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Perspective in Spatial Descriptions

HOLLY A. TAYLOR

Tufts University

AND

BARBARA TVERSKY

Stanford University

In order to describe a spatial environment, people must take a perspective on it. Previous researchers had claimed that in describing space, speakers take listeners on mental tours, using a consistent perspective. In contrast, we find that people use survey and mixed perspectives as well as route perspectives, and that the configuration of an environment affects perspective choice. We show that gaze, route, and survey perspectives use language differently and argue that they correspond to prototypic relative, intrinsic, and extrinsic frames of reference, respectively. We speculate that the correlation of viewpoint, referent, and terms of referent in the three perspectives occurs because each reflects a natural way of interacting with an environment.

Knowledge about space is one of the earliest forms of knowledge people use. That knowledge comes to us through many senses, primarily sight, sound, and touch. Spatial knowledge allows us to reach things in our immediate surroundings, to navigate in our larger environment, and to make inferences about both. Spatial knowledge is critical to our interactions with each other and to our interactions with the physical world, indeed to our very survival.

Describing space was undoubtedly one of the earliest uses of language, conveying to someone who was not there where to go for the best roots and tubers, and where not to go to avoid danger. Spatial layouts of environments, large and small, can be transmitted remarkably well solely by language (Taylor & Tversky, 1992b).

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Spatial language is so prevalent and useful that it has been widely adopted to describe nonspatial things as well (for examples and discussion, see Clark & Clark, 1977; Cooper & Ross, 1975; Lakoff & Johnson, 1980). Familiar examples come from the domain of time, where spatial terms like "before" and "after" have been extended to temporal meanings, such as "She arrived *before* the deadline" or "They arrived *after* the crowd had dispersed." (Clark, 1973). Spatial language has been extended metaphorically to convey abstract meanings such as, "I'm feeling *up* today," or "He's at the *bottom* of the heap," or "That field is *wide open.*"

Here, we investigate people's descriptions of spatial environments, focusing primarily on perspective. Perspective has fascinated researchers not only of language but of visual cognition and social psychology as well. Although people necessarily experience the world from their own perspectives, talking about and recognizing the world from other perspectives is essential for interacting with the physical and social worlds. Three areas of previous research are relevant to the current endeavor: organization in spatial descriptions, frame of reference in spatial statements, and perspective in extended spatial descriptions.

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Organization in Spatial Descriptions

Despite the myriad possibilities for organizing environments, such as the small Town, Amusement Park, or Convention Center depicted in Figs. 1, 2, and 3, there is remarkable consistency across informants in how they organize the elements of an environment. In the first experiment described in this paper, subjects studied one of the maps depicted in the first three figures in anticipation of either writing a description or sketching the map from memory. In fact, they did both, in counterbalanced order. In a previous analysis (Taylor & Tversky, 1992a), we found a high degree of consistency in grouping landmarks and in ordering the groups in both descriptions and depictions. Describers began with either important functional features, such as entrances, or with large environmental features, and thereafter grouped landmarks by spatial proximity or function. Overall, people organized the environments more or less the same, whether they expected to draw or to describe, and in both drawings and descriptions. The similarity of organization across conditions suggests that the organization is not inherent in the medium but rather in memory.

Three Frames of Reference

Spatial descriptions contain statements that locate objects with respect to a reference frame. A reference frame may include an origin, a coordinate system, a point of view, terms of reference, and a reference object. Theorists of spatial language have distinguished three kinds of reference frames depending on their origins: deictic or viewer-centered, intrinsic or object-centered, and extrinsic or environment-centered (e.g., Buhler, 1982; Carlson-Radvansky & Irwin, 1994; Fillmore, 1975; Garnham, 1989; Levelt, 1984, 1989; in press; Levinson, in press; Miller & Johnson-Laird, 1976; Retz-Schmidt, 1988; Shepard & Hurwitz, 1984; Tversky, in press a). Researchers interested in object recognition, spatial cognition, and environmental psychology have attempted similar distinctions (e.g., Hart & Moore, 1973; Levinson, in press;

