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Turning the Tables: Language and Spatial Reasoning*

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Abstract

This paper investigates possible influences of the lexical resources of individual languages on the conceptual organization and reasoning processes of their users. That there are such powerful and pervasive influences of language on thought is the thesis of the Whorf-Sapir linguistic relativity hypothesis which, after a lengthy period in intellectual limbo, has recently returned to prominence in the anthropological, linguistic, and psycholinguistic literatures. Our point of departure is an influential group of cross-linguistic studies that appear to show that spatial reasoning is strongly affected by the spatial lexicon in everyday use in a community (Brown and Levinson, 1993b; Pederson et al., 1998). Specifically, certain groups use an absolute spatial-coordinate system to refer to directions and positions even within small and nearby regions ("to the north of that coconut tree") whereas English uses a relative, body-oriented system ("to the left of that tree"). The prior findings have been that users of these two types of spatial systems solve rotation problems in different ways, ways predicted by the language-particular lexicons. The present studies reproduce these different problem-solving strategies in monolingual speakers of English by manipulating landmark cues, suggesting that the prior results were not language effects at all. The results are discussed as buttressing the view that linguistic idiosyncracies do not materially restrict the thought processes of their users.

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Running head: LANGUAGE AND SPATIAL REASONING

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Abstract

This paper investigates possible influences of the lexical resources of individual languages on the conceptual organization and reasoning processes of their users. That there are such powerful and pervasive influences of language on thought is the thesis of the Whorf-Sapir linguistic relativity hypothesis which, after a lengthy period in intellectual limbo, has recently returned to prominence in the anthropological, linguistic, and psycholinguistic literatures. Our point of departure is an influential group of cross-linguistic studies that appear to show that spatial reasoning is strongly affected by the spatial lexicon in everyday use in a community (Brown and Levinson, 1993b; Pederson et al., 1998). Specifically, certain groups use an absolute spatial-coordinate system to refer to directions and positions even within small and nearby regions ("to the north of that coconut tree") whereas English uses a relative, body-oriented system ("to the left of that tree"). The prior findings have been that users of these two types of spatial systems solve rotation problems in different ways, ways predicted by the language-particular lexicons. The present studies reproduce these different problem-solving strategies in monolingual speakers of English by manipulating landmark cues, suggesting that the prior results were not language effects at all. The results are discussed as buttressing the view that linguistic idiosyncracies do not materially restrict the thought processes of their users.

I. Introduction

Language has means for making reference to the objects, relations, properties, and events that populate our everyday world. Commonsensically, the relevant linguistic categories and structures are more-or-less straightforward mappings from a preexisting conceptual space, programmed into our biological nature. This perspective would begin to account for the fact that the grammars and lexicons of all languages are broadly similar, despite historical isolation and cultural disparities among them; moreover, that the language learning functions for young species-members look about the same across languages.

But having assigned the language identities to underlying conceptual identities among their users, what are we to make of the — less pervasive, but also real — linguistic differences among languages? Could it be that the situation is symmetrical? That insofar as languages do differ from each other, there are corresponding differences in the modes of thought of their users? More marvelously by far, could the linguistic differences be the original causes of distinctions in the way peoples categorize and reason? Benjamin Whorf and Edward Sapir offer a positive answer to such questions. In Sapir’s words:

> Human beings do not live in the objective world alone, nor alone in the world of social activity as ordinarily understood, but are very much at the mercy of the particular language which has become the medium of expression...the “real world” is to a large extent unconsciously built up on the language habits of the group (E. Sapir as quoted by Whorf 1956; p. 134).

The popularity of this position has diminished considerably in academic favor in the last half of this century, for two main reasons. First, the universalist position of Chomskian linguistics, with its potential for explaining the similarities of language learning in children all over the world, captured the imagination of a generation of scholars. Second, a series of experimental studies documenting the independence of hue and brightness perception from linguistic color-naming practices seemed to settle the controversy in favor of the universalists (see particularly Berlin and Kay, 1969; Heider, 1972; Heider and Oliver, 1972; Jameson and Hurvich, 1978).

Recently, however, a number of discussions and experimental studies have reawakened interest in the question of how language may influence and shape thought. Rightly, the studies of color vision and naming, elegant and compelling as they were, have been judged too topically narrow as the basis for writing off the position as a whole. Even more important, effects of language use, or indeed any learning effects at all, would be least likely in peripheral, low-level perceptual processes such as hue discrimination. Therefore they do not constitute a fair test (Lucy, 1996).

Many recent studies have focused on a more central perceptual domain: commonalities and differences in how languages treat spatial properties and relations (Jackendoff, 1996; Talmy, 1978). To be sure, ultimately linguistic-spatial categories must be built upon a universal perceptual base originating in brain structure shared by all nonpathological humans (Landau and Jackendoff, 1993). But within these constraints there is room for languages to differ. This possibility is instantiated in several crosslinguistic differences in spatial encoding (Brown and Levinson, 1992, 1993a, 1993b; Bowerman, 1996a, 1996b). Children appear to find it easy to acquire whatever spatial-linguistic categories their language makes available in its simplest vocabulary and phraseology (Bowerman, 1996a, 1996b; Choi and Bowerman, 1991) and to tailor their speech to accommodate to the domains of applicability of the language-specific terms (Slobin, 1991).

We pursue here the further question of whether such linguistic differences in the mapping of space onto language impact the ways that members of a speech community come to conceptualize the world, as Whorf and Sapir would have it. Do the differences in how people talk result in differences in how they think? Specifically, could the cross-linguistically observed differences in spatial categorization influence nonlinguistic spatial categorization? Recently, several commentators have posited that language differences in the spatial domain actually do have such nonlinguistic effects on category formation and category deployment in tasks requiring spatial reasoning.

Our point of departure for the current studies comes from a major comparative cross-linguistic research inquiry focusing on the relationship between linguistic patterning and spatial reasoning (Brown and Levinson, 1993b; Pederson, Danziger, Wilkins, Levinson, Kita, and Senet 1998). There are in general three ways in which languages express spatial regions and orientations: in terms of the inherent properties of the objects themselves ("the front of the house," " the nose of the plane"), their cardinal positions ("west of Cleveland"), or their positions relative to the orientation of the speaker or listener ("on your left," "to the right of the toolshed"). Most languages have the formal resources to make reference to spatial arrays in all of these ways. But as Pederson et al. have documented, in most cases a given speech community favors one of them, at least for small-scale description. Though in English we *could* say "Give me the spoon that's northeast of your teacup," this sounds pretty ludicrous. We are strongly inclined to use relative terminology ("...to the left of your teacup") instead.

