spatial distinctions for nonlinguistic purposes. Because we find linguistic relativity effects in a domain that seems basic to human experience and is directly linked to universally shared perceptual mechanisms, it seems likely that similar correlations between language and thought will be found in other domains as well.

1. A CROSSLINGUISTIC AND CROSSCULTURAL STUDY OF SPATIAL REFERENCE. The primary goal of our project is to test, refine, and reformulate hypotheses about language and human cognition drawing on in-depth information from a broad sample of non-

* This article developed from a presentation entitled 'Cultural variation in spatial conceptualization' at the Ontology of Space Workshops, First International Summer Institute in Cognitive Science, SUNY Buffalo, July 1994. The presenters were Eve Danziger, Kyoko Inoue, Sotaro Kita, Paulette Levy, Eric Pederson and David Wilkins. All of the current authors made substantive intellectual and written contributions to this paper. All figures copyright of the Max Planck Institute for Psychology.

(Indo-)European languages and cultures. To this end, we rely on independently derived analyses both of the linguistic facts and of conceptual representations during nonlinguistic tasks.

Many linguistic studies that characterize themselves as cognitive have proceeded directly from a semantic analysis (often of a single language) to speculations on the nature of human conceptual categories. Much linguistic work emphasizes that the categories of spatial relations underlie nonspatial reasoning as well. MacLaury (1995, 1997), for example, takes the basic relationship between a (spatial) figure and a (spatial) ground to analogically underlie the organization of color categorization. While such work can usefully serve to formulate testable hypotheses about cognition, we must also explicitly link the results of semantic analysis with the results from (nonlinguistic) psychological research—and this is seldom done (although see Lucy 1992b). Experimental studies in cognitive linguistics such as that of Sandra and Rice (1995)—while of importance—engage the subjects in language tasks. Experimental work such as that discussed in Tomlin 1997 concerns the mapping relation between a controlled cognitive state (attention) and co-temporaneous linguistic production. In contrast to such studies, we explore the relations between linguistic and nonlinguistic behavior by examining each independently.

We focus here on the variation in spatial conceptualization. More specifically, we address the categorization of small-scale scenes according to properties attributed to the axis transverse to the viewer, i.e. left/right discrimination of static locations in tabletop space.

All humans, and indeed many other mammals, share the same neurophysiological subsystems, whether visual, auricular or kinesthetic, involved in knowing where our bodies are. The basic physical environment (whether city or camp, desert or swamp) is likewise similar: gravity exerts pressure, objects scale according to size and distance, etc. Repeated through the philosophical, psychological, and linguistic literature, we find the assumption that humans naturally categorize their spatial environment using the planes of the human body—dividing ‘front’ from ‘back’ and ‘left’ from ‘right’. This division, together with ‘up’ and ‘down’, gives us the three dimensions of naïve space. Immanuel Kant (1768, translation 1991, cf. Levinson & Brown 1994) argues for the fundamental and irreducible nature of the left/right distinction. Views similar to Kant’s dominate the psychology of language and semantics (see Clark 1973, Lyons 1977:690, or Miller & Johnson-Laird 1976). That is, ‘front’ and ‘back’ and ‘left’ and ‘right’ have been conceived of as fundamental solutions to the problem of angles on the horizontal plane: using non-horizontal planes, we can divide the horizontal plane into front/back halves and left/right halves. Then we can talk about things to the ‘front’ and ‘left’ of ourselves by defining regions of space projected from our own body parts.

Clark, for example, makes a number of predictions about language acquisition, based on the following assumptions. ‘We are now in a position to summarize the main characteristics of man’s P(perceptual)-space. When man is in canonical position, P-space consists of three reference planes and three associated directions: (1) ground level . . . and upward is positive; (2) the vertical left-to-right plane through the body . . . and forward is positive; and (3) the vertical front-to-back plane . . . both positive directions’ (1973:35). ‘Since P-space is a human universal, it should condition L[linguistic]-space in every language’ (1973:54).

For speakers of modern European languages, there is an intuitive appeal to the assumption that projecting one’s own body quadrants into regions of space is fundamental and universal, but this assumption must be tested. To start with, are the linguistic

systems that describe spatial location essentially the same or are they variable across languages? If variable, are the differences merely linguistic or do they imply conceptual or cognitive differences?¹ If it proves possible to show significant cultural variation in nonlinguistic spatial cognition which in turn corresponds to variations in the linguistic system, then there is a general lesson for the cognitive sciences: even apparently basic conceptual representations are formed from an interaction of biological endowment with significantly varying cultural and linguistic input.

To search for greater linguistic variation, we look at less familiar languages. In this article we demonstrate that there is notable linguistic variation in the linguistic representations of such spatial relations. This naturally leads to the question of whether speakers also COGNIZE about spatial relations in different ways. Indeed, we find that there is also variation in cognition that significantly challenges common assumptions about what is conceptually universal. Covariation of linguistic representation and cognitive representation raises the topic of linguistic relativity.²

This work expands on previous linguistic relativity studies by considering language data in two atypical ways: (1) we used as broad a set of languages as was practically possible and (2) we looked at patterns of language use, not just grammatical descriptions. This work is domain specific—not unlike the work within the color tradition of Berlin and Kay (1969) (see the discussion of domain-specific research in linguistic relativity in Lucy 1997). In our case, however, we start with patterns of extensional reference derived from interactional discourse rather than with an elicitation of lexical items.

The work presented here has been conducted in thirteen different language communities using data from ten language families, with parallel research into the associated cultures.³ Table 1 lists the researchers responsible for the study of the particular language communities.⁴

Except for the work in Tamil Nadu, the Netherlands, and Japan, these field sites are within small-scale ‘traditional’ and often nonliterate societies. Most of these communities have had no extensive linguistic or cultural documentation, and research within them requires more anthropological field techniques. These field sites provide long-

¹ The same issues recur, often in specialized form, in many areas of the psychology of language. For example, to what extent must children, during their acquisition of language, learn to make culture-specific discriminations of meaning, and to what extent are the major dimensions already given to them in the natural processes of development? Or consider the implications of the fact that certain semantic discriminations (e.g. concerning the visibility of referents or their shape or their number) are obligatory in some languages but not in others. Does this imply that nonlinguistic thoughts may be different for speakers of different languages (Lucy 1992b) or that thoughts to be encoded have to be regimented into a certain language-specific form just prior to encoding (Slobin 1991, 1996)?

² Linguistics (and the cognitive sciences in general) is witnessing a growing attention to issues surrounding linguistic relativity (see Lucy 1992a, Lee 1996, Gumperz & Levinson 1996, Bowerman & Levinson 1998, Wassmann & Dasen 1998). We will be concerned with establishing covariation before positing a causal model.

³ Arandic is a subfamily name. In connection with this research, Wilkins has done research on several very closely related Arandic varieties (often considered from a linguistic standpoint to be dialects of the one language—see Wilkins 1989). These include Mparntwe Arrernte, Eastern Arrernte, Western Arrernte, Alyawarr and Anmatyerre.

⁴ Note that closely related fieldwork has also been conducted in additional communities by other researchers associated with the project: Inuktitut (Shanley Allen), Pohnpeian (Elizabeth Keating), Yucatec (Suzanne Gaskins, John Lucy), Tzotzil (John Haviland, Lourdes de León), Tongan (Giovanni Bennardo), Yupno (Jürg Wassmann), Bettu Kurumba (Eric Pederson), Popolcán (Roberto Zavala), Jaminjung (Eva Schultze-Berndt), Saliba (Anna Keusen), Guugu Yimithirr (John Haviland, Lourdes de León, Stephen Levinson).

LANGUAGE	FAMILY (COUNTRY)	RESEARCHER
Mopan	Mayan (Belize)	E. Danziger
Tzeltal	Mayan (Mexico)	P. Brown, S. Levinson
Yucatec	Mayan (Mexico)	C. Stoltz
Totonac	Totonacan (Mexico)	P. Levy
Kilivila	Austronesian (Papua New Guinea)	G. Senft
Longgu	Austronesian (Solomon Islands)	D. Hill
Kgalagadi	Bantu (Botswana)	S. Neumann
Hai'llom	Khoisan (Namibia)	T. Widlok
Arandic	Pama-Nyungan (Australia)	D. Wilkins
Tamil	Dravidian (India)	E. Pederson
Belhare	Tibeto-Burman (Nepal)	B. Bickel
Dutch	Indo-European (Netherlands)	Staff
Japanese	Uncertain (Japan)	K. Inoue, S. Kita

TABLE 1. Language communities under consideration.

term bases for past and future research. Accordingly, each researcher can conduct linguistic and experimental work monolingually, while at the same time developing an ethnographic understanding of the local community and its structure.

Clearly, the number of languages and cultures under detailed examination is smaller than ideal and should not be interpreted as representative of the world's languages. 'New' language communities could not be casually added to the sample, since the nature of this research requires that each researcher be a committed field worker at that site. Even though a convenience sample, this set of language communities is broader in typological and cultural range than most other in-depth comparative (typically pairwise) work in semantics and conceptual structure (see Lucy 1996, 1997 for a survey of recent work).

In collecting our language data, we look carefully at interactive language USE within speech communities rather than relying on general grammatical descriptions or lexical elicitation with individuals. We examine the semantic and functional qualities of language in controlled, but naturalistic, contexts and derive our semantic typing from these contexts.⁵ All language data have been drawn directly from native speaker discourse with no reliance on secondary sources.⁶ After analyzing these linguistic data, we hypothesize which cognitive representations might be associated with each type of language use. These predictions are confirmed in nonlinguistic experiments, one of which is reported on in detail here.

2. SPATIAL REFERENCE IN LANGUAGE. We begin our investigation with a survey of the language used in spatial descriptions. Occasional field reports (e.g. Bateson & Mead 1942; Laughren 1978 for Warlpiri; Lee 1950 and Harvey Pitkin quoted in Talmy 1983 for Wintu; and Haviland 1993 for Guugu Yimithirr), had already suggested that

⁵ See Lucy (1992b) who—in addition to more naturalistic observations—had consultants describe line drawings and generated linguistic generalizations from those descriptions. From these observations, he also formulated and tested specific hypotheses about corresponding conceptualization/cognition.

⁶ These data are further supported by traditional elicitation, the collection of naturally occurring language usage, as well as ethnographic observations of naturally occurring spatial behavior and cultural uses of space. Many of the researchers associated with this project are principal researchers for the language they work with: Danziger (1994, 1996a) for Mopan, Brown (1994) for Tzeltal; Levy (1992a,b, 1994) for Totonac; Senft (1986, 1996) for Kilivila; Hill (1994) for Longgu; Wilkins (1988, 1989, 1997) for Arrernte (see also Wilkins & Hill 1995), and Bickel (1997) for Belhare.

the projective left/right distinction (e.g. ‘the man is to my left/right of the tree’) might not have a fundamental and universal role in spatial conception—at least as revealed by language. Some languages might not use a projective left and right for spatial reference at all. Indeed, as fieldwork on this topic became more comparative, we found more fundamental cultural variation than had been imagined possible in the cognitive sciences. For an overview, see Levinson (1996, 1998) and Senft (1997). This is particularly interesting because spatial reference and cognition is where one might not expect deep cultural differences. Differences may be great across cultures in terms of navigation (particularly in different types of terrain), but the interaction with the immediate environment (e.g., items placed before a subject) might have been expected to be largely structured in terms of common systems of human perception and motor operations.