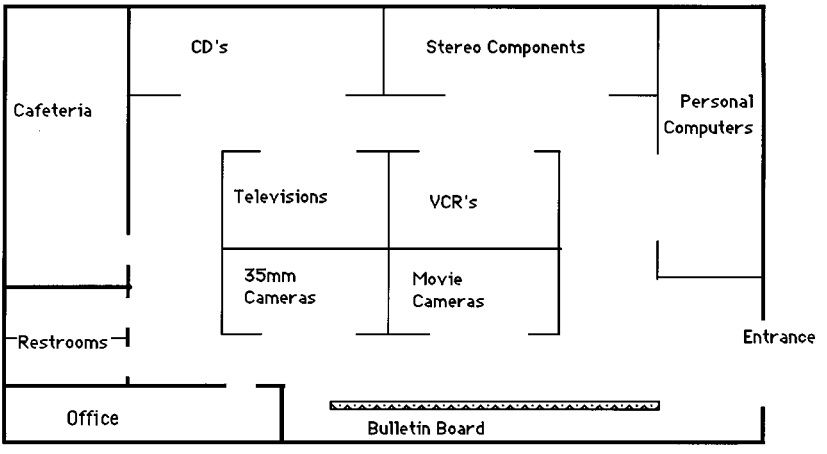

FIG. 1. Map of Convention Center. Figure appeared in Taylor and Tversky (1992a, 1992b) and is used with permission.