Conceptually, the first step in the cross-linguistic project has been to document the vocabulary by which speakers typically describe the positions and movements of objects in space. Standardized procedures were established for eliciting these spatial descriptions from the native speakers of a broad range of languages, living in both small-scale traditional (e.g., Mayans, Austronesians) and large-scale (Japanese, Dutch) cultural communities: see Pederson et al., 1998, for a description of these procedures. The second step was to devise experimental procedures which required subjects of differing linguistic background to observe spatial arrays, and then to identify or reconstruct "the same" array after being reoriented, usually by 180 degrees. The question under experimental review is whether incommensurabilities in the spatial vocabularies of the subject populations predict differences in their performance on the identification and reconstruction tasks after reorientation.

***Absolute* versus *Relative* spatial encoding systems**

The major spatio-linguistic distinction studied by Pederson et al. is between *absolute* versus *relative* encoding of spatial directions and locations. For example, Los Angeles is always to the west of New York, independent of the position of an observer; hence *west* is an absolute spatial term. In contrast, for an observer in Cincinnati facing north, Los Angeles is to her left and New York is to her right; but if she turns to face south, Los Angeles is to her right. Hence *left* is a term describing location relative to the body-orientation of the observer herself.

As Pederson et al. have described, most languages with which we are familiar favor relative spatial terminology for describing small-scale spatial layouts. But for many other language communities, the facts about everyday speech conventions are otherwise. An example described in detail in Brown and Levinson (1992) is Tzeltal, a language spoken by about 15,000 Mayans in the area of Municipo Tenejapa, in Chiapas, Mexico. Their village is on a hill. In Brown and Levinson's words,

> ...there is a system of 'uphill'/'downhill' orientation that is fundamental to the spatial system...based on the overall inclination of the terrain of Tenejapa from high South to low North, so that [the term for] 'uphill' (and correspondingly, 'downhill'...) [make] primary reference to the actual inclination of the land...the terms may be used on the flat to refer to cardinal orientations, or prototypical 'uphill' direction. This system then replaces our use of left/right in many contexts: when there are two objects oriented such that one is to the South of the other, it can be referred to as the 'uphill' object...Now, curiously, this system of North/South alignment is not complemented by a similar differentiation of the orthogonal. There is a named orthogonal...but the term is indifferent as to whether it refers to East or West; what it really means is 'transverse to the incline.' So there is a three-way distinction.

(p. 596, 1992).

An experimental paradigm: Lining up the animals

Pederson et al. studied spatial reasoning cross-linguistically in several ways, all variations on a single procedural theme: The subjects memorize the positions of items in an array shown to them. The array is then removed. After a brief delay, the subjects are turned around (usually, 180 degrees) and asked to recall the original array so as to calculate a response. For example, in the variant we will use in the experiment presented below, three left-right symmetrical toy animals are lined up facing the same way on a table top (for a schematic depiction of the procedure, see Figure 1, adapted from Brown and Levinson, 1993b, Pederson et al., 1998). The subject memorizes this array and then, after a brief delay interval, is moved to another table. This second table is oriented 180 degrees from the original. The subject is now handed the three original animals in random order, and asked to position them in "the same way as before."

FIGURE 1 ABOUT HERE

Cross-linguistic outcomes of these studies for Tenejapan and Dutch subject groups are graphically shown in Figure 2, adapted from Brown and Levinson, 1995. The Figure plots the distribution of absolute responses by subjects from the two languages.[1] These results can be summarized as follows: The overwhelming majority of speakers of languages favoring absolute terms consistently rearranged the animals such that if they had on the first table been going north, they went north after rotation as well. Whereas speakers of languages favoring relative terms overwhelmingly often rearranged the animals such that if they had been going left on the first table, they went left after rotation as well. The difference is that *what is north* does not vary under rotation, while *what is left* certainly does.

FIGURE 2 ABOUT HERE

It looks, then, as though a language distinction (absolute versus relative spatial terminology) is influencing reasoning in a very dramatic and straightforward way. However, it is possible that some third variable that differs between the subject populations is responsible both for the linguistic difference between them, and for the way they habitually go about solving spatial tasks. Specifically, each language population in the Brown et al. experiments was tested in its own community under the social and geographical frame-of-reference context that commonly obtain there. For example, the Tenejapan population was tested on its hill, out of doors, near a largish rectangular house. The Dutch population, presumably more used to a school-like situation, was tested indoors in a laboratory room. Reasonable enough. But this means that only part of the required experimentation were done, for two factors were varying at once – the language and the frame of reference in which the spatial task was to be solved. Which one caused the characteristically different behavior of these groups? To find out, it is necessary to determine whether a single linguistic group would change its reasoning style if the spatial-contextual conditions of experimentation were changed. We report on such a set of manipulations below. Because the results do reveal powerful effects of the conditions of test, we will end by suggesting nonlinguistic (or "non-Whorfian") interpretations for them.

II. Spatial reasoning in varying frames of reference: An experimental review

Subjects for all the experiments that we now report were drawn from a single cultural and linguistic subgroup: monolingual native-English speaking undergraduates at the University of Pennsylvania. The experimental question was whether we could induce Tenejapan-like and Dutch-like spatial reasoning behavior in this single population by appropriate changes of the spatial contexts in which they are tested. For comparability, each of the five experiments employed the line-up-the-animals task of Pederson et al., 1998.

The rotation paradigm: Line up the animals

As just noted, we adopted the ingenious method designed by the Pederson et al. group, here described in further detail. The materials and procedure are shown in Figures 1 and 3 (adapted from Pederson et al, 1998). As Figure 1 indicates, the subject was first seated on a swivel chair at a table (the “Stimulus table”) and asked to study an array of three toy animals (out of 5 animals in the total test-set of animals) that had been placed there in advance. Subjects were also asked to name each animal to assure that there was a consensual name for each. Because these were a toy dinosaur, lion, dog, rabbit, and elephant, there was no disagreement about the labels. Each toy was symmetrical along its longitudinal axis and was approximately 10 cm long. Both in practice and test trials, the experimenter always set up the animals so that their noses pointed in the same cardinal direction, either north or south, depending on the trial (equivalently, in the testing circumstances, either to the left or to the right). The subject was instructed to study the array for as long as he liked. Now the animals were scooped up by the experimenter. In an initial practice trial, the subjects were then handed the three animals and asked to set them up again (“make it the same”), again on the Stimulus Table (all of our subjects always did this correctly).