2.1. FOCUSED COLLECTION OF LINGUISTIC DATA. A vital part of our research has been the production of a set of instruments for collecting reliable data about spatial description in different languages and cultures. It is not a trivial undertaking to design stimuli that will systematically cover an expected set of possible oppositions (an ETIC grid), while being open to unexpected kinds of discrimination. Nor is it possible, even if one is well informed in advance, to cover all the distinctions in any one language exhaustively, because this would entail a set of stimuli of unmanageable size for comparative work.

A kit of tasks and stimuli was devised and modified by (especially) Penelope Brown, Eve Danziger, Lourdes de León, Stephen Levinson, Eric Pederson, Gunter Senft, and David Wilkins. This kit consists of a set of stimulus materials for field workers including suggestions for conducting focused elicitations using interactive games, and (most relevant to the current discussion) specific probes into target areas of special interest for spatial expressions.⁷ The probe tasks involve a DIRECTOR who is allowed to see (arrays of) stimuli and a MATCHER who cannot see the stimuli, but who must use the director’s verbal instruction to re-create what the director sees from a set of duplicate materials. Table 2 provides a partial list of the types of games in this kit.

LANGUAGE GAME	TYPE
Men-and-tree	Photograph matching; horizontal plane relations
Farm animals	Matching object arrays; horizontal plane relations
Wooden man	Matching posture configurations with human model
Route descriptions	Motion on horizontal plane
Tinker Toy™	Complex figure construction; caused motion elicitation

TABLE 2. Director/matcher games for spatial relations.

We stress that such elicitation tasks create a particularized context with its own dimensions and parameters, and results obtained from any one task can be assumed to be applicable only to substantially similar contexts. Nonetheless, there is generally a high degree of agreement between language use in such spatially-focused contexts and that observed in more day-to-day contexts. In all field sites, other extensive investigations were conducted to provide additional validation of the more exacting procedure of these director/matcher games. These varied across researchers and field conditions, but included traditional language consultant work and narrative collection.

⁷ The kit expands upon de León’s (1991) earlier use of interactional games as a method for focused linguistic elicitation with Tzotzil speakers. Carroll and von Stutterheim (1993) use similar techniques. These in turn drew on yet earlier studies by Clark and Wilkes-Gibbs (1986) and Weissenborn (1986). For a more detailed description of these methods, see Senft (1994b).

We focus here on data from one such game: the men-and-tree game. We select this game for discussion because it involves static arrays of objects on the horizontal plane. This game consists of four subgames. Each subgame is played with two identical sets of twelve color photographs.⁸ These sets contain subsets of photographs which contrast with one another along single parameters. One set is placed (in a shuffled array) in front of the director, and the other (in a different shuffled array) in front of the matcher. The two players sit side by side and are screened off from one another such that they cannot see each other's photographs, nor can they see each other's gestures (see Figure 1). All sessions were audiotaped and most were videotaped.

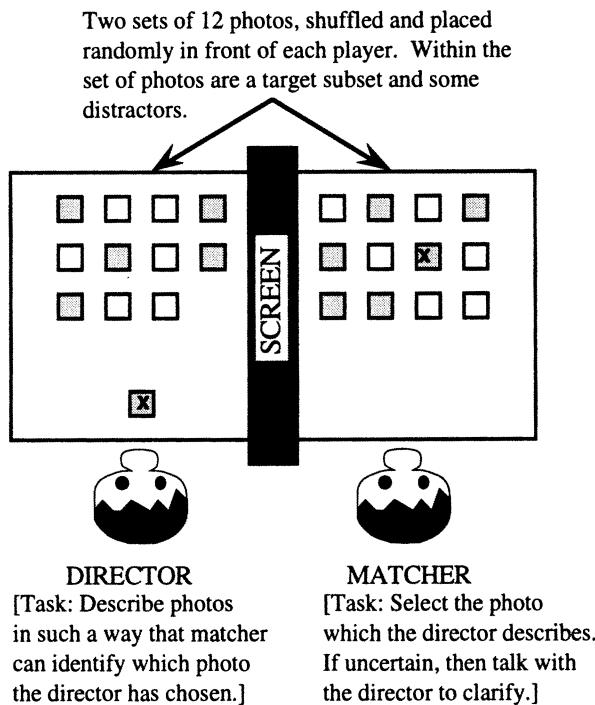


FIGURE 1. Arrangement for playing the men-and-tree game.

The director selects one of the twelve photographs and describes it (especially as it contrasts with the other photographs) to the matcher. From verbal description and discussion alone, the matcher must select the photograph that the director describes. After both players agree that they have selected the same photograph, the selected photograph is put aside, the director selects another photograph from one of the remaining eleven photographs, and play continues until all photographs have been described. Players may back up play to look at and discuss photographs discussed earlier; the matcher may subsequently revise selections if so desired.

The players are encouraged to interact with and question each other during play. Most players do discuss the photographs (sometimes extensively) providing both meta-

⁸ Eve Danziger and Eric Pederson, with assistance from Penelope Brown and many others, were primarily responsible for the design of the game. We are aware that the use of photographic stimuli introduces a fixed perspective (from the camera) of the depicted objects, which may complicate the analysis. Other related language games used the manipulation of three-dimensional objects.

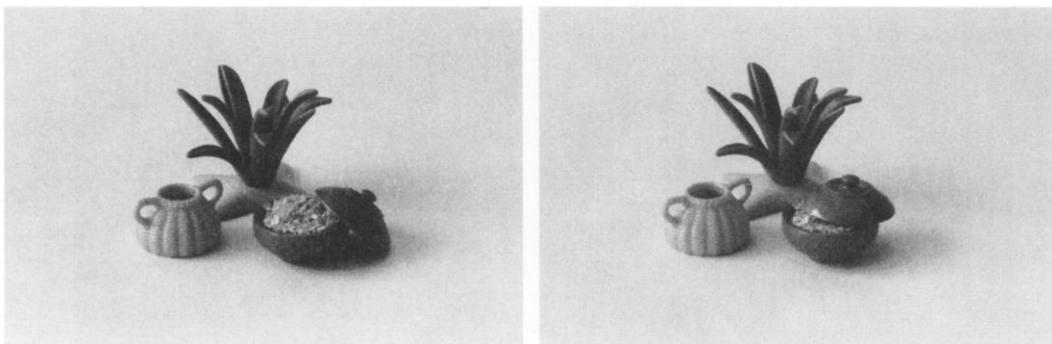


FIGURE 2. Sample photographs from set 1.

commentary as well as elaborated use of spatial descriptors. Further, the extensional reference of the spatial terms can be directly observed on the selected photographs. Ambiguities or unclarities for the matchers are typically observable to the investigator through the matches which the players consider.

The first (training) set of play (set 1) shows various arrangements of small objects (e.g. two photographs of a small carved container with a lid slightly or fully ajar, see Figure 2). This set—while interesting for its own material—does not highlight contrasts in horizontal plane relationships.

There are three more sets (2,3,4) of play. These other three sets contain a mixture of (i) photographs with critical horizontal plane contrasts (with toy men and sometimes a tree, hereafter called the FOCAL SET of photographs) and (ii) photographs with other types of distinctions, showing objects other than toy men and trees—along the lines of the photographs in set 1. For example, in set 2, two photographs show brightly colored balls and two show a toy man in the middle or in the lead of a line of pigs. For current purposes, these may be treated as distractor photographs. In the following discussion, we focus on set 2 as the most relevant to transverse spatial relations.

The focal subset of horizontal plane photographs from set 2 (i.e. numbers 2.3 through 2.8, see Figure 3), show a featured object (toy man with a clear front and back) and a nonfeatured object (a toy tree with little differentiation of its sides). The arrangement of these figures was designed to elicit spatial reference in two ways: (i) discussion of differences in transverse (to the viewer/speaker) location, and (ii) discussion of differences in the orientation of the featured object (the toy man, who is facing along the transverse axis in photographs 2.3, 2.4, and 2.5). For this set, a toy man was chosen to provide obvious body features to use for locations and a toy tree was chosen as having minimally salient physical features with which to locate the toy man.

Given that these photographs are part of an interactive discourse task involving a matcher and director, we may view this set as essentially constituting its own discourse world. Within the constraints imposed by the linguistic system on the one hand, and the photo world and the particular context of play on the other hand, each director-matcher pair may devise and negotiate their own repertoire of linguistic means for identifying distinctions in that discourse world during the course of playing the game.

Recall that this particular discourse world involves the absence of visual contact between speaker and addressee. A directly linguistic result of this preimposed constraint is that direct deictic locutions and gestures (e.g. ‘this one’; explicit pointing) are useless for distinguishing stimuli from one another. Without such a constraint, such deictic

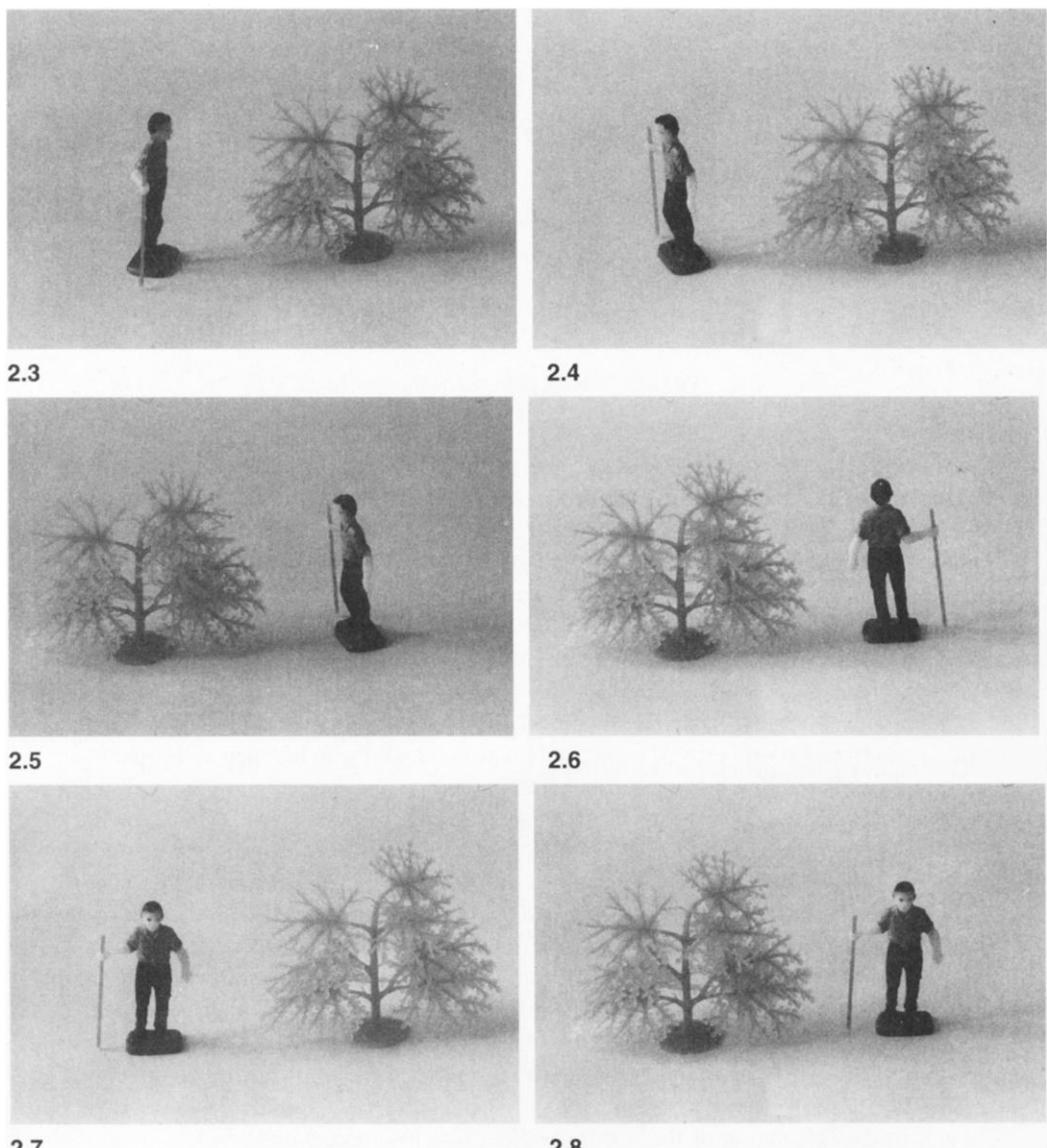


FIGURE 3. The photographs from set 2 depicting transverse relations.