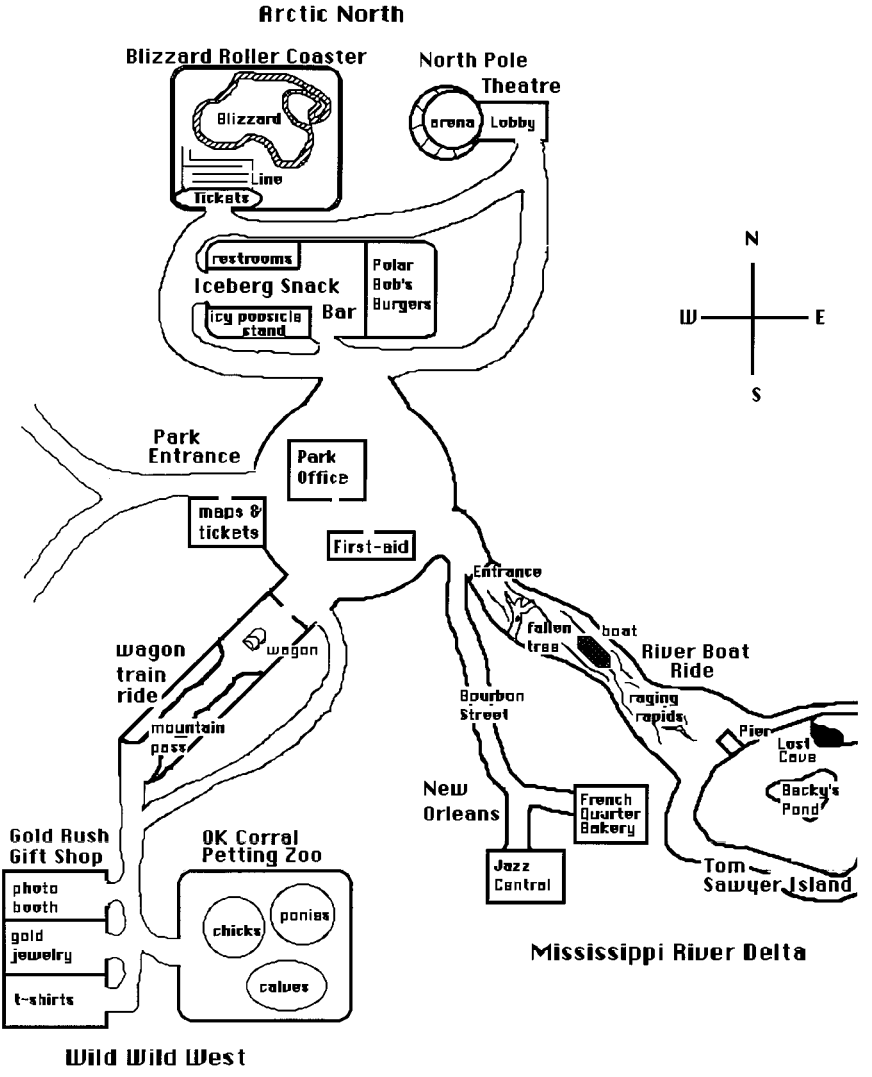

FIG. 2. Map of Amusement Park. Figure appeared in Taylor and Tversky (1992a) and is used with permission.

Marr, 1982; Pinker, 1984; Pick & Lockman, 1981; Shepard & Hurwitz, 1984; Tversky, in press a). Although a trichotomy based on the center of a reference frame, viewer, object, or environment, is attractive, it has a source of controversy and confusion, too complex to review here. The different features of reference frames do not always seem to correspond. In particular, it has been difficult to distinguish viewer-centered and object-centered in a principled way.

In an effort to resolve the controversies, Levinson (in press) has realigned the distinctions, changed the terminology slightly, and presented a prototypic case for each reference frame. We will adopt his system here. In *relative* uses, the origin of the coordinate system is one of the participants, the speaker or the addressee. Locations of things are described in relation to that individual's front, back, left, and right, with respect to some other object in the scene. Comprehending "the car is to the right of the tree" depends on knowing how the speaker (or addressee) is oriented with respect to the