Now the experiment proper began. The experimenter set up three of the animals on the Stimulus Table, as the subject watched. The subject studied this new array as long as he liked, followed by a 30-second delay. The subject was then swiveled on her chair 180 degrees to face the Recall Table, which was empty, and handed the three animals in random order. She was told to “make it the same.” This procedure was repeated (of course, changing the particular animals and their arrangement on each trial) with each subject five times. About 15% of the time subjects asked for clarification (of what we meant by “the same”). The experimenter blandly responded “Just make it the same” and, improbably enough, the subject then always said “OK” and carried out the task.[2]

FIGURE 3 ABOUT HERE

As schematized in Figure 3, there are two correct ways that subjects could reconstruct the array on the Recall Table: The left-hand column of animals is the relative solution; the right-hand column is the absolute solution. With vanishingly rare exceptions, each of our subjects always chose one of them and individual subjects were consistent across the five trials as to their style of solution. We now describe three frame-of-reference conditions under which (different) subject groups of monolingual English speakers were tested.

Experiment 1: Landmarks in the reference world (Blinds-Up/Blinds-Down)

This experiment, and those that follow, we altered the context in which subjects carried out the line-up-the-animals task by adding implicit landmark cues of various kinds. For after all, the results found for the Dutch and Tenejapan subjects of Pederson et al. might be attributable to the differential availability of such landmark information in a featureless laboratory room versus complex landscape.

FIGURES 4 and 5 ABOUT HERE

Subjects, materials, and procedure: Twenty subjects participated, 10 in each of two landmark conditions. In both these conditions, subjects were tested in a laboratory room which was essentially featureless except for a floor-to-ceiling window at one side. As shown in Figure 5, the testing tables were set up in such a way as to be similar to the placement of the house that had been visible to Brown and Levinson’s Tenejapan subjects (Figure 4). One half of the subjects were tested in this room with the blinds pulled down, so that they could not see what lay behind the window. For the other 10 subjects, the blinds were in their raised position. Under this latter condition, the subjects if they looked toward the window would view the familiar sight of the university library that lay across the street from the testing laboratory. No mention of the state of the blinds or of landmarks was made to any of the subjects.

Results: The results are shown in Figure 6. The subjects in the Blinds-Down condition behaved much as the Dutch subjects in Brown and Levinson (see Figure 2 for comparison). The subjects in the Blinds-Up condition behaved differently, yielding a U-shaped distribution that lies somewhere between the prior Dutch and Tenejapan results. Even with the few subjects tested in each condition, the difference between Blinds-Up and Blinds-Down subjects approaches significance using the same evaluative instrument used in the prior studies by Brown and Levinson (Mann-Whitney U-test, $p = .056$).

FIGURE 6 ABOUT HERE

Experiment 2: Strengthening the landmark cues by going Outdoors

Although the experiment just presented in its Blinds-Up condition added a landmark cue analogous to the house that was visible to the Tenejapans, raising the blinds by no means reproduced the rich landmark conditions of an outdoor landscape. We therefore now performed an additional manipulation which was truer to what we can surmise about the Tenejapan testing conditions.

Subjects, materials, and procedure: Ten new subjects, again undergraduates at the University of Pennsylvania, were tested. We found an area of the Penn campus that roughly reproduced surface landmarks of the Tenejapan testing ground, though it was flattish rather than hilly. This was a large grassy area, with buildings and roads visible, as schematized in Figure 7. It being inconvenient to set out tables on this bumpy ground, we laid out large towels as substitute tables. And we used slightly larger animals so that they would be in reasonable scale to these towels. In all other regards, the experiment was just as in Experiment 1 (and just as in Brown and

Levinson, 1993b).

FIGURE 7 ABOUT HERE

Results: The results of this manipulation are shown in Figure 8 (again, see Figure 1 for comparison).[3] As inspection of the Figure shows, the subjects now evidenced a bias toward absolute responses, much like the Tenejapan subjects of Brown and Levinson and Pederson et al. To evaluate this finding statistically, we compared the effects for the Blinds-Down (or no landmark) condition against the present one. Again using the Mann-Whitney U-test, the difference between these conditions was highly reliable ($p = .006$). Notice, then, that the difference previously obtained by Brown and Levinson for Dutch versus Tenejapan speakers (Figure 1) is reproduced here between groups of Americans when they essentially have no landmarks (and thus act like Dutchmen) versus when they have strong landmark cues (and thus act like Tenejapans).

FIGURE 8 ABOUT HERE

Experiment 3: Controlled landmark cues (Absolute/Relative Ducks)

In the experiment just described, we looked at the effects of ambient landmark cues in the visible world. And we found that these biased our subjects toward absolute interpretations of the spatial reasoning task, as compared to the relative bias of other subjects who were tested in the featureless (Blinds-Down) condition of Experiment 1. Yet we cannot say that the landmarks out of doors on the Penn campus matched those of the Tenejapan testing situation, or were greater or lesser in degree of richness or informativeness. Readers with an eye for detail, in fact, upon examining Figure 8 will have noticed that the Americans in the outdoor condition were not quite so absolute in their performances as the Tenejapans had been. Can landmark information, if it is salient enough, completely determine the degree to which a single population solves spatial problems from a body-oriented versus geography-oriented perspective? To find out, we now examined the effects of matched absolutely versus relatively placed landmarks.

Subjects, materials, and procedure: Twenty subjects participated in this experiment, 10 in each of two conditions. Each of these subjects was tested in the original laboratory room where Experiment 1 had been conducted. Now the blinds were always up. As shown in Figure 9, a little toy stood on the Stimulus Table, to the right/south side of the subject him/her self. This toy was placed there before the subject entered the testing room, and it remained there, unmentioned and unmoved, for all 5 trials. As the Figure shows, it was a pair of kissing styrofoam ducks on a paper lake (i.e., a longitudinally symmetrical toy, approximately 17 cm long). As usual, the subjects' task was to memorize the positions of the three line-up animals (as in Figure 1) placed on the Stimulus Table as before. No line-up animal was closer than 15 cm to the duck landmark. When subjects swiveled to the Recall table, they always saw an exact replica of the duck landmark to one side of it, placed there in advance. For half the subjects (the relative biasing, or Relative Ducks group), the replica was always on the right of the subject. For the other half (the absolute biasing, or Absolute Ducks group) the replica was always on the south of the Recall table.