indication might well have surfaced as the preferred or even the exclusive linguistic means of identifying photographs for many speakers. The motivating advantage of this elicitation design is that participants in this discourse world can draw only on the shared verbal language system to solve the problems of spatial reference posed by the task (see Weissenborn 1986).

The output of the task is a stream of interactive discourse that can be transcribed, glossed, and translated. Example 1 provides a sample verbal description of photograph 2.8 taken from the transcript of a pair of Arrernte (Arandic) speakers (collected in Central Australia by Wilkins.)

- (1) *Photo 2.8 is described as the 4th description (2:5-9-10-8-2-4-6-12-1-11-7-3)*

S.T. (woman, late thirties) directing V.D. (woman, fifties)

Game played facing north [director sitting east of matcher]

Nhenhe kenhe ularre-theke tne-me, warlpele re,

this/her but face.towards-WARDS stand-NPP, whitefellah 3SGS,

arne itwe-le. Ularre-theke are-me-le tne-me,

tree near-LOC face.towards-WARDS look-NPP-SS stand-NPP,

ikngerre-thayte-le. . . , Ikngerre-thayte-le warlpele re tne-me

east-side-LOC. . . , east-side-LOC whitefellah 3SGS stand-NPP

ularre-theke are-me, arne-arle kenhe itere-le.

face.towards-WARDS look-NPP, tree-FOC but side-LOC

'In this next one (he's) standing facing towards us, the whitefellah, next to the tree. (He's) standing looking towards us, (standing) on the east side. [Long pause, with no response from matcher] The whitefellah is standing on the east side and looking towards us, but the tree is at (his) side.'

The richness of detail embodied in such transcripts—some of it spatial and some of it nonspatial and interactional—hinders efficient and direct initial identification and comparison of basic systems of spatial reference employed by speakers from a variety of speech communities. To facilitate such comparison, further coding and processing of the data is required. In §2.2, we present one of the means we employed for making the crosslinguistic data more amenable to both qualitative and quantitative comparison. (This analysis was developed by Wilkins.)

2.2. FUNCTIONAL EQUIVALENCE. What one language does with a dedicated morpheme, another language might express with a construction and/or pragmatic rules. Accordingly, in order to allow for broad scale comparison of languages, our level of comparison can be neither morphemes nor lexical items. Rather, our level of crosslinguistic comparison must be contextually interpreted utterances.⁹ We are extending the scope of research in linguistic relativity: instead of comparing grammar alone, we are comparing linguistic PRACTICE—the meaning patterns that consistently emerge from domain-directed interactive discourse of members of a given speech community.

We begin the analysis of the focal set of game 2 with a systematized description of each pair's interaction and of the distinctions they identify. From this approach, we are able to determine the FUNCTIONAL EQUIVALENCE of propositions for certain types of extensional contrasts. For any target subset of photographs in a particular game, two propositions are functionally equivalent if they distinguish the exact same subgroup of photographs from the rest. For example, 'tree in east' will be functionally equivalent to 'man in west' for these photographs.

⁹ It may be tempting to try to compare speakers of languages that make different grammatical distinctions (as has been done by, e.g., Lucy 1992b) on the assumption that grammatical differences are somehow deeper (or at least more pervasive) than different uses of lexical elements. To conduct such research, one would need to find comparable grammatical domains which categorize conceptual-semantic distinctions differently. One would then ask whether these crosslinguistic differences in the treatment (i.e. the carving up) of the same grammatical domain correspond in a regular and predictable fashion to aspects of nonlinguistic cognitive behavior. Such an approach may be effective when it comes to pairwise comparison of languages, but runs into serious difficulties once the sample of languages includes a number of typologically distinct languages.

The metalanguage for rendering the propositions in our data is a form of annotated English. The propositions render the number of arguments (as understood in discourse), the figure/ground relation, and the particular spatial relation. In the recorded interaction, we look first for those negotiated propositions that allow the matcher to narrow his/her search domain within the subset of photographs under consideration. Such propositions are labeled DISTINGUISHING PROPOSITIONS. Propositions that are true of all focal photographs in the photo world under examination (e.g., 'there is a man' or 'the man is holding a stick') are excluded from current consideration. For example, an English-speaking director who uses an utterance which encodes the proposition 'the man is standing on the left', has narrowed the director's search domain within the focal set down to photographs 2.3, 2.4, and 2.7 (see Figure 3), and this then is considered a distinguishing proposition. To further isolate photograph 2.4 from this set of three, the director must provide an utterance with another distinguishing proposition, such as 'the man is facing to the left' or 'the man has his back to the tree', and the two distinguishing propositions together will be sufficient to enable the matcher to select photograph 2.4.¹⁰

In the Arandic example given above (1), the director uses three distinguishing propositions to identify photograph 2.8: 'man is standing east' (or more specifically 'the man is standing on the east side'); 'man is facing us' (or more specifically 'the man is standing facing towards us'); and 'tree is at man's side'.

After extracting these propositions from the sessions, we can tabulate which propositions were used by consultants when describing that photograph. We can also indicate which photographs those propositions are true of (whether or not they were used for a given photograph). The Arrernte (Arandic) example of (1) plus the additional material from that session is given in Table 3. Note that by this stage of data processing, we

TABLE 3. Distinguishing propositions used by Arrernte pair, Men and Tree focal set, Game 2.

PROPOSITION	PHOTOGRAPH					
	2.3	2.4	2.5	2.6	2.7	2.8
tree standing in east	•	•✓			•✓	
tree standing in west			•✓	•		•
man standing in east		•✓	•			•✓
man standing in west	•	•✓			•✓	
man facing (looking) eastwards	•✓					
man facing (looking) westwards		•✓	•✓			
man facing (looking) towards us (=S)					•✓	•✓
man facing (looking) away from us (=N)				•✓		
tree is at man's side				•	•	•✓
man looking towards tree	•✓		•			
man looking away from tree		•✓				
Position selected in game	12th	6th	1st	7th	11th	4th
Order selected in subset (2.3–2.8)	6th	3rd	1st	4th	5th	2nd
Successful match?	+	+	+	+	+	+

✓ proposition was said of this photograph (whether true or not)

• proposition is true of this photograph (whether used or not)

+ match successful

¹⁰ This assumes that by that point in the play, 2.4 has not been falsely selected earlier.

have abstracted well beyond the actual linguistic forms used by language in order to compare across propositions or proposition types.

Across the top of the table appear the numbers of each of the pictures in the focal set. Down the side, we note the propositions used to distinguish the photograph scenes in playing the game. We indicate with a checkmark which photograph the proposition was actually used for; a bullet indicates which photograph or photographs that proposition is in fact true of, irrespective of whether the director chose to describe the photograph with that proposition. This is relevant because the matcher could reasonably interpret that proposition as referring to each photograph we indicate with a bullet.

We group propositions according to the types of information they make use of—for example, we separate propositions about standing information ('tree standing in east') from propositions about facing information ('man facing west'). Finally, we note the order in which the photographs were selected for description in the course of the game.

As the game proceeds, the set of possible choices becomes smaller. If we were concerned with an error analysis here, the reduced degrees of freedom (and the variable order of play) in this design would become critical. Since we are simply considering the types and use of distinguishing propositions at this stage, the data are robust enough to give a clear picture of usage.¹¹

Table 3 lists contrasts on both horizontal axes (sagittal and transverse to the players). Considering just the transverse axis, we see that the propositions 'tree standing in east' and 'man standing in west' (or, more precisely, the Arrernte linguistic forms from which these propositions are derived) are functionally equivalent because they identify photographs 2.3, 2.4, and 2.7 together as a subgroup as opposed to 2.5, 2.6, 2.8.

In this contrast set, the man and the tree are arranged in such a way that from the observer's point of view in the photographs 2.3, 2.4, and 2.7 the man is on the left and the tree is on the right side of the photograph (see Fig. 3). Conversely, in 2.5, 2.6, and 2.8, the man is on the right and the tree is on the left. Accordingly, the English propositions 'man standing left of tree' and 'man standing right of tree' would be systematically functionally equivalent to respectively each of the aforementioned pairs of propositions used by Arandic players facing north. That is, the English propositions would make the same contrastive cut among the photographs.

With this type of analysis we create a database for each language which is readily comparable with all the other languages of our sample. The systems of related propositions in different languages are functionally equivalent if they reveal exactly the same pattern of contrasting subgroups of photographs. Assembling the functionally equiva-

¹¹ Still, one might ask whether the diminishing set of choices and variable playing order have a significant effect on what people say. As far as the analysis in this paper is concerned, it does not appear to. Firstly, directors often gave very full descriptions even to the last photo (on the chance of picking up an error that may have been made earlier). Table 3 for instance reveals that, for the Arrernte (Arandic) pair discussed above, the very last photo discussed in the game (2.3) was described by two distinguishing propositions ('man facing eastwards' and 'man looking towards tree'), which would have uniquely identified the photo no matter at which stage of the game the description had been given.

Further, a photo that is no longer on the table may still remain in the discourse context. In all of the sites, there are occasions where people would refer to photos that had already been described ('You remember the one where . . .', 'It's like the one that . . .'). Even where descriptions become reduced such that they do not contain the same number of distinctions as may have been given for earlier photos, the type of distinguishing propositions does not change. There is no evidence in our data that, for instance, early in the descriptions one sort of spatial language is used and in the reduced descriptions a different sort of spatial language is used. On the rare occasions where a director comes to the end and says something like 'last photo', then the proposition would not be considered a distinguishing proposition and would not show up in the table and subsequent analysis.

lent propositions across our sample of languages allows us to ask whether player-pairs from different language communities contrast the same groups of photographs in this discourse world. Because the contrast between 2.3, 2.4, 2.7 vs. 2.5, 2.6, 2.8 is the most directly relevant to our concerns about encoding of transverse spatial relations, we will limit our discussion to this specific contrast.