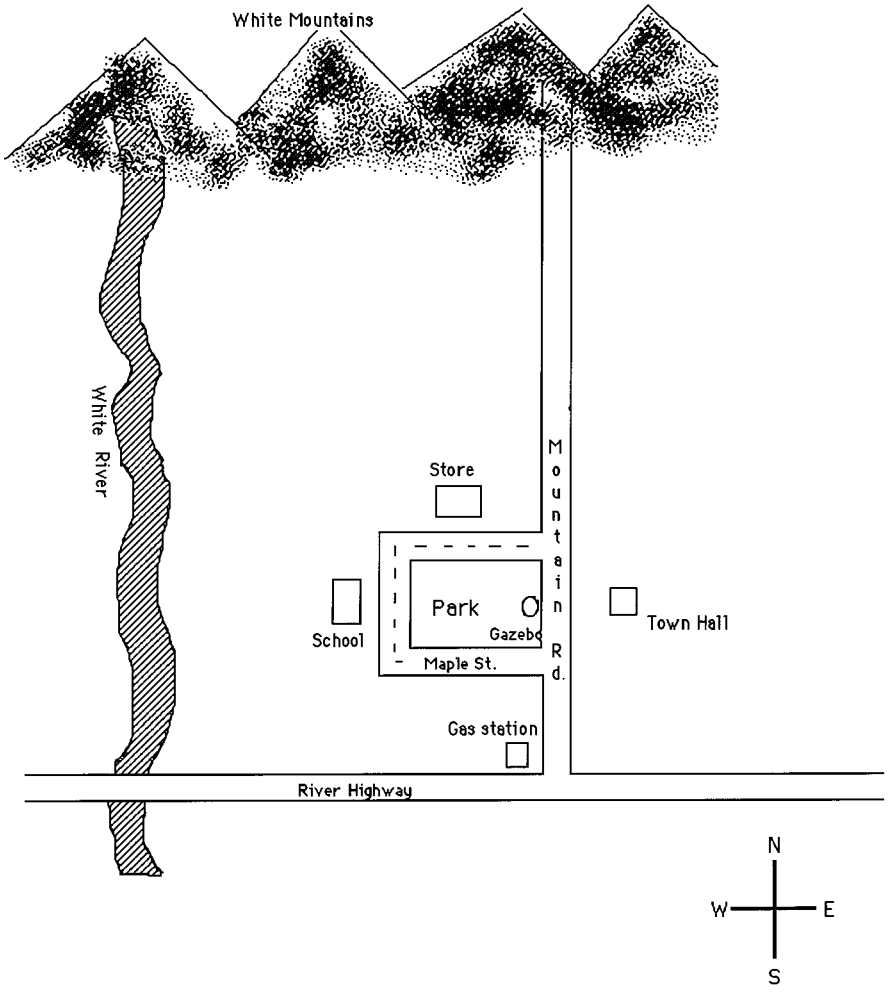

FIG. 3. Map of Town. Figure appeared in Taylor and Tversky (1992a, 1992b) and is used with permission.

tree, as "right" is with respect to the speaker's (addressee's) right side. Thus, relative uses require three terms, an origin, the figural object, and a reference object. Relative uses are deictic in the traditional sense of being viewer centered and requiring knowledge of the viewer's orientation. In *intrinsic* uses, the origin of the coordinate system is a specific object, and locations of things are described in relation to the object's intrinsic front, back, left, right, top, and bottom, as in "the car is in front of the building." Here, "front" is understood in terms of the building's natural front side. Such usage depends on participant's agreement on the intrinsic sides of the reference object. Because the origin can also be a person, intrinsic uses so defined include cases previously termed *deictic* by some (e.g., Levelt, 1989). In contrast to relative cases, intrinsic uses require only two terms, the figural object and a reference object with acknowledged sides. In *absolute* or *extrinsic* uses, the origin of the coordinate system is external to the scene. The most common extrinsic coordinate system is the cardinal directions, *north, south, east, west* (and *up* and *down*), but others are possible, for example, *stage left, stage right, upstage,* and *down stage* in theater parlance. Extrinsic uses also require two terms, the figural object and a reference object. In their prototypical cases, Levinson's distinctions have preserved the tri-

chotomy based on person, object, and environment as well as the correspondences with terms of reference.

However, these cases described by Levinson are canonical ones, and exceptions exist, exceptions that break the correspondences. Although the prototypic relative case has a person as an origin and the prototypic intrinsic case has an object as an origin, it is possible for relative uses to be object centered, as in, "from the entrance, the ticket office is right of the elevator." It is also possible for intrinsic uses to be person centered, as in "the dog is in front of Joe" or "the dog is in front of me." Still other possible uses confound environmental reference terms with speaker or object as center, as in "the car is north of the building" or "the car is north of me." Despite the possibility of exceptions such as these, there is elegance and simplicity to Levinson's scheme, and, so far, it has been gaining acceptance (see papers in Bloom, Peterson, Nadel, & Garrett, in press).

There has been little agreement on which reference frame is the default, with Levelt (1989) advocating deictic, Miller and Johnson-Laird (1976) proposing intrinsic, and Garnham (1989) arguing for extrinsic. This lack of agreement suggests that the situation plays a role in determining frame of reference. Only recently have the determinants of reference frame been checked empirically (e.g., Bryant, Tversky, & Franklin, 1992; Carlson-Radvansky & Irwin, 1994; Franklin, Tversky, & Coon, 1992; Friederici & Levelt, 1987; Schober, 1990, 1993; Tversky, in press a), and those studies do point to situational factors. In addition, different language communities preferentially use different reference frames (Levinson, in press). Finally, use of perspective in extended spatial descriptions is more complicated than in single sentence descriptions.