FIGURE 9 ABOUT HERE

Results: The results of this manipulation are graphically shown in Figure 10. Now the results were exactly like those obtained for the Dutch (relative-responding) and Tenejapan (absolute-responding) subjects of Brown and Levinson, 1993b (compare Figure 10 and Figure 2). To evaluate this finding statistically, we again performed the Mann-Whitney U-test and found a highly reliable difference for the absolute-biasing and relative-biasing conditions of the present experiment ($p = .003$).

FIGURE 10 ABOUT HERE

III. General discussion

Our investigations were designed to provide further evidence relating to the Whorf-Sapir hypothesis, or rather to its descendant theorizing in the current literature of linguistic relativity. Our starting point was a series of particularly striking demonstrations from Brown and Levinson, 1993b and Pederson et al., 1998, of a correlation between cross-linguistic spatial-terminological differences and the manner of solving simple tasks of spatial reasoning by speakers of those languages (Figure 2). Their subjects whose everyday spatial terminology, for relatively small-scale arrays, was body-oriented solved the rotation problem relatively; whereas subjects whose terminology (at this grain) encoded cardinal direction solved the same problem absolutely. This work has been justly acclaimed for the enhanced perspective it is providing on language-culture relations. At minimum it stands as a welcome antidote to much familiar linguistic and psychological inquiry that assumes by default that all communities are about the same as, say, a community of Ivy League sophomores residing together in a Philadelphia dormitory. At the same time – and as this group of investigators has always been careful to emphasize – the findings are solely of a correlation between language and reasoning, and as such are hard to interpret causally.

The manipulations we have described were all conducted with English speakers, to see if the absolute/relative spatial reasoning distinction could be reproduced within a single language community. If so, this would weaken or negate the claim that language differences, and the putative constraints these place on reasoning, were the underlying cause of the original effects. Moreover, we so designed the experiments as to expose an alternative explanation of the original results: Our subjects behaved absolutely or relatively depending on the presence and strength of the landmark cues made available to them. As landmark cues were strengthened in three steps: Blinds-Up (Experiment 1), to Outdoors (Experiment 2), and finally to Absolute Ducks (Experiment 3), the

English-speaking group responses moved progressively toward the Tenejapan absolute behavior, becoming completely equivalent to it under the Absolute Ducks condition. Contrastingly, in the absence of landmarks (Blinds Down, Experiment 1) or with relative-biasing landmarks (Relative Ducks, Experiment 3), the subjects behaved like Pederson et al.'s Dutch and Japanese subjects.

When do creatures solve spatial problems "absolutely" versus "relatively"?

The present results suggest that it is not the nature, even the *learned nature*, of an individual to solve spatial problems in the absolute versus relative way. Rather, individuals from the same linguistic-cultural population will solve the same spatial problem differently depending on the cues made available in the environment. This finding is not really a new one at all. Rather, it reproduces in detail the findings from prior lines of investigation of spatial reasoning by animals and young children.

During the 1940's and 1950's, the question was asked whether animals are naturally "response learners" or "place learners" in regard to navigating through space to arrive at a goal (e.g., Tolman, Ritchie and Kalish, 1943). This issue, seen as a crucial one for understanding the nature of learning, was operationalized within experimental contexts that are formally analogous to the rotation task as designed by Pederson et al., and replicated in the present article.[4] Typically, rats were trained to find food at one leg of a maze. Then either the rat or the training maze itself would be rotated 90 or 180 degrees. If the animal continued to turn in the trained direction on the maze even after rotation, he was judged to have learned only a response (say, "Turn left to get food"). If instead he responded to extralinguistic cues and thus made a different turn on the rotated trials, he was assumed to have learned something more sensible; namely, to turn toward the place where the reward was previously found (say, "Turn North to get food"). But in fact, neither characterization of rat learning was ever shown to be the correct one. As with the experiments we have just reported, the findings were best understood not by considering possible inherent or learned tendencies to make the same turn or to go to the same place. Rather, the animals were responsive to the information provided to them (Blodgett and McCutchan, 1947). In a definitive review of this literature, Restle wrote:

> There is nothing in the nature of a rat which makes it a “place” learner or a “response” learner. A rat in a maze will use all relevant cues, and the importance of any class of cues depends on the amount of relevant stimulation provided as well as the sensory capacities of the animal. In place-response experiments, the importance of place cues depends on the amount of differential extra-maze stimulation. (1946, p. 226).

In short, thousands of rats gave their lives for very little gain, as the place-learner/response-learner distinction was apparently misdrawn to start with. When provided with sufficiently rich and stable landmark cues, any self-respecting rodent will use them and thus be classified as a place learner. In the absence of landmark cues, the disoriented rat is dependent solely upon his kinesthetic sense and so repeats his prior response. Related results have been reported for young infants. Though they often seem to repeat a directional response unheeding of reorientation, if the landmark cues provided are rich and stable enough even 6-month olds have been shown capable of place learning (for a review, see Bloch and Morange, 1997).

Why do groups fix on relative or absolute terminology?

Granting now that we produced place learning and response learning in our American subjects by varying the strength and reliability of landmark cues, how could this bear on the general tendency of human populations to adopt one or the other strategy in devising and using a spatial terminology? For after all, we must explain more than why our American subjects choose a particular strategy of reasoning on the fly, depending on features of the immediate context. The phenomenon that Pederson et al. have exposed is that communities of speakers choose among potential linguistic resources and *regularly* (or “*habitually*”) prefer either “the spoon to the north of your teacup" or "the spoon to the left of your teacup." What factor or factors could lead to the long-term preference for a "place oriented" versus "response oriented" terminology? We will first mention some global distinctions among the cultural communities whose terminology has been studied in the cross-language project. Thereafter, we will suggest that a single factor – geographical cohesion in community life – accounts quite naturally for why social groups develop preferences in their everyday terminology for referring to regions and directions in space.