The first question to ask is whether this contrast between these two subsets of photographs is actually encoded by all the speech communities. (Players may solve this matching task without making a cut that groups 2.3, 2.4, 2.7.) Table 4 lists examples of (functionally equivalent) propositions that distinguish the photographs 2.3, 2.4., 2.7 from 2.5, 2.6, 2.8.¹² Language communities are ordered such that groups with similar patterns of usage are placed near one another in the table.

LANGUAGE COMMUNITY	PLAYER- PAIRS	DISTINGUISHING PROPOSITION	
		PROPOSITIONS TRUE OF PHOTOS 2.3, 2.4 & 2.7 AND NO OTHERS	PROPOSITIONS TRUE OF 2.5, 2.6 & 2.8 AND NO OTHERS
Arandic	4	'man standing in east'	'man standing in west'
Tzeltal ^a	3	'tree standing downhill of man'	'tree standing uphillwards of man'
Hai om ^b	4	'man stands in "land of soft sand"'	'man stands in "river land"'
Longgu ^c	1	'tree standing on side towards sea'	'tree standing on inland side'
Tamil	4	'tree on north'	'tree on south'
Totonac	2	'tree stands east'	'tree stands west'
Yucatec	4	'man is on my side'	'man is on your side'
Belhare ^d	3	'tree right of man'	'tree left of man'
Kgalagadi ^e	1	'man at left'	'man at right'
Japanese	3	'man is at left side of tree'	'man is at right side of tree'
Dutch	3	'man standing to left of tree'	'man standing to right of tree'
Kilivila	6	(no functional equivalent)	(no functional equivalent)
Mopan ^f	3	(no functional equivalent)	(no functional equivalent)

TABLE 4. Cross-linguistic functional equivalents.

^a See Brown and Levinson (1993a).

^b See Neumann and Widlok (1996) and Widlok (1997).

^c See Hill (1997).

^d See Bickel (1997).

^e See Neumann and Widlok (1996)

^f See Danziger (1996b, 1997, 1998).

This table illustrates, among other things, that the one subset of three photographs can be distinguished from the other in several different ways. That is, functional equivalence is independent of the semantics of the expressions. In Tzeltal (Mayan), for example, speakers use the propositions 'tree standing downhill of man', and 'tree standing uphillwards of man'. These propositions are functionally equivalent in the context of play to the Belhare (Sino-Tibetan) propositions 'tree to the right of man' and 'tree to the left of man', as well as to the Longgu (Austronesian) propositions 'tree standing on the side towards sea' and 'tree standing on the inland side'. As the English-style metalanguage is designed to evoke, the semantics of these different propositions are quite distinct. In contrast to the bulk of the languages sampled, there was a systematic absence of this contrast among player-pairs speaking Kilivila (Austronesian) and Mopan

¹² Except for Longgu and Kgalagadi—for which we only have comparable data from single pairs of players—we are certain that these are not observations idiosyncratic to specific player-pairs. The languages listed as having functional equivalences for this contrast had this contrast systematically made by all player-pairs of the game.

(Mayan). This suggests that a typological cut can be made between Kilivila and Mopan on the one hand and the other languages on the other.

In §2.3 we briefly discuss the contrast between those languages that made the functional contrast in Table 4 and those that did not. We then examine in more detail the semantic factors that account for the differences *WITHIN* the functionally equivalent proposition types used for expressing this contrast.¹³

2.3. INFORMATION TYPES. Functional equivalents are used for distinguishing pictures 2.3, 2.4, and 2.7 from pictures 2.5, 2.6, and 2.8 in many, but not all, languages in our sample. In particular, Mopan and Kilivila players do not make use of any propositions that distinguishes these specific subsets of photographs from one another. All of the players of the other languages do use such distinguishing propositions. Since this provides an obvious disjunction between Mopan and Kilivila, on the one hand, and the other languages in the sample, on the other, we can make a first typological division of our sample of languages here.

We will follow Talmy (1978) in calling the object being located the **FIGURE** and the object with respect to which the figure is located the **GROUND**. For distinguishing among these photographs, Mopan and Kilivila players used no information about transverse relations other than that which was actually about features of the figure and ground (e.g. ‘at the foot’, ‘at the side’, ‘at the edge’). While all of the other languages also used such strategies, they additionally used strategies that relied on information beyond features of the figure and ground (see Danziger 1997). For example, Mopan Maya speakers playing the Men and Tree game described the photographs in such a way as to locate the tree with respect to some part of the man’s body (his front, face, back, and so forth).¹⁴

(2) *Mopan: men-and-tree game 2.*

S. (age 19) directing her sister H. (age 17),

2.4 is described, as the first description in the game;

(2.6 was selected as the match for this description).

Ka' a-käx-t-e' CONJ 2ACTOR-seek-TR-SUBJ_3UNDERGOER ART little child DX1 a . . . t-u-pach ART at-3POSSESSOR-back ich rait	a nene' tz'ub' ada' . . . a _top'-o . . . be_located-3UNDERGOER ART bush-ECHO ke'en-∅ u-che'.	a top'-o . . . in right be_located-3UNDERGOER 3POSSESSOR-stick 'You should find this little child . . . who . . . the bush is located at his back . . . His stick is in (his) right.'
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In 2, the use of *pach* ‘back’ clearly refers to a part of the ground object (the toy man’s back) to which the figure (the tree) is related. The use of such body-part terms does not refer to regions associated with the speaker except perhaps incidentally when the speaker happens to also be the ground (see Danziger 1996b, 1997; Levinson 1996; see also Levinson & Brown 1994 for Tzeltal). This is true even where the body-part

¹³ The examples in the table are not meant to be exhaustive. Yucatec, for example, also used left and right as well as compass directions in play. Pederson (1993) presents data from twelve pairs of Tamil-speaking players of this game. Only four Tamil-speaking pairs were used for this specific analysis. The Kilivila players used no functionally equivalent propositions for this context and contrast set of photographs. However, in different contexts (see Senft 1994b), Kilivila speakers used translation equivalents of ‘right’ and ‘left’ as well as local landmarks to represent relations on the transverse axis.

¹⁴ See Danziger (1994, 1996a) for grammatical details.

terms appear to be translation equivalents of English *left* and *right*. In photograph 2.8 (see Fig. 3), the bush is to the toy man's right side and to the viewer's left side. Thus the final proposition in 3 must make reference to the right side 'part' of the toy man and not to the player or speakers in the game:

(3) *Men-and-tree game 2.*

M. (age 28) directs her female neighbor and frequent companion A. (age 32).

2.8 is described, as the first description in the game and is matched with 2.8

M: Naach-Ø a top'. Tz'ekk tzeel. Pere—
be_far-3UNDERGOER ART bush a_little side. But
‘The bush is far away. A little to the side. But—’

A (interrupts): Ich lef waj ich rait?
In left INTERROG in right?
‘To the left or to the right?’

M (replies): Ich rait ke'en-Ø a top'-o.
in right be_located-3UNDERGOER ART bush-ECHO
‘The bush is to the right.’

This kind of usage, with translation equivalents of 'right' and 'left' referring exclusively to the parts of the toy man in the photographs, will make certain distinctions among the photographs in the men-and-tree set, but not others. This usage will distinguish for example, 2.7 ('tree at man's left') from 2.8 ('tree at man's right'). But it will not readily distinguish 2.3 from 2.5 ('tree at man's chest').

In fact, none of the three Mopan directors who played the men-and-tree game made any linguistic distinction between 2.3 and 2.5 of the set. Nor was any such distinction requested by their Mopan matcher partners in the ensuing conversation. Example 4 is the full description of 2.5 offered by one Mopan director (both 2.5 and 2.3 remained on the matcher's table, and 2.3 was selected as a match).

(4) Ka' a-ka'-käx-t-e' a nene' tz'ub'
CONJ 2ACTOR-again-seek-TR-SUBJ_3UNDERGOER ART little child
a . . . t-u-ta'an ke'en-Ø top'-o.
ART at-3POSSESSOR-chest be_located-3UNDERGOER bush-ECHO
‘You should find the little child again who ... has the bush at his chest.’

It is not surprising under these circumstances that photographs 2.3 and 2.5 were often crossmatched by Mopan players. Indeed, all three player pairs made this crossmatch. (No other crossmatches were made by more than a single pair of Mopan players.) Under experimental conditions, and with larger numbers of Mopan speakers, the tendency to treat two-dimensional images which are left-right reflections of one another as similar to one another has been fully reproduced (Danziger 1997, Danziger & Pederson 1998, see also Levinson & Brown 1994, Verhaeghe & Kolinsky 1991).

Cases like Mopan and Kilivila, in which speakers consistently do not make the contrast between 2.3, 2.4, 2.7 (functionally equivalent to man 'left', tree 'right') and 2.5, 2.6, 2.8 (man 'right', tree 'left') are the minority in our sample. In most of our language data-sets, we find propositions making the distinction between these two subsets of photographs. Still, even functionally equivalent propositions that make this particular contrast between photographs show great differences in informational or semantic content across the languages. In Tamil, for instance, speakers

may say of photographs 2.5, 2.6, and 2.8 either that the tree ‘is on the left side’ or that the tree ‘is on the north side’ (when the players are facing east). But these two expressions are not informationally equivalent—even if they may be functionally equivalent in a given context. They rely on different shared knowledge and require different calculations. Without access to the circumstances of the utterance, to know that ‘the tree is on the left side’ does not tell us whether the tree is on the ‘north’, ‘south’, ‘east’, or ‘west’ side. Thus, though extensionally identical, they are intensionally distinct (as per the traditional Fregean distinction between reference and sense).

In order to translate from an information system in which a lexeme glossed as ‘left’ is embedded to one in which lexemes glossed as ‘north’, ‘south’, and so on are embedded, we need access to different information from that which was encoded in the original utterance. The system of using (speaker’s) left and right requires knowledge of the speaker’s own internal left/right division and the projections from this. The system of cardinal directions requires knowledge of the position of the figure and ground in the larger world and is indifferent to the speaker. (See Levinson 1996 for a discussion of the different logical properties of these systems.) Different pairs of speakers were tested facing different cardinal directions and any use of the cardinal terms shifted accordingly (i.e., while the man might be standing to the east in 2.7 for one pair of players, he would be standing to the north for another pair in a different orientation).

English speakers have the potential to produce utterances like ‘the bee is sitting on your north shoulder’ (intended with reference to cardinal-point north), though members of English-speaking communities would not typically use such a formulation. They would prefer to say something like ‘the bee is on your left shoulder’. Indeed, if an English-speaker were to use the formulation with the cardinal point, it is unlikely that the interlocutor would be able to rapidly and efficiently decode it. Speakers of Australian languages like Warlpiri and Arrernte (Arandic), however, have the completely opposite coding bias, and would use a cardinal-point term, not body-based ‘left’ and ‘right’ in such a context. Importantly, the lexicons of some languages (e.g. Arrernte, Guugu Yimithirr, Tzeltal) simply do not have spatial terms for left and right that generalize beyond a limited set of body parts (see also Levinson & Brown 1994, Danziger 1996b, 1998). That is, terms for ‘left hand’ and ‘right hand’ are strictly body part terms like ‘nose’ and ‘mouth’. This means that it is impossible for an Arrernte speaker to formulate anything intensionally similar to ‘The man is to the left of the tree’.¹⁵

The concept FRAME OF REFERENCE (developed in Gestalt psychology, see Asch & Witkin 1948, also Rock 1990, 1992) helps us to draw out a typology to characterize the linguistic preferences of speakers in different communities, as they differently convey particular types of spatial information in what is nevertheless a similar context. Here, the frame of reference is the internally consistent system of projecting regions of space onto a figure-ground relationship in order to enable specification of location.