Perspective in Extended Spatial Descriptions

In a study that has become a classic, Linde and Labov (1975) asked New Yorkers to describe their apartments. Over 95 percent took addressees on an imaginary tour of their apartments. Like the route descriptions of Taylor and Tversky (1992b), speakers addressed listeners as "you," took a changing viewpoint from within the environment, and described landmarks in terms of *front, back, left,* and *right* with respect to "your" current imagined position. Since that study, linguists and psycholinguists alike have assumed that the typical form of a spatial description is a route or mental tour (e.g., Levelt, 1982b; 1989). Levelt has provided a rationale for this. Like others, he observed that although space is three-dimensional, speech is linear, so that describing space requires imposing an order on the world. Where there is a "natural" order in the world, it should be selected in description. For environments, a mental tour mimics a common way of experiencing an environment, by exploration. It has also been claimed that for extended discourse, people adopt a single frame of reference and use it consistently in a description (Levelt, 1982a). Like a natural order, consistency promotes coherence and comprehension.

Other research has been presented as support for mental tours as the standard style of spatial description, in particular, the work of Ehrich and Koster (1983) asking subjects to describe a doll house room from memory and of Levelt (1982a, 1982b) asking subjects to describe networks of colored circles. On closer inspection, however, the "tours" given by speakers in those situations have different character from the tours given by Linde and Labov's (1975) subjects. Significantly, those "tours" don't entail hypothetical movement of addressees but rather of eyes. In Ehrich and Koster's case, perhaps because the doll house room was small and viewed from the outside, speakers took listeners on what Ehrich and Koster termed a "gaze tour." Speakers adopted a fixed point of view from outside the room and described locations of furniture relative to each other in terms of "in front of" and "to the left" with respect to the outside viewpoint, as if their eyes were moving around the scene. Shanon's (1984) subjects' descriptions of their dormitory rooms were similar. Additionally, the modal ("ego-oriented") subject in Levelt's (1982a) study (as Levelt, 1989, later noted) also followed a gaze tour, describing locations of nodes relative to each

other from a fixed outside viewpoint, neither using the second person nor verbs of motion. Only a minority of subjects produced descriptions like Linde and Labov's (1975) routes. Termed "pattern-oriented," they took a viewpoint within the network and mentally traversed it, describing it from the changing point of view of a traveler. Ullmer-Ehrich (1982) pointed out some differences between gaze and route tours. A gaze tour has a fixed origin and a route tour has a varying one. In a gaze tour, subjects of noun phrases are objects in the room whereas in a route tour they are addressees. In a gaze tour, verbs are states but in a route tour they are actions. What has been called a "gaze tour" does not seem to be a tour at all.

Levinson's distinctions, developed to account for single spatial utterances, can be extended to styles of extended spatial discourse (Tversky, in press a). For the most part, a gaze tour uses a relative frame of reference. Gaze tours typically locate objects relative to other objects from a fixed outside point of view, as in "the lamp is to the right of table." In contrast, a route tour typically uses an intrinsic frame of reference. Route tours usually locate objects relative to the addressee's intrinsic sides, as in "go right to the blue dot." These uses are not the prototypic uses outlined by Levinson; a gaze tour using a relative frame of reference may not have an addressee as an origin and a route tour using an intrinsic frame of reference may have an addressee as an origin rather than an object.

Route directions have also been cited as evidence for mental tours as the preferred mode of spatial description (e.g., Klein, 1982, 1983). However the type of route description given in response to a request for directions differs from the route descriptions given in response to a request for descriptions. In the case of directions, speakers use the imperative, but not in the case of descriptions. For directions, speakers mention only the landmarks thought essential for keeping on the route, but in the case of descriptions, people mention many landmarks. Route directions seem to use a mixture of relative and intrinsic frames of reference, consistent with the traditional sense of deictic.

It is evident, then, that not all spatial descriptions are route tours, nor is a route the only natural way of experiencing an environment. Scanning an environment from a single viewpoint is a normal way of experiencing an environment, and forms the basis for gaze tours. Viewing an environment from the top of a tree or a hill is also a natural way to experience an environment. It provides a survey viewpoint, similar to a map. Continuing the extension of distinctions of spatial frames of reference to spatial descriptions, a description analogous to a survey viewpoint would use an extrinsic frame of reference. In our previous work, we found that readers formed accurate mental models of environments described from either route or survey perspectives (Taylor & Tversky, 1992b). Now we turn to studying spontaneous descriptions of environments, extending the type of environments from the rooms, apartments, and networks used previously. We also turn to studying language use in descriptions more systematically than in the past. In the first experiment, we examine in detail the language used to describe the three environments depicted in Figs. 1, 2, and 3. In the second experiment, we expand the number and characteristics of the environments to uncover the structural determinants of perspective choice. In the third experiment, we examine perspective in descriptions of environments learned by exploration.