Cultural effects on experimental findings: Pederson et al., 1998, reported on the line-up-the animal task in six languages. Three of these languages (Tzeltal, Longgu, Arrandic) are spoken in traditional, largely unschooled, linguistic-cultural communities and the results for all three followed the absolute pattern. Two other languages (Dutch and Japanese), both spoken by technologically advanced and schooled populations, are those that yielded the relative pattern. (The sixth language studied, Tamil, is a mixed case that we will discuss just below). In the present experiments, under the comparable testing condition (Blinds-Down) we again achieved the relative pattern for a schooled, technologically advanced culture, English-speaking Americans. There has been extensive discussion of the fact that unschooled and schooled populations often behave quite differently in experimental tasks, no matter how "simple" these seem to be. Indeed Lucy (1996) speaking from within the anthropological linguistic community provides a convincing review, concluding that literacy and school performance have considerable effects on both "patterns of thought" and "language socialization practices for the inculcation of cultural world-view." (Lucy, 1996, p. 57). Discussions of the relations of language categories and language practices to school practice go back to Vygotsky (1978) and are the subject matter of a vigorous and continuing linguistic anthropological tradition (see also Bernstein, 1971, Greenfield, 1972, Scheiffelin and Ochs, 1986, Scribner and Cole, 1973). A problem in interpreting the cross-linguistic results on spatial reasoning, then, is that in all the cases on which Pederson et al. reported, they have been confounded with important cultural variables such as schooling. One might well believe that culture affects language use and even lexicalization patterns without believing the converse: that language patterns affect culture.

Pederson (1995; Pederson et al., 1998) made an interesting attempt to unconfound the linguistic and cultural variables that covaried in the studies that we have discussed thus far by testing individuals from two communities, both of which spoke the same language, Tamil. Tamil has the formal resources for both the absolute and relative spatial reference terms. All the same, the two Tamil-speaking communities varied in their habitual use, one community preferring the absolute and the other preferring the relative terms for describing small-scale regions and directions. A test of these two populations might exclude the alternative culture-difference, as opposed to language-difference, explanation that we have just suggested. However, the results of this manipulation turned out to be quite unclear. The animals-in-a-row experiment yielded no reliable difference between the two subpopulations of Tamil speakers. Another experiment, informally reported in Pederson et al., yields a reliable difference in the predicted direction: The Tamil population that habitually uses relative terms solved a spatial task relatively, and the population that habitually uses absolute terms solved the same task absolutely. However, this new experiment in practice suffered from exactly the same confound it was designed to disentangle. The more urbanized, schooled, Tamil population was the one exhibiting the relative bias both in speech and in spatial reasoning (i.e., they behaved more like the Dutch and Japanese). The more rural and traditional Tamil subpopulation showed the absolute bias that characterized the Tenejapans.

Summarizing, the results of all the animal-in-a-row studies, including our own, seem to cohere as arising in the presence of supralinguistic cultural differences. These differences predict both the favored linguistic terms and the spatial reasoning patterns, a distinctly "non-Whorfian" generalization. But why should traditional cultures prefer absolute spatial terminologies and schooled urbanized cultures prefer the relative ones? "Culture" is too vague and undifferentiated an explanation of the spatial reasoning phenomena. As we next discuss, all these findings are suggestive of a more specific solution: Shared landmark cues vary in their stability and familiarity across communities, much as they do in the various conditions of our experiments.

Geography and the absolute-relative distinction: Recall that the absolute-responding Tenejapan population resides in a small village on the side of a hill, and employs a 3-term spatial terminology that alludes to the spatial coordinates of this hill, "downhill" (e.g., "tree standing downhill of man."), "uphill," and "across-the-hill" or, as it were, "athwart." It is interesting that spontaneous descriptions from speakers of other spatial-absolute languages studied by this research group again make reference to what must be rich local landmarks, e.g., "man stands in 'land of soft sand'" (Haijlom), "tree standing on side towards sea" (Longgu; these quotes from native speech appear in Pederson et al., 1998, p. 568). As Pederson (1995) points out, it would not be surprising at all if persons living in a small and geographically coherent layout would rely heavily on mutually known local landmarks to orient themselves in space.

Pederson attempted to counter this landmark explanation of absolute solutions in these spatial tasks by removing his Tamil villagers from their homes and immediate work places: "I always tried to select an environment for testing, such as the front of the headman's storehouse, which would be reasonably removed from the subjects' daily life.", p. 55). But as we have demonstrated, mildly unfamiliar landmarks (as in the Outdoor condition of the present experiments, see Figure 7) are useable cues and induce absolute responses. Moreover, previously unknown landmarks, even such adventitious ones as kissing styrofoam ducks (Figure 9), markedly affect spatial reasoning. Regardless of the language spoken, it seems, people will use landmark cues when these are available. It doesn't even have to be people: Rats too will take advantage of landmarks to find hidden food pellets if only these cues are made rich and reliable enough.

Summarizing, we can best understand the findings of the cross-linguistic studies (and the within-language Tamil study) by noting a cross-cutting factor: the geographical and interpersonal cohesion of a society. There seems to be no consensual "uphill" that can serve as a reference point in the very large and shifting communities in which linguistically interacting English, Dutch, or Japanese speakers generally find themselves. "You'll find the railroad station just north-east of the Drexel University parking lot" is not too useful a direction to give the British tourist who has just arrived in Philadelphia. Body-orientation is the obvious alternative for establishing momentary spatial coordinates. In contrast, as the Pederson et al. studies appear to show, people like the Tenejapans, who live in a small, mutually familiar, geographical area, typically use its local landmarks to devise a spatial coordinate system that makes absolute reference to its stable and salient features ("uphill," "inland," etc.). This is so even when the traditional populations have the formal linguistic resources for encoding both absolute and relative spatial terminology.

Of course the present authors do not know too much about traditional unschooled cultures that live in faraway places. Large disparities between investigator and investigated make it difficult to interpret either naming practices or experimental responses across these cultural divides. On the other hand, one does not have to go all the way to Chiapas to find communities that favor absolute spatial terminology. One of us is a native of a highly urbanized culture whose members live and work and play all crammed together on a skinny little island, about 16 miles long. Culturally diverse as this community is, its residents share a small, stable, geographical landscape, rich in local cues. Perhaps this is why their terminology is absolute and --like that of the Tenejapans – makes do with only three terms in habitual use: *uptown*, *downtown*, *cross-town*.