¹⁵ Language contact with English may be making some inroads into Arandic. Still, Wilkins never recorded speakers using the terms *akwe-arrayt* ‘right arm/hand’ or *akwangenye* ‘left arm/hand’ for anything but body-part reference, though Henderson and Dobson (1994:75) note that ‘in directions, compass points or directions relative to some point are usually used rather than terms like ‘left’ and ‘right’, but use of these [i.e. the Arandic terms for left arm and right arm] have been adopted from English to some extent’.

INFORMATION TYPE (FRAME OF REFERENCE)	LANGUAGE
Intrinsic alone	Kilivila (Austronesian) Mopan (Mayan)
Relative Participant derived (and intrinsic) information	Japanese (Uncertain) Dutch (Indo-European)
Absolute Geo-cardinal derived (and intrinsic) information	Arandic (Pama-Nyungan) Tzeltal (Mayan) Longgu (Austronesian)
Mixed cases (relative plus absolute) Participant and geo-cardinal (and intrinsic) information	Belhare (Tibeto-Burman) Hai om (Khoisan) Kgalagadi (Bantu) Tamil (Dravidian) Totonic (Totonicapan) Yucatec (Mayan)

TABLE 5. Grouping of languages by information type (transverse axis, men-and-tree set 2).

We find three distinct types of frame of reference in our language data: (1) cases like Mopan and Kilivila in which an INTRINSIC frame of reference (see, e.g. Levelt 1984, Danziger 1997, 1998) is exclusively used;¹⁶ (2) the RELATIVE frame of reference, which uses information about the bodily arrangement of a speech participant; and (3) the ABSOLUTE frame of reference, which uses information external to both the speech participants and to the figure-ground scene (whether this is from abstract fixed bearings like 'north' or from concrete features of the larger surrounding landscape such as 'inland side').

In short, language communities may have functionally equivalent strategies for describing certain contrasts, but we cannot presume a semantic uniformity across language usage. Indeed, the underlying systems may be quite different. A summary of the typological groupings of the languages in our sample for which we have adequate data is presented in Table 5.¹⁷

Roughly half of the languages in our sample use both the relative and the absolute frames of reference in the men-and-tree game context—either the same speakers use both systems, or speakers vary within the language community. We find, however, that in some languages in our sample either all the speakers use the relative frame of reference or all the speakers use the absolute frame of reference. That is, in some language communities, speakers playing the men-and-tree game regularly provide external information that is always about a speech PARTICIPANT and never about the geography surrounding the players or about fixed bearings (GEO-CARDINAL); see examples for Dutch (5) and Japanese (6) below. In other communities, speakers provide external information which is always geo-cardinal and never about a speech participant; see examples for Tzeltal (7) and Longgu (8) below as well as for Arandic (1) above. Photograph 2.8 is described in each example for comparison.

¹⁶ We use INTRINSIC in the sense of Levinson 1996. This frame of reference includes cases in which the speaker is actually also the ground of the spatial relationship described (see Danziger 1997). Note that the photograph stimuli themselves ensure that our discussion is restricted to encodings of locations of objects situated ACROSS the viewer's line of vision only. The encoding of locations of objects on other axes (especially the vertical) can be expected to yield different typological patterns across the languages of our sample.

¹⁷ Thanks to Balthasar Bickel, Penelope Brown, Eve Danziger, Deborah Hill, Kyoko Inoue, Sotaro Kita, Stephen Levinson, Paulette Levy, Sabine Neumann, Eric Pederson, Gunter Senft, Christel Stolz, Thomas Widlok, and David Wilkins for these data. The typing in Table 5 is not intended as exhaustive. These all involve projections of coordinate systems. Use of demonstrative marking, for example, does not involve projection and it is not clear how demonstratives would fit into this scheme.

(5) Dutch (use of relative frame of reference)

*Men-and-tree game 2.**B. (age 22, female, college) directs J. (age 21, female, college)**2.8 being described as the 7th description (2:2-1-9-10-3-5-8-6-7-4-12-11)
and is correctly matched.*

even kijk-en, dan het mann-etje ook rechts van het boom-pje
 DISC see-INF, then ART man-DIM also right of ART tree-DIM
 en even kijk-en, kijk-t naar jou toe
 and DISC see-INF, see-3s to 2SOBJ PTC

‘Let’s see, then the man also to the right of the tree and let’s see, is looking at you.’

(6) Japanese (use of relative frame of reference)

*Men-and-tree game 2.**MF (age 25, female, graduate student) directs MM (age 25, female, graduate student) 2.8 described as 10th description (2:10-1-9-6-4-3-5-11-2-8-12-7)
and is correctly matched.*

MF: de ki no migi-gawa ni hito ga i-te kocchi o
 then tree GEN right-side at man NOM exist-CONN this.way ACC
 mi-te i-ru shashin
 look-CONN PROG-PRES photo

‘Then the photo where the man is at the right side of the tree and looking this way.’

MM: migi-gawa ni
 right-side at
 ‘at the right side’

MF: hai
 yes
 ‘yes’

(7) Tzeltal (use of absolute frame of reference)

*Men-and-tree game 2.**Petul (boy, age 15) and Marta (girl, age 12).**2.8 described as the 8th description (2:1-2-3-4-5-6-7-8-9-10-11-12); correctly matched*

‘Uphill’ (roughly equivalent to south) corresponds to viewer’s left,
 ‘Downhill’ (roughly equivalent to north) corresponds to viewer’s right.
 sok xan tekel te’.

with again standing(of.trees) tree

jich ay ta ajk’ol te te’-e,
 thus there.is AT uphill ART tree-PHRASE,
 te winik-e jich tek’el ta alan ine.
 ART man-PHRASE thus standing(of.humans) AT downhill there
 jich ya x-k’aboj bel ta be ine.
 thus INCPL ASP-look going AT path there

‘Again there’s a tree standing there.

Thus the tree is at the uphill side.

The man is thus standing downhill there.

Thus he’s looking towards the trail there.’

(8) Longgu (use of absolute frame of reference)

*Men-and-tree game 2.**H (adult man) directs MZ (adult woman).*2.8 described as the 9th description (2:12-7-11-1-9-3-2-6-8-5-10-4);
correctly matched*Players facing TOLI (roughly equivalent to west)*'inoni e na'o mai, m-e zuala
person 3SG face hither, CON-3SG stand

vavo-na vau-i e to'i iva
on-3SG stone-SG 3SG hold walking.stick
e na'o mai vu ala'a
3SG face hither to east
'ai oro vu asi, 'ai e zuala ava vu longa
tree bend to sea, tree 3SG stand side to inland

'The man is facing me, and he's standing
on the stone, he's holding a walking stick
he's facing me toward the east
the tree bends toward the sea, the tree stands on the inland side.'

The idea that there are three frames of reference in spatial cognition has circulated in the psychological literature since the time of the Gestalt theorists. In practice the majority of this work is concerned with the vertical dimension (e.g. Carlson-Radvansky & Irwin 1993). The idea that one might, for the purposes of everyday communication, use each of these three frames of reference to specify fixed bearings on the horizontal has not been extensively explored (recall the discussion in §1). Here we have empirically demonstrated that the choice of linguistic frame of reference for projection of coordinates in tabletop space is quite differently distributed across languages—even in a standardized referential and interactive context.

3. SPATIAL COGNITION. We now take up the question of whether the interest of our findings goes beyond a purely linguistic analysis: in particular, do the differences in crosslinguistic usage co-vary with differences in nonlinguistic spatial conceptualization and problem solving?

We take as a general premise that a variety of cognitive strategies exists for solving many problems. We also assume (uncontroversially, we believe) that the spontaneous availability of different strategies to individuals is sensitive to facts of their experience. We propose that using a language is one kind of experience that could make certain cognitive strategies (i.e. those parallel to the semantic systems used in a language) seem natural to individuals. Cognitive strategies might differ in their spontaneous availability to speakers of languages that differ significantly from one another in the relevant domain.

This leads us to a clear hypothesis for testing: *users of different language systems (in a given context) should correspondingly vary in their choice of nonlinguistic spatial problem-solving strategies (in analogous contexts).*

To test this hypothesis, we examine speakers of the typologically maximally contrastive languages: those populations where the relative frame of reference is used to the exclusion of the absolute frame of reference in tabletop space and vice versa. We exclude the purely intrinsic languages (Mopan, Kilivila),¹⁸ and the mixed case lan-

¹⁸ See Danziger (1998) for a discussion of Mopan reactions to problem-solving tasks like those described below.

guages from current consideration—although we shall examine one mixed case language in §3.4 (also see Neumann & Widlok 1996 for an account of mixed case language use). We use a nonlinguistic problem-solving task for which two different but equally correct solutions are possible. The first solution is based on information derived from the subject (isomorphic to linguistically relative). The second solution is based on information derived from geo-cardinal information (isomorphic to linguistically absolute). The responses must demonstrate which information was selected for the solution independently of any linguistic formulation or protocol.

3.1. LOGICAL PROPERTIES OF FRAMES OF REFERENCE. The immediate problem is that both relative and absolute frames of reference are functional equivalents in many contexts—as for example demonstrated in the men-and-tree game. How then do we distinguish between behavior structured by reference to an absolute frame of reference from behavior structured by reference to a relative frame of reference?

When the relation between a figure and ground is encoded (linguistically or otherwise) using an absolute frame of reference, the figure and ground retain the same encoding even when the speakers or viewers change their viewpoint on the scene. That is, a cup to the north of a saucer remains to the north of a saucer INDEPENDENT of which side it is viewed from.

Conversely, when the relation between a figure and ground is encoded using a relative frame of reference, the figure and ground have different encoding whenever the speakers or viewers move themselves around the array. That is, a cup to the speaker's left of the saucer from one perspective may be to the right of a saucer when the speaker has moved to view the display from the other side (without any movement or rotation of the figure or ground). The encoding of the arrangement is viewpoint DEPENDENT.¹⁹

This difference between the logical properties of these two frames of reference allows us to create a context in which the different logical properties become apparent. An array is memorized or mentally encoded at one location from one perspective and then the subject is rotated 180 degrees to another location. An array reconstructed using relative encoding should resemble a 180-degree rotation of an array reconstructed using absolute encoding and vice versa (see Fig. 4).

A battery of experimental tasks was devised that exploited the property of viewpoint-independence (associated with absolute systems) vs. viewpoint-dependence (associated with relative systems). In §3.2, we discuss the rotation experiment, which has been conducted on the largest collection of populations; in §3.3, we briefly discuss four similar experiments.