Experiment 1: Detailed Analysis of Description Perspective

In this experiment, subjects studied maps of environments and wrote descriptions of them from memory. Although prior researchers had claimed that route descriptions are the norm, we believed this conclusion was based on a combination of examining a narrow range of environments and of interpreting the data narrowly. Survey viewpoints are natural ways of experiencing environments, so survey descriptions provide a natural way of relating an environment. Outside the psychological literature, survey descriptions abound, in travel guides, textbooks, and novels. By using a broader range of more representative environments, we expected survey as well as route descriptions. Because none of the environments depicted could be

viewed from a single place (unless treated as a map rather than an environment, something subjects rarely did), we did not expect gaze tours.

Previous researchers have characterized only route and gaze tours, and have done that impressionistically, using examples as support, not by predicting types of language use and systematically counting them. Here, we distinguish survey and route descriptions on a number of features that predict systematic differences in language use. A prototypic survey description takes a view from above and describes locations of landmarks with respect to one another in terms of *north, south, east,* and *west.* A prototypic route description takes a view from within an environment, and describes locations of landmarks with respect to the changing position of the addressee in terms of the addressee's *left, right, front,* and *back.* These are prototypic or ideal descriptions of pure perspective use; actual discourse, however, is not always ideal or pure. Thus, we analyzed the descriptions in two phases, the first subjective and the second quantitative. In the first phase, we categorized the descriptions by perspective type, using our best judgment in difficult cases. In the second phase, we counted instances of language use. The critical uses of language distinguishing perspectives are the reference object, another landmark for survey descriptions and the addressee for route descriptions, and the terms of reference, *north, south, east, west* for survey descriptions and *front, back, left,* and *right* for route descriptions. The two perspectives should also differ in verb use. Because a survey description has a single viewpoint, it should use primarily stative verbs, and because a route description has a changing viewpoint, it should use more active verbs. Consequently, route descriptions should have more orientation changes than survey descriptions. Finally, it has been claimed that survey descriptions are more hierarchical, for example, first dividing a whole environment into parts, and then describing each part in turn (Taylor & Tversky, 1992b). Route descriptions, by contrast, are linear (Levelt, 1982b; Taylor & Tversky, 1992b).

Of course it is possible to mix these uses of language, for example, to take an addressee on a mental tour but describe locations of landmarks using the cardinal direction terms. To the extent that these uses of language are correlated, thus forming distinct perspectives, the idea that real tours and surveys form the bases for the descriptions is strengthened. It is also possible to switch perspectives, claims to the contrary not withstanding.

Irrespective of perspective, coherent descriptions should adhere to the given/new principle (e.g., Haviland & Clark, 1974), according to which established information should be conveyed prior to new information. The old information serves as a mental hook for attaching the new information. Applying this principle to spatial descriptions leads to the expectation that people will first describe a known spatial location and then describe the position of a new landmark with respect to it. Each component of a description containing locative information should consist of a known spatial location followed by a new landmark. Then, ordering spatial components in a continuous or organized fashion is known to promote comprehension (e.g., Denis & Denhiere, 1990; Ehrlich & Johnson-Laird, 1982; Levelt, 1989; Mani & Johnson-Laird, 1982).

In a previous paper (Taylor & Tversky, 1992a), we reported analyses of these descriptions that revealed how subjects organized the environments. In this paper, we report analyses of the descriptions that reveal perspective. The methodology for Experiment 1 is taken from Taylor and Tversky (1992a).