IV. Final Thoughts

We began this discussion by raising the general question of how language categories might, or might not, influence thought. For the special instance of spatial usage and problem solving just reviewed, clearly there is a correlation between language, culture, and thought, detailed in the compelling cross-language studies by Pederson et al. and replicated in our investigations of American English. However, we also found that the variation in how spatial problems are solved can be found even when one does not vary the culture or the language of the subject population, but varies landmark cues instead. Indeed the same differences can be induced in laboratory animals, again as a function of supplying or withholding landmark information. These findings lead us to reject the explanation offered by Pederson et al. for their findings. They assert: “The linguistic system is far more than 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.” (1998, p. 586). Elegant as this statement is, we do not find it defensible on the evidence. Rather, it seems to us, one would want to turn it on its head: Linguistic systems are *merely* the available formal and expressive medium that enables speakers to describe their mental representations of the nonlinguistic world. Depending on the local circumstances in which human beings find themselves, they select accordingly from this linguistically available pool of resources for describing regions and directions in space.

Speaking more generally, however, it must be acknowledged that the Whorf-Sapir debate has been joined, since its inception 50 or so years ago, as a series of local skirmishes: Does language influence thought about hue? Numerosity? Causality? Objecthood? Or, as in the present studies, spatial organization? No such particularized investigation can really be decisive as to whether interesting effects of language on thought can be found in other, so far unstudied, domains. All the same, limited findings do have a way of contingently influencing our broader beliefs. For example, Pederson et al. suggested that their obtained results for language and space provided “reason for optimism” that related effects of language on thought would be found in other domains. Turning the tables, we take the present findings of the robustness of human thought to variation in linguistic usage patterns to be an optimistic one. All languages have the formal and expressive power to communicate the ideas, beliefs, and desires of their users. From this vast range of possibilities, human communities select what they want to say and how they want to say it. This stance is at bottom the same one that explains why the Elizabethans habitually used terms for falconry and we do not, and why vacationers at Aspen and Vail find it useful to develop many words for snow. Transparently, thought influences language use.

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Notes

[1] These authors generally plot percent absolute responses against number of subjects. The resultant graphs can be visually misleading when the number of subjects in various conditions differs by a wide margin. Therefore we always replot these results by percent rather than number of subjects.

[2] Small procedural details differ between the original Brown and Levinson task and the one reported here: These authors (see also Pederson et al., 1998) had some distance between the tables, to avoid their subjects' sometime tendency to look forward to the recall table while they were at the stimulus table. With our undergraduate subjects, it was sufficient to tell them not to look toward the other table. So the Brown et al. subjects were walked, rather than swiveled, between stimulus table and recall table. This walk-time added a few seconds between training and test, so the delay for Brown et al. subjects might have been slightly longer than for our subjects. And of course, our toys were different from their toys.

[3] One outlier in this experiment performed in a way that Pederson et al., 1998, observed more often in their subjects, and which they called "monodirectional." Such subjects always set up their animals in a canonical way, regardless of how that relates or does not relate to the original facing direction on the presentation table. Pederson et al., reasonably enough, excluded such subjects in presenting their results. Because we had only one subject of this kind, and because the results were so overwhelming anyhow, we did not exclude her. Another subject on one trial placed two animals facing each other, as though kissing. We included this odd subject in our results too. Had we excluded these two individuals, the results shown in Figure 7 would have been even more dramatic.

[4] We are indebted to Henry Gleitman (personal communication) for pointing out to us the relevance of the animal literature in the present regards.

Figure Captions

Figure 1. The set up for a trial. Subject first faces the Stimulus Table to memorize an array of animals. Then the subject is rotated 180 degrees and asked to recreate the array again.

Figure 2. Proportion of absolute choices for speakers of two languages: The majority of the Tenejapans chose the absolute response for all five trials, while the majority of the Dutch chose the relative response for all five trials.

Figure 3. Absolute (a) and relative (b) response styles: Subjects who saw the stimulus table set up a in Figure 1 usually responded in one of these two ways.

Figure 4. Adapted from Brown & Levinson 1993. Subjects were tested outdoors next to a house.

Figure 5. The Library is to the south of the tables just as was the house in Figure 4.

Figure 6. Subjects in the Blinds-Down condition predominantly chose the relative response. In the Blinds-Up condition, most subjects preferred either all absolute responses or all relative responses.

Figure 7. The subjects were tested outdoors where there are various buildings to the south and southeast.

Figure 8. Contrasting the Outdoor condition with the indoor Blinds Down condition. Subjects in the Outdoors condition resemble the Tenejapans while subjects in the Blinds Down condition resemble the Dutch.

Figure 9. Duck toys are placed on the sides of the table before the subject enters the room.

Figure 10. The subjects’ preference for absolute or relative response is predicted by the positioning of the ducks.