3.2. EXPERIMENTAL TASK: ANIMALS-IN-A-ROW. This experiment involves memorizing a transverse sequence of three different toy animals all right-left symmetrical and all facing the same direction.²⁰ The subject is then turned around 180 degrees and reconstructs the memorized array. Our interest is the direction the three animals are facing in the reconstructed array (see Fig. 5). The two distinct types of conceptual coding demonstrated by the directional placement are isomorphic to the absolute and relative linguistic frames of reference.

¹⁹ When an array is encoded using only an intrinsic frame of reference, then the relations are constant INDEPENDENT of moving the viewer (as in the experiment to be discussed) or even of rotating the entire array as a unit.

²⁰ Critical assistance with design and analysis of the experimental tasks presented in this paper was provided by Suzanne Gaskins, John Lucy, László Nagy, and Bernadette Schmitt.

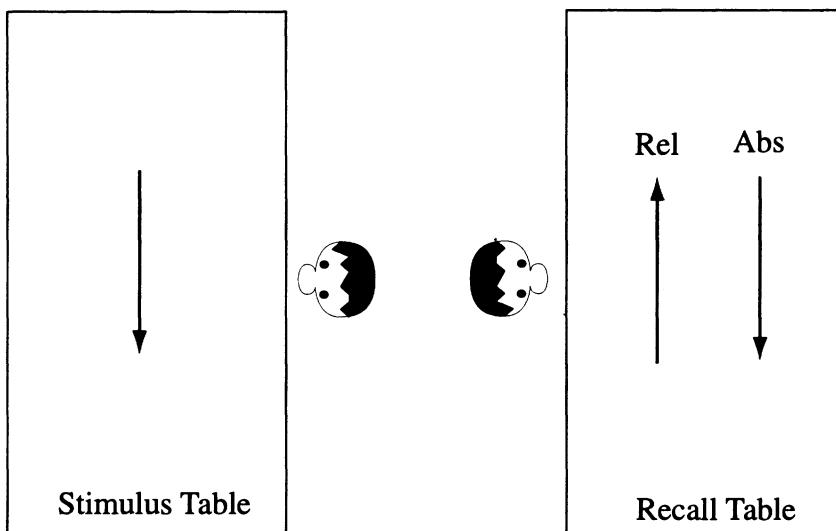


FIGURE 4. Schema of absolute vs. relative encoding under 180° rotation.

The task of placing the animals facing in a specific direction is essentially embedded in the primary task of placing the animals down in the memorized order. In one type of conceptual coding, the direction of animals is encoded with respect to the subject's body and his/her orientation. Thus, if body orientation is changed between stimulus and recall, what is retrieved from memory is constant to the body-frame, and no allowance is made for the change in fixed bearings with respect to the larger external world. We call this type of encoding RELATIVE CONCEPTUAL CODING. In the other type of conceptual coding, the direction is encoded with respect to anchoring points that lie outside of the memorized array itself and also outside of the subject's body. Possible anchoring points

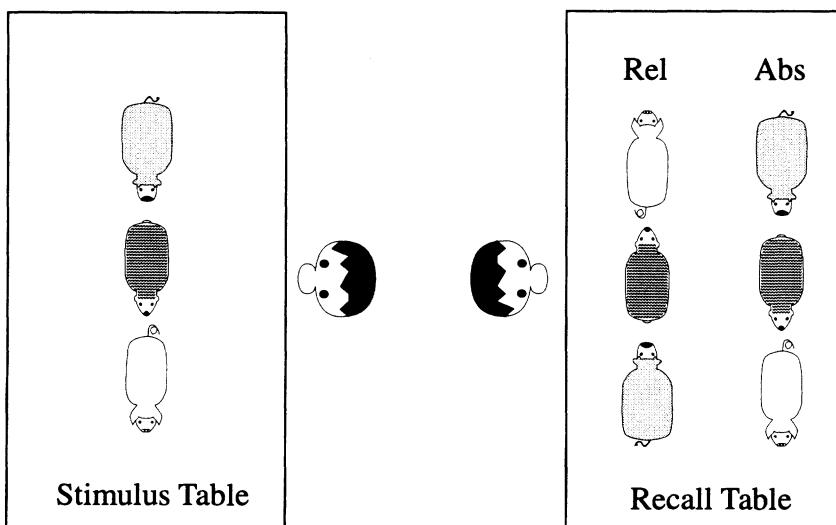


FIGURE 5. Animals-in-a-row experiment.

include cardinal points and landmarks. Unlike the relative conceptual coding, this type of coding is not sensitive to the body orientation at retrieval. We call this ABSOLUTE CONCEPTUAL CODING.

Spatial context in this recall task was the tabletop representation of toy objects separated by a small distance from each other. This gave a highly similar context to the men-and-tree linguistic task presented in §2.1 as well as to other linguistic tasks (not described here) involving toys and figures presented in tabletop or manipulable space.

STIMULI. The stimuli were four plastic toy animals (pig, horse, cow, and sheep) from the Duplo™ series for infants. Their shapes are symmetrical along their head-to-tail (sagittal) axis. The four animals have distinct colors and shapes. The sizes range from five to seven centimeters from the head to the tail, and they are all 2.5 cm wide and 3–4 cm tall.

LAYOUT. Two parallel tables or mats were placed about 4–6 meters apart such that the subject stood between the two tables and rotated 180 degrees in walking from the one to the other.²¹ The subject started at the stimulus presentation table and then turned and walked to the recall table.

SUBJECTS. In the interest of maintaining a clear prediction from the linguistic type, we focus on the responses of subjects who were either linguistically relative or linguistically absolute in this context. Forty Dutch, 16 Japanese, 27 Tzeltal, 16 Arrernte, and 16 Longgu adult native speakers (mixed male and female) were recruited in their native speech communities (see Table 1 for the researchers responsible for the data collection; the Japanese experimental data was collected by K. Inoue).

PROCEDURE. Each subject was tested individually. A session consisted of several training and practice trials followed by five recorded trials, as described below.²² The animals were identified with the appropriate linguistic forms. For all trials, the experimenter set up a row of three animals from the four available on the presentation table. Animals were separated from each other by roughly six centimeters.

Throughout the experiment, all instructions were given in the subjects' native language. Instructions did not contain any words denoting spatial directions or locations. If a reference to a location or direction became necessary during the training, deictic terms ('here') and pointing gestures were used.

A line of three animals facing to either the subject's left or right was assembled. The subjects were told to remember the animals 'just as they are'. The subjects were allowed to look at the stimulus array as long as they liked. The subjects were asked whether they were ready, and if they were, the array was removed. For the initial practice trial(s), the subject immediately replaced the animals on the stimulus

²¹ A variant of this design would be to have the tables set up such that the subject rotated 90 degrees in walking from one to the other. Such a design would provide a more visually striking difference between absolute and relative rebuilding strategies, that is, the two rebuilds would be perpendicular to one another. We elected not to run this design in the comparative study because it is not clear in such a design that the subject following each strategy would have comparable tasks: an absolute strategist would be rebuilding an array which would be on a saliently different visual axis from the originally viewed array. The relative strategist would be rebuilding on the same visual axis. This was considered a potentially unbalanced design.

²² A small number of trials was administered for each subject because keeping a subject in a novel testing situation for an extended period of time was not socially appropriate in some field sites. Nonetheless the results do demonstrate a general difference between two groups of individuals (speakers of linguistic groups using either an absolute or a relative frame of reference in the context examined).

presentation table without any subject body-rotation. The direction and the order of animals were corrected if necessary. This procedure was repeated until the subject's performance became consistent. Note that as long as the subject remains at the stimulus presentation table, any rebuilding according to either relative or absolute information will be identical, so neither encoding is cued.

In the recorded trials, the rebuilding was performed after thirty seconds delay at the recall table.²³ Subjects were told that they would do the same thing, but that this time they should reconstruct the sequence of animals on the other table. Again, three animals were placed on the presentation table. After the subject indicated readiness, the animals were removed. The subject was requested to wait for thirty seconds, and then walk to the recall table. Here, the experimenter offered the animals to the subject, and said 'Make it again, just the same'. No correction was made to the subject's response. All presentations were on the transverse axis. The order and direction of the stimulus array were changed for each trial, according to counterbalanced sequences repeated across sets of eight subjects.

CODING. Responses were coded for either absolute or relative DIRECTION in which the animals were facing when rebuilt. Occasionally a subject rebuilt the animals in a line that was off the transverse axis; these responses were recorded as neither absolute nor relative.

The SEQUENCE (e.g. cow right/east–sheep middle–horse left/west) in which the animals were rebuilt was also recorded as either absolute, relative, or different from the original sequence. This sequence information primarily indicates how well the subject remembered the original array. For example, if the display cow-sheep-horse is rebuilt as sheep-cow-horse, this is a poorly remembered trial and not considered in terms of absolute/relative response. (The task of directional placement is embedded within the 'more difficult' task of remembering the sequence of the animals.) When the rebuilt sequence is identical to that of the original array, it can be coded as relative (e.g., cow right/west, sheep middle, horse left/east) or absolute (horse right/west, sheep middle, cow left/east).

RESULTS. The instructions should have given the subjects a primary understanding of the task as rebuilding the line of animals in the same sequence as on the presentation table. Attention to the direction the animals were facing was less consciously focal. Evidence that direction was less consciously attended to comes from debriefing interviews with the Arandic subjects: fourteen of sixteen subjects reported having used a mnemonic for remembering the order of the animals. Eight subjects reported using only visual imagery, four reported word or letter repetition of animal labels, two reported both, and two were unable to say. In contrast to consciously remembering order, only seven of the 16 subjects reported having a mnemonic for remembering the direction of the animals (and many who could not report a strategy were surprised to hear that the animals had been put down in different directions on the stimulus table over the different trials). Five subjects reported using visual imagery, and two reported a mix of imagery and labeling for landmark and cardinal direction. That only two out of 16 subjects reported a conscious linguistic mnemonic for directional information suggests

²³ This delay reduces the chance of simple recall from short-term memory. Subjects were allowed to look at whatever they wanted (typically at the clock indicating elapsing seconds). The subject and experimenter did not converse during this period. There was additional delay and visual input resulting from walking between the tables.

that this measurement is largely of nonlinguistic behavior. Accordingly, we will discuss the results from the directional coding as the more likely indicator of nonlinguistic cognitive encoding. Nonetheless, there was a very high correlation (Spearman correlation coefficient = 0.938, $p < 0.005$) between the sequence and the direction responses.

Implementation of this task yielded one rebuilding strategy that we had not anticipated: five Arrernte, three Longgu, and two Dutch speakers were excluded from the final analysis because they showed a recall pattern with invariant orientation on every trial (for example, always facing the animals toward the window)—regardless of the original facing-direction on the presentation table. This pattern of response reveals no choice between relative or absolute conceptual coding, but rather a MONODIRECTIONAL strategy, which falls outside of the hypothesis to be tested (see Danziger 1998). After excluding these monodirectional subjects, all the responses from the five groups of subjects can be classified as either an absolute directional response or a relative directional response; that is, whether the display is rebuilt according to absolute or relative spatial recall.