Method

Subjects

Seventy undergraduates from Stanford University participated individually, either for pay or in partial fulfillment of a course requirement for introductory psychology. Approximately equal numbers of male and female subjects were recruited. All subjects recruited were native English speakers. The data from three subjects, two non-native English speakers and one subject who did not follow instructions, were eliminated from analysis.

Materials

Three fictitious environments were drawn using an Apple Macintosh and the software Macpaint and were printed on standard 8.5 × 11 in. paper. The environments differed in scale, ranging from a single building to an enclosed Amusement Park with several buildings to a small Town. The building, a Convention Center, contained 13 landmarks. The Amusement Park contained 17 landmarks, and the Town contained 13 landmarks. The Town and the Convention Center were adapted from previous research (Taylor & Tversky, 1992b). The maps appear in Figs. 1–3. A compass rose appeared on each map, indicating that the maps were oriented with north at the top.

Design and Procedure

The subjects received one of two instruction sheets. Both instructions informed the subjects that they would study a map for 5 min in order to later recall the information. The instructions described different recall tasks, one telling the subjects they would draw the map from memory and the other telling the subjects they would write a verbal description of the map. The instructions for the description told the subjects to write their description so that someone who was unfamiliar with the environment and had never seen the map could read the description and know where all the landmarks were. The experimenter then clarified any questions about the procedure.

The subjects received one of the three maps to study. Overall, 24 subjects received the Town map, 24 received the Convention Center map, and 22 received the Amusement Park map. Of the subjects eliminated from analysis, two received the Town map and one received the Convention Center map. The subjects could study the map for as long as 5 min, but could move on to the recall task whenever ready. After the study phase, the experimenter told the subjects that instead of the single task described on the instruction sheet, they would actually be asked to do two memory tasks, draw a map and write a description. Order of tasks was counterbalanced across subjects so that half the subjects performed the expected task first and half performed the surprise task first. The subjects completed the tasks at their own pace, but within 30 min. The results of subjects' descriptions will be discussed in this paper.

Results

Review of Previous Findings

This data set was previously analyzed to assess how environments are organized in descriptions (Taylor & Tversky, 1992a). Some of the results from this paper are relevant to the discussion here. From the descriptions, it was clear that most subjects treated the maps as environments rather than spatial arrays. Overall memory was excellent. On average, subjects mentioned 94.6% of the landmarks in their descriptions. The descriptions conveyed spatial location specifically enough so that a new group of subjects who read the descriptions accurately placed 90.8% of the landmarks.

Analysis of Perspective Phase 1: Judgments

Two coders (the authors) coded each description as route, survey, or mixed. Examples of each appear in Table 1. The coders first coded each sentence of each description. The coders initially agreed on 83% of the sentences, and came to agreement on the rest. When all but two landmarks were described according to one perspective type, then the entire description was coded as having that perspective. When more than two landmarks were described using the less dominant perspective type, the description was scored as mixed. The categories refer to entire descriptions, not to individual sentences. The criterion was based on number of landmarks rather than number of sentences as some sentences located no landmarks while others located several. One description of the Convention Center was a gaze tour, constructed as if standing at the entrance and seeing through walls and rooms. Because there was only one description of this type, it is not included.

The number of descriptions of each perspective type for each environment is displayed in Table 2. For the Town, survey and mixed descriptions predominated, for the Convention Center, route and mixed descriptions predominated, with the Amusement Park in between

TABLE 1
EXPERIMENT 1: EXAMPLE DESCRIPTIONS IN EACH PERSPECTIVE

Route description (Convention Center):

You enter from the southeast corner of the building. As you come in, turn right. To your right will be the "personal computers" room. Continue until you're forced to make a left. The "Stereo components" room will be in front of you as you turn left. Now you're facing west. To your left as you walk down the hall will be (first) the "VCR's" room and then the "televisions" room. To your right, you'll pass the "CD's" room. At the end of this hall you'll see the cafeteria. Here you'll have to turn left again. You'll pass the door to the cafeteria on your right, but no doors to your left. After the cafeteria, you'll pass the restrooms. The office is at the end of this hall. Turn left once more. There will be doors to your left again, as in the second hall. The first one leads to the "35mm cameras" room, the second to the "movie cameras" room. To your right, you'll pass a bulletin board. At the end of the hall, you'll find a water fountain to your right, and the entrance/exit door once more.