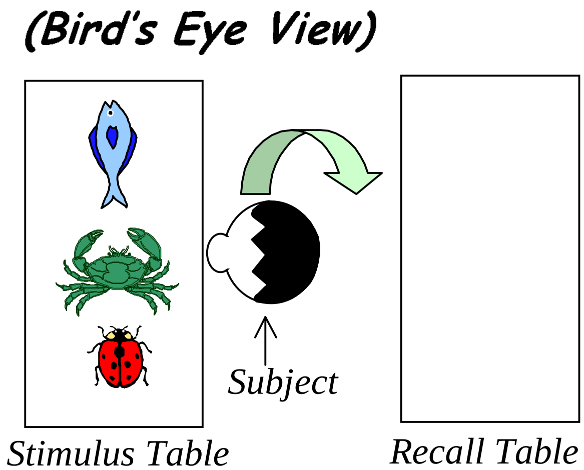


Figure 1

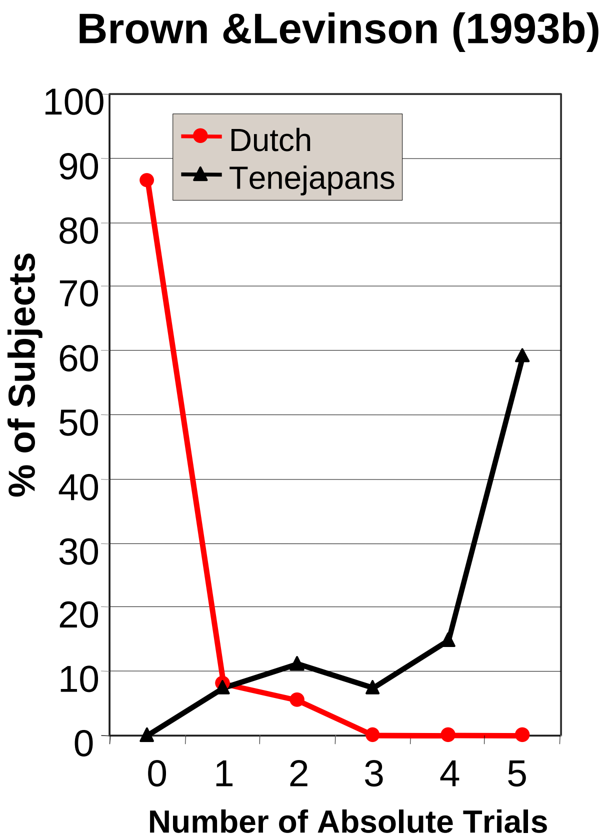

Brown &Levinson (1993b)
Dutch
Tenejapans
% of Subjects
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
Number of Absolute Trials

Figure 2

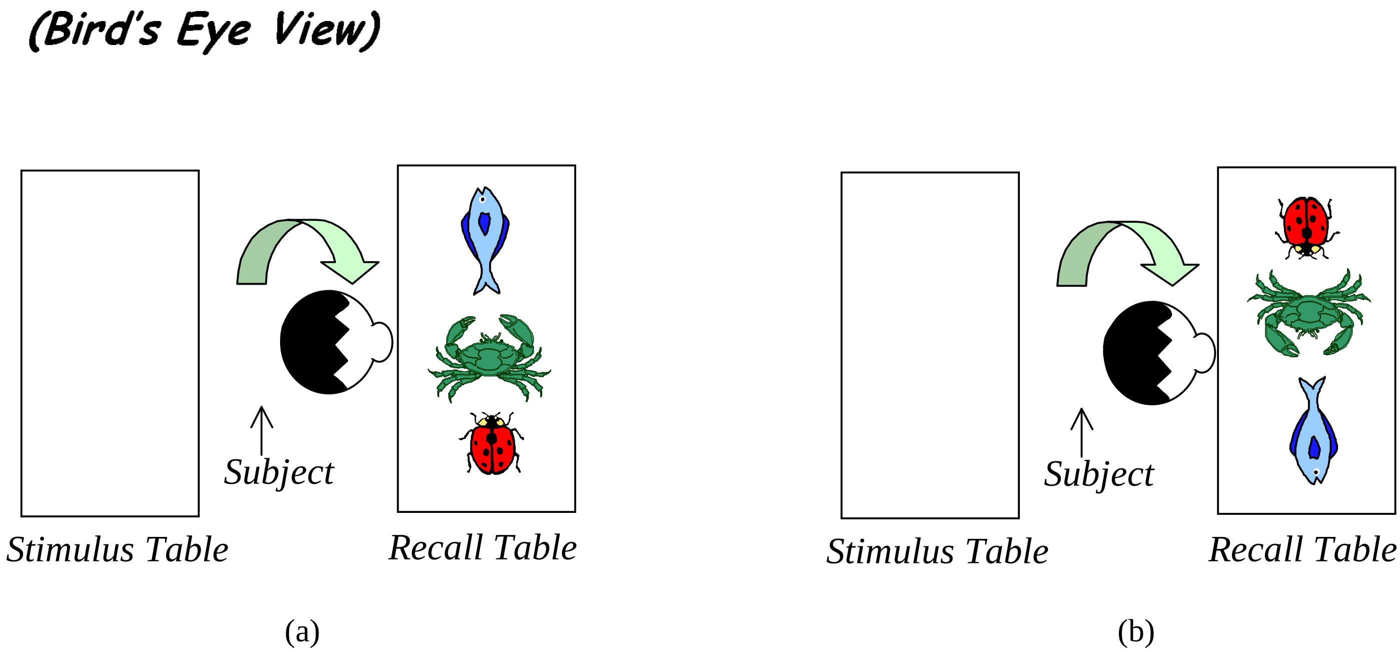

(Bird's Eye View)
Subject
Stimulus Table
Recall Table
(a)
Subject
Stimulus Table
Recall Table
(b)

Figure 3

Tenejapans

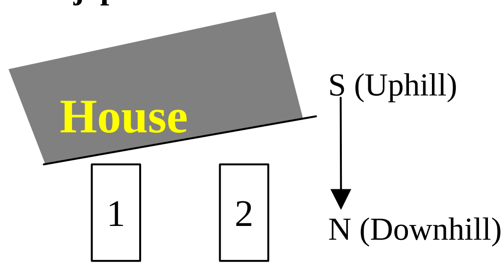
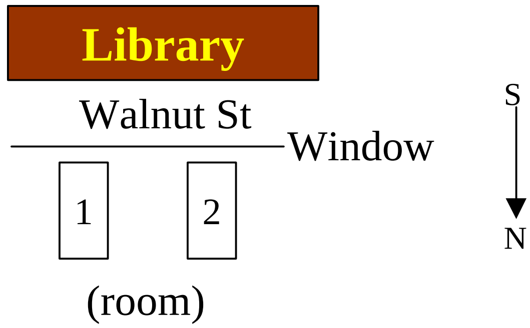


Figure 4



Condition 1: Indoor BLINDS-DOWN
Placing Americans in a setting like the Dutch.

Condition 2: Indoor BLIND-UP
Placing Americans in a setting like the Tenejapans.