We graph the linguistic absolute samples (Tzeltal, Longgu, and Arandic) in Figure 6 and graph the linguistically relative samples (Dutch and Japanese) in Figure 7. The subjects (excluding those with monodirectional responses) are plotted according to the individual's number of absolute responses over five trials. Note that fewer absolute responses is the logical equivalent to more relative responses since the number of absolute responses and relative responses always adds up to five (no responses were placed off the transverse axis). For example, 16 of 27 Tzeltal subjects gave 5 absolute and 0 relative responses; 4 of these 27 gave 4 absolute and 1 relative responses, and so on.

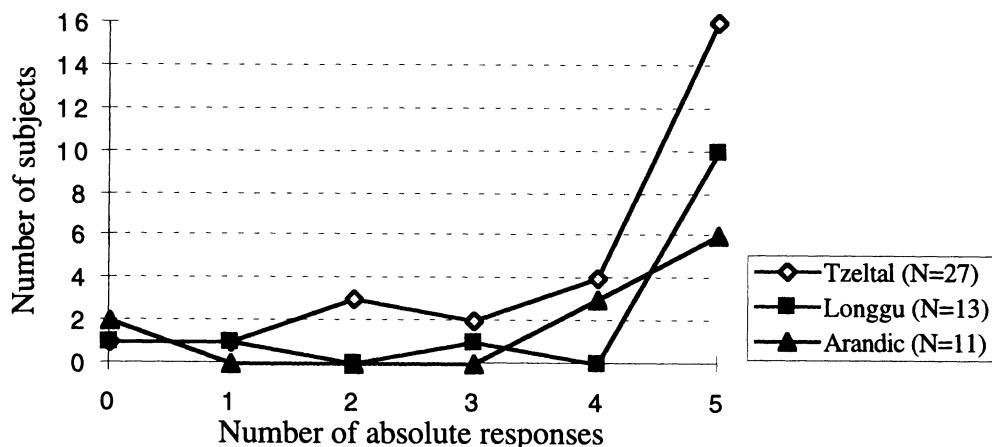


FIGURE 6. Relation between absolute language use and spatial recall.

The subjects from both of the populations using a relative frame of reference to describe the transverse axis of the men-and-tree language game were clearly more likely to give conceptually relative responses. Subjects from each of the populations using an absolute frame of reference were more likely to give conceptually absolute responses. When the linguistically absolute populations ($N = 51$) and the linguistically relative populations ($N = 54$) are compared with respect to the ratio of absolute responses over all trials, the difference between the two groups is statistically very highly reliable (Mann-Whitney U test, $U = 241.5$, $p < 0.001$). (The average number of absolute

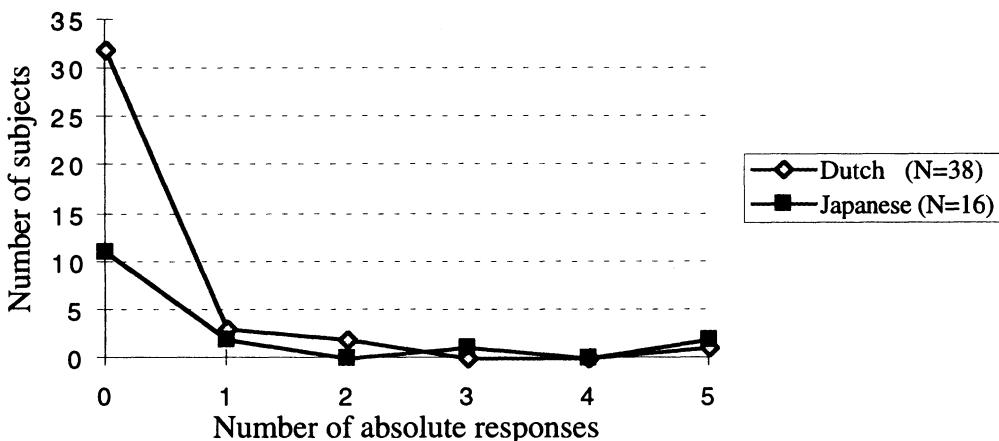


FIGURE 7. Relation between relative language use and spatial recall.

responses (out of 5 trials) was 0.50 for the linguistically relative groups combined and 4.02 for the linguistically absolute groups combined.)

The results indicate that the frame of reference identified in the linguistic elicitation task correlates well with the conceptual frame of reference used in this recall task. Other within-population variables which were coded, such as literacy, gender, age, and degree of schooling do not reliably correlate with cognitive performance in this experiment.²⁴

3.3. DISCUSSION. This work constitutes one of the few attempts to investigate the relation of language to conceptual representation—*independently measured*—over a sample of cultures, exploiting the contrastive properties of various languages in one domain. The results indicate that there is indeed a general correlation between the way language use preferentially encodes a spatial array, and the way that speakers of that language will tend to code it for solving certain nonlinguistic tasks.

While the direction of causation has not been demonstrated, these results are consistent with the hypothesis that the language one speaks—perhaps together with other cultural facts—*influences the types of conceptual parameters one will use to solve a nonverbal problem*. Since language use is a reflection of social behavior (the men-and-tree data derive from social communication), the patterns of language use are associated with linguistic communities.

Our results indicate that individuals cognize in the same way within communities, but not necessarily across communities. How could this be so, if not ultimately the result of a communicated model? The linguistic system of encoding a spatial frame of reference provides just such a model. Other semiotic and cultural systems may well enter into the equation, but this linguistic representation is highly prominent. In order for a speaker to use a frame of reference linguistically, there simply must be an internal representation fully consistent and translatable with that frame of reference.

We still need to determine to what extent the results from these specific contexts can be generalized across other aspects of spatial language and cognition. As mentioned

²⁴ However overall, the linguistically relative communities are more formally educated than the linguistically absolute communities.

in §2.1, the men-and-tree data are generally in alignment with language data derived from other methods and contexts (from different language games to naturalistic observation). Table 6 lists a number of other cognitive experiments that further tested the extent to which an absolute vs. relative linguistic system is reflected in memory and reasoning within the context of tabletop or manipulable space. Detailed results are not given here, but the experiments are summarized below.

All of these nonlinguistic tasks shared the fundamental design of the animals-in-a-row experiment. That is, the subject is shown stimuli on one table. He or she is rotated 180 degrees and led across to an opposite table. The subject then reconstructs, selects, or makes an inference on the basis of the stimuli earlier presented.

Because of differing field conditions, not all language communities tested with the animals-in-a-row memory experiment were tested with each of the other experiments. Overall, the results of each of these experiments support our basic hypothesis: subjects speaking languages typed as either relative or absolute for transverse relations mentally encoded and reasoned in ways homologous to the linguistic encoding. From this, we feel confident that the phenomenon we are describing extends across multiple tasks and contexts.

Conducting sets of these experiments also allows for a more in-depth examination of the specifics of individual language communities. Some such studies have been reported for Kilivila (Senft 1994a), Mopan (Danziger 1998), Tamil (Pederson 1995), Tzeltal (Brown & Levinson 1993a, Levinson & Brown 1994), plus a pair-wise comparison of Kalagadi and Hailom (Neumann & Widlok 1996). These provide a complement to the broader crosslinguistic approach discussed so far.

EXPERIMENT	COGNITION TESTED
Animals-in-a-row	Visual recall memory of objects
Red and blue chips	Visual recognition memory of 2-D shapes
Completed path task	Recognition memory, inference
Motion maze task	Recognition memory, cross-modal interpretation
Transitive inference	Memory, inference

TABLE 6. Experiments that contrast absolute vs. relative encoding.

In experiment 2 (red and blue chips) the subject sees a card in a specific orientation with two simple geometric figures printed on it.²⁵ After rotation, the subject selects from an array of four identically imprinted cards, each varying only in orientation, and not representational of real world objects. Like the animals-in-a-row experiment, this task tests recognition memory encoding under rotation. In this experiment, however, the cards are all identical except for their spatial orientation. There is also the presentation of stimuli at 90-degree rotations as well as 180-degree rotations.

In experiment 3 (completed path task) the subject is shown a printed path to some point with a final missing section.²⁶ After the interval and rotation, the subject selects one of three printed plastic cards as the one which shows the path section that would complete the original path. Like experiment 2, this tests recognition memory under rotation. Unlike experiment 4, the stimuli are entirely static, but there are multiple

²⁵ More complete descriptions of this experiment can be found in Brown & Levinson 1993b and Pederson 1995.

²⁶ More complete descriptions of this experiment can be found in Brown & Levinson 1993b and Pederson 1995 as well as in Levinson 1998 and Danziger 1998.

routes (both relative and absolute) which could complete the path and the subject selects one of these at table two.

In experiment 4 (motion maze task) the experimenter moves a toy man on the presentation table to form a path having one or two 90-degree turns.²⁷ After an interval, the subject is rotated and presented with a printed maze/map with a complex network of intersecting paths. The subject indicates where the toy man would arrive following the original path from the center of the maze. This tests inference of location following a motion event with rotation of the subject. The subject sees a motion event and anchors that in a static path, preserving relative or absolute encoding in the process.

Experiment 5 (transitive inference) tested transitive inference in spatial relations (see n. 25). The subjects are shown geometric objects A and B side by side on the presentation table. On the second table, they see objects B and C also side by side. Returning to first table (now completing 360 degrees rotation), the subject infers the nature of the spatial relationship between A and C. This tests both recall memory and the logical elements used during a challenging spatial reasoning task. The results of experiment 5 for two (sub-)populations are discussed in §3.4.

3.4. THE MIXED LANGUAGES. In addition to gathering results from other experiments, we also gathered results for many other languages than those reported for the animals-in-a-row experiment. Recall that roughly half of the languages included in Table 5 are coded as 'mixed'. This category does not mean the same thing for each language. Each of these languages presents a unique and complex situation.

As one example, Pederson (1993) presents a case study of one so-called mixed population. The Tamil language (South Dravidian) has a full set of cardinal direction terms as well as terms used for the regions projected from speaker's left and right sides. These appear to be (at least passively) part of the complete lexicon of all adult speakers, but familiarity with the linguistic use of these terms varies widely depending on the exact subcommunity to which the speakers belong. Most speakers (at least in the Madurai district of South India where these studies were conducted) use only the relative and intrinsic frames of reference or use only the absolute and intrinsic frames of reference in the men-and-tree game discussed above. Pederson collected examples (9 and 10 here) from two different pairs of speakers describing and successfully matching photograph 2.8.

(9) *Tamil: men-and-tree game 2 (relative frame of reference)*

V. (male, c. 25) directing K. (male, c. 32).

2.8 is described and correctly matched. (2.7,6,1,10,4,8,2,12,9,5,3,11)

un-kal valatu-kkai pakkatt-ile oru paiyan iru-kkir-aañ

2.OBL-RESP right-hand side-LOC INDEF boy COP-PR-3SM

a-nta . . . valatu-kkai-le oru kampu iru-kki-tu

DIST-DEM right-hand-LOC INDEF stick COP-PR-3SN

a-nta paiyan un-kal-aip paar-ttiru-pp-aañ . . .

DIST-DEM boy 2-RESP-ACC see-PERF-FU-3SM

'There's a boy on your right hand side.

That . . . There's a stick in his right hand.

The boy is looking at you.'

²⁷ This experiment was designed by Pederson.