Mixed description (Amusement Park):

Walk in the entrance to your right. Immediately before the oval center will be maps and tickets, directly ahead will be Park Office. Head north and you will run into snack shop. Upon entering Burgers will be to your right (east), popsicles to your southernly left and restrooms to your northerly left with a path out in between them. Pathways lead into and around the Snack Shop to the right (East and North) is the arena and theater with a lobby connecting it to the pathways. Around the left and Northward of the Snack shop is the Blizzard ride with tickets and line on South side. A path above the Snack shop connects the two attractions. Back at the Park Office as you head south in the southeastern portion of the oval is the first aid booth. There are two main pathways down to the west and the other to the east. In the west you can either take the wagon ride or walk on a path around it to get to the Gift Shop which is directly opposite the OK Corral Petting Zoo. North to South in the Gift Shop are the photo shop, jewelry store, and t-shirts. Across the way as you enter the Zoo are the ____in the back behind the two side by side stalls are the ponies. To get to the easterly southern branch you must walk all the way back up to the oval. At the beginning of the South easterly branch there is a split; to your right as you head down (west) is Bourbon Street which leads to two posts: the jazz cafe directly in front of you, and the French Quarter Bakery to your left (east). Down the other (east) path is a long river ride (past a fallen tree and then rapids) into an oval like park with Tom Sawyer island which contains a pond in the easterly middle and a hidden cave all the way on the eastern side.

Survey description (Town):

North of town are the White Mtns. and east of town is the White River, which flows south from the White Mtns. The main road by town runs in the east-west directions and crosses the White River. The stables are on the south side of this road, named River Hwy. and across the road to the north is the town. Running up through the town from River Hwy. to the White Mtns. is Mtn. Rd. The gas station is on the west side of Mtn. Rd. and the north side of River Hwy., at the intersection, and the restaurant is just across Mtn. Rd. from the gas station. The town hall is on the east side of Mtn. Rd. a little farther along, and the Maple St. circle is on the west side of Mtn. Rd. across from the town hall in the middle of the circle created by Maple St. and Mtn. Rd. is a park with a gazebo. On the west side of the circle facing onto Maple St. is the school and on the north is the store.

($X^2(4, N = 67) = 9.97, p < .05$). Put differently, in describing the Town, people rarely used a pure route perspective, and in describing the Convention Center, people rarely adopted a pure survey perspective. Thus, the perspective selected depended on the environment.

In all of the mixed descriptions, subjects switched perspectives, sometimes more than once. The perspective switches fell into patterns. For the Town, in 9 out of 10 mixed perspective cases, subjects generally described the large features such as the mountains, rivers, and highways from a survey perspective and the smaller features, the buildings, from a route perspective. For the Convention Center, 7 out of 10 subjects used a route to describe the outer rooms and a survey to describe the inner rooms, and for the Amusement Part, all seven subjects used a survey perspective to describe at least some of the three main branches. In addition to switching perspectives, many subjects used both perspectives redundantly. In most cases, subjects did not signal when they switched perspective. Here is an example of switching pure perspectives without signaling from a Town description: "Town is S of the White Mountains which

TABLE 2
NUMBER OF DESCRIPTIONS IN EACH PERSPECTIVE

	Route	Mixed	Survey
Town	2	10	10
Amusement park	9	7	6
Convention Center	10	10	3

run E-W. From the mountains, Mtn. Rd. runs directly S into town. At the first road in town, a right turn takes you past a store to the right, then a left turn takes you past a school to your right again." Following is