Figure 5

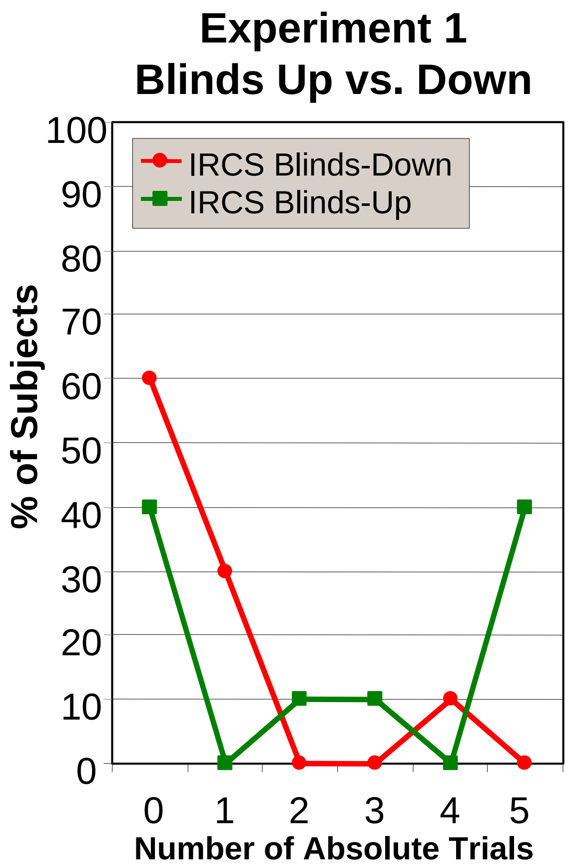

Experiment 1
Blinds Up vs. Down
IRCS Blinds-Down
IRCS Blinds-Up
% of Subjects
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5
Number of Absolute Trials

Figure 6

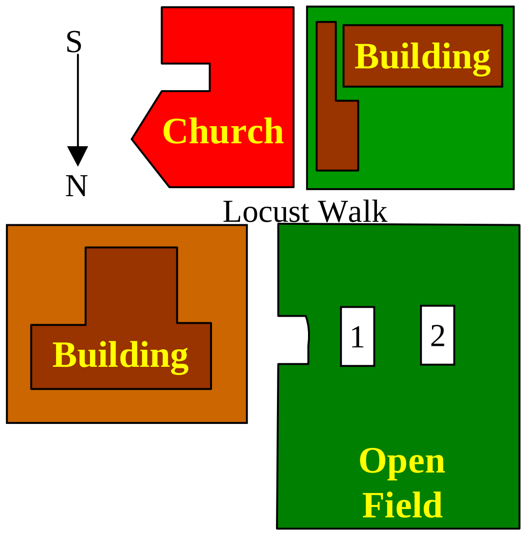


Figure 7

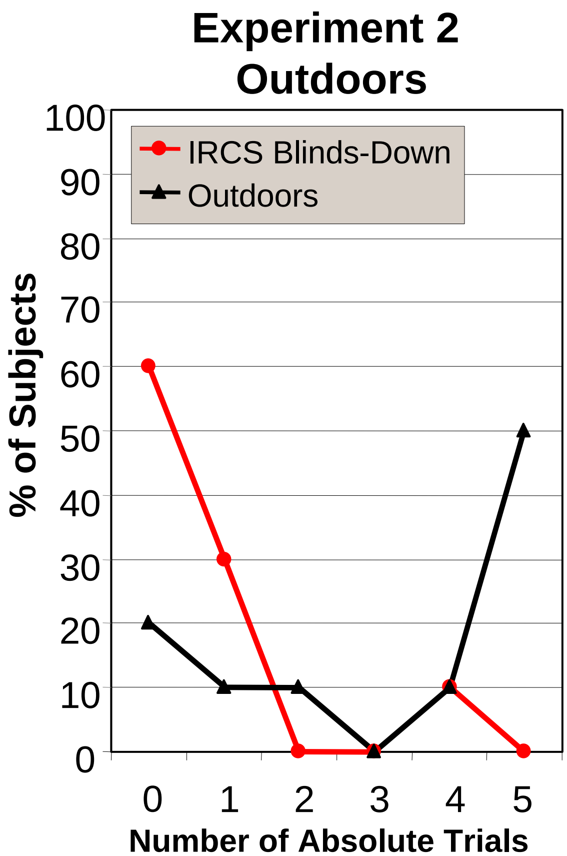

Experiment 2
Outdoors
IRCS Blinds-Down
Outdoors
% of Subjects
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
Number of Absolute Trials

Figure 8

Duck Ponds on the sides of tables as "landmarks."

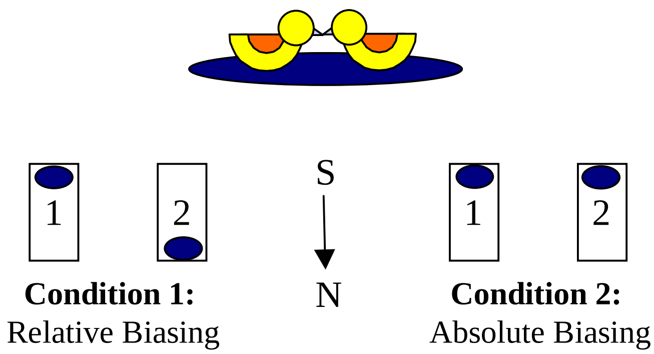


Figure 9

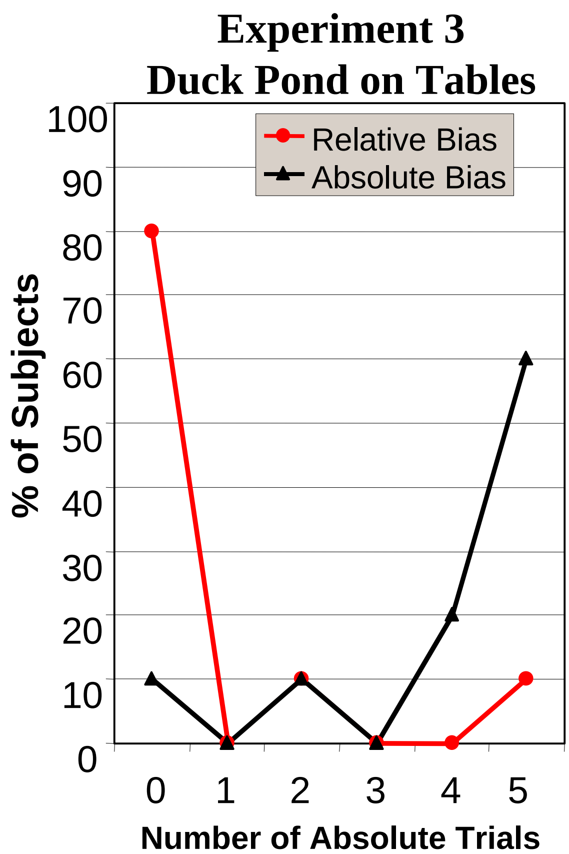

Experiment 3
Duck Pond on Tables
Relative Bias
Absolute Bias
% of Subjects
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
Number of Absolute Trials

Figure 10