(10) *Tamil: men-and-tree game 2 (absolute frame of reference)*

M (male, age 23) directing S (female, age 55). Players facing north.

2.8 is described and correctly matched. (2.1,2,3,4,5,6,7,8,9,10,11,12)

oru ceti meer-ku pakkam iru-kk-u

INDEF plant west-DAT side COP-PR-3SN

kiya-kku pakkam oru paiyan ni-kkir-aan

east-DAT side INDEF boy stand-PR-3SM

a-van vanter-ku mukam tirump-i ni-kkir-aan

DIST-3SM TOPIC south-DAT face turn-ADV stand-PR-3SM

'There's a plant on the west side.

On the east side a boy is standing.

He is standing with his face turned to the south.'

Essentially, while Tamil may be listed as showing mixed relative and absolute usage in Table 5, individual speakers largely are either relative speaking, or absolute speaking, but not both. We can clarify our linguistic typing of Tamil into two distinct subpopulations: absolute speaking and relative speaking (in the contexts represented by the men-and-tree description task).

The animals-in-a-row experiment was conducted with Tamil subjects. There was a clear difference between the relative and absolute speaking subsamples: 45% (14 of 31) of the linguistically absolute Tamils gave monodirectional responses. Only 12% (2 of 17) of the linguistically relative Tamils gave monodirectional responses. Further study is needed to understand why so many in the absolute speaking subsample, but few in the relative speaking subsample, show a preference for monodirectional responses in the animals-in-a-row task.

The remaining subjects in both subpopulations (those who did not give monodirectional responses) were often typable as consistently giving either absolute or relative response types. However, many subjects would alternate response types and there was no clear preference in either group for either conceptual frame of reference in this experiment.²⁸

The animals-in-a-row task thus does not provide clear data for the complex Tamil situation, but the experiments mentioned in the previous section all provided clearer Tamil results. In the transitive inference experiment, for example, there is a highly reliable contrast between relative and absolute speaking Tamil subjects in their choice of a solution to the nonlinguistic task ($p < 0.001$ for comparison between samples; $p < 0.01$ for linguistically relative vs. chance; $p < 0.05$ for linguistically absolute vs. chance). See Figure 8.²⁹

From this, we can see that even within a single language, the use of a single linguistic frame of reference by a particular speaker can correlate with that person's choice of nonlinguistic problem-solving strategy. We should not, therefore, conclude that differences across populations rest only on the grammatical or lexical resources which are available in the languages as a whole—that is, the full repository of possibilities across speakers and dialects (cf. Hymes 1966 and Lucy 1996:52–55). We must look at the

²⁸ In contrast, while 5 of 16 Arandic subjects also gave monodirectional responses to the animals-in-a-row experiment, the remaining subjects showed a clear preference for absolute responses.

²⁹ The results for this task reported in Pederson 1995 do not reflect all of the subjects reported on here. Further, that paper collapsed results from two slightly different versions of the experiment. All of the subjects reported on here performed the same version of the experiment and should be strictly comparable with one another.

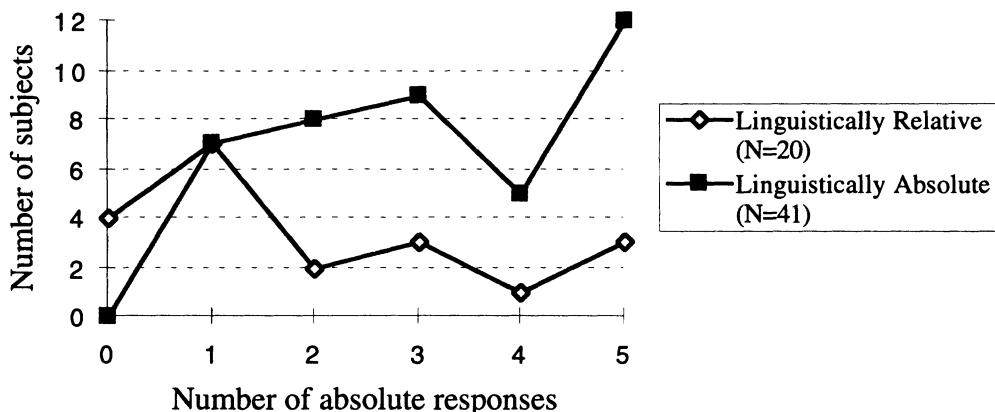


FIGURE 8. Absolute vs. relative-speaking Tamils on transitive inference.

habitual language usage of individual speakers in specific contexts. This use can crucially depend on the social environment. Most relative speakers of the Madurai district live in the city of Madurai itself. Most absolute speakers of the same district live in rural areas. However, the correlations are only approximate and the exact nature of speech communities is being investigated.³⁰

4. CONCLUSIONS

LINGUISTIC FINDINGS. Communities differ in dramatic ways with respect to spatial reference in language. Importantly, we find that the human body is by no means a universal template for creating projective coordinate systems for spatial reference in tabletop space.

A major crosslinguistic variation in spatial description is the FRAME OF REFERENCE employed to describe different spatial arrays. In our sample, we find three major linguistic coordinate systems relevant to figure/ground locations on the transverse axis. These we have called ABSOLUTE (based on fixed bearings or other geo-cardinal notions), RELATIVE (based on perspectival concepts such as 'in front (of me)', 'to the left') and INTRINSIC (based on object coordinates such as 'behind (the house)', 'at the tip of the post').

Many language communities use a variety of absolute or geo-cardinal systems in precisely the same contexts in which other language communities use relative projections of the speaker's left, right, front, and back body parts. Other language communities use neither system in this context, relying solely on features intrinsic to the referential objects themselves.

These differences between language communities are quite systematic: (i) the available number of general spatial systems which are found can be sorted into a limited set of categories; (ii) given a constant context, speakers within certain communities are generally consistent in their choice of spatial systems—demonstrating a general pattern for that community; and (iii) even when the semantics of one system differs dramatically from the semantics of another system (as in the case of relative vs. absolute language use), we find that different systems may be used to make functionally equivalent contrasts.

³⁰ In this connection, note that the characterization of Mopan spatial language given here is most appropriate to female speakers (see Danziger 1997). The reports for the other languages in the linguistic data collection do not indicate any gender differences in this domain of spatial language. These characterizations of Tamil language use clearly apply to both the men and women within each linguistic subcommunity.

METHODOLOGICAL INNOVATIONS. The most general lesson from these findings is that we must look carefully at broad samples of languages and language communities before assuming (or positing) linguistic universals—no matter how intuitively obvious these universals might seem. Further, it is not enough to rely on conventional grammatical descriptions of languages. The grammatical structure of a language is certainly an important determinant of the structures of contextualized language use. As such, general grammatical descriptions of a language can be used to formulate hypotheses about linguistic relativity but such grammatical descriptions must be carefully checked against the precise communicative strategies recurrently used in the relevant contexts. To do this, we have used director/matcher language games, which facilitate interactive discourse between native speakers on precisely our topics of interest. The linguistic data from these sessions are both reliable and efficiently collected. These approaches based in actual linguistic usage offer a considerable refinement over purely grammatically based approaches to the enigmatic relationship between language and thought. Further, the standardized nature of these games allows more exact comparison across languages than is possible with traditional elicitation methods.

Turning to the question of the relation between linguistic and cognitive representations, it is critical to determine the cognitive representation independently of the linguistic representation. To do this, the cognitive tests must be as minimally linguistic as possible. We developed a battery of nonlinguistic experiments for recall, recognition, and inference among spatial arrays.

While the determination of cognitive representation must proceed independently from the linguistic data collection, we must also remember that language use is always contextually dependent. Because of this, we must also carefully coordinate the contexts of the cognitive tests such that they share as much context with the linguistic elicitation as possible.³¹

An initial problem for our project was that the absolute and relative frames of reference are functionally equivalent in most contexts and therefore difficult to distinguish in most nonlinguistic behavior. However, when the subject is rotated by 180 degrees, each frame of reference has its own discernible logical properties. This allows us to design cognitive experiments in such a way that the subjects' responses indicate the frame of reference they are using.

COGNITIVE FINDINGS. We hypothesized that users of different language systems should vary in their choice of nonlinguistic spatial problem-solving strategies in a way analogous to their language use. The findings of our cognitive experiments are indeed parallel to our linguistic findings.

As with the linguistic findings, there is a fairly consistent pattern of cognitive response within each community, and communities differ dramatically from one another. Cognitive representations of seemingly basic spatial relations are culturally variable in nontrivial ways: people from different groups clearly categorize these relations differently, even when their behavior might initially appear superficially similar (e.g. functionally equivalent in terms of the types of contrasts made).

Most importantly, there is a striking relation between the cognitive responses and the linguistic patterning of each community. Subjects from language communities

³¹ This is also vital in Lucy's approach (1992b: chap. 1), although he phrases the problem differently: the investigator must have a third standard of reality from which to independently evaluate the cognitive and linguistic data. Having sufficiently similar stimuli for both the linguistic and the cognitive data collection works toward this end.

where the absolute frame of reference is dominant in tabletop space also tend to perform nonlinguistic tasks in tabletop space using an absolute frame of reference. Subjects from language communities that employ a relative frame of reference in the same domain tend to perform the nonlinguistic tasks using a relative frame of reference. In short, linguistic coding correlates strongly with the way spatial distinctions are conceptualized for nonlinguistic purposes.

LINGUISTIC RELATIVITY. Our results of course, hold only for the single domain of transverse relationships in tabletop space. Perhaps the domain we chose to investigate happened to yield these results because of some idiosyncrasy of the domain; we do not presume generalizability to other domains. For this reason, these findings are just one part of a larger program systematically investigating issues of linguistic relativity across a variety of conceptual and linguistic domains.

We do, however, feel optimistic that these correlations between language and thought will generalize to some other domains as well—when these are investigated in the manner described here. The domain of these spatial relations seems especially basic to human experience and is quite directly linked to universally shared perceptual mechanisms. Since linguistic relativity effects are found here, it seems reasonable that minimally they could be found in other, less basic domains as well. Finally, there must be a mechanism at work that creates mental representations consistent with social language use. It seems improbable that such a mechanism would be specific only to this one domain. Rather, such a mechanism would potentially operate across many areas of human cognition.

What then might this mechanism involved in linguistic relativity consist of? We surmise that language structure—as instantiated in the social patterns of language use—provides the individual with a system of representation, some isomorphic version of which becomes highly available for incorporation as a default conceptual representation. Far more than developing simple habituation, use of the linguistic system, we suggest, actually forces the speaker to make computations he or she might otherwise not make. Any particular experience might need to be later described, and many are. Accordingly many experiences must be remembered in such a way as to facilitate this. Since it seems, based on our findings, that the different frames of reference cannot be readily translated, we must represent our spatial memories in a manner specific to the socially normal means of expression. That is, the linguistic system is far more than just an AVAILABLE pattern for creating internal representations: to learn to speak a language successfully REQUIRES speakers to develop an appropriate mental representation which is then available for nonlinguistic purposes.

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Eric Pederson
 Linguistics Department
 1290 University of Oregon
 Eugene, OR 97403
 [epederso@darkwing.uoregon.edu]

[Received 6 January 1997;
 revision received 4 November 1997;
 accepted 25 November 1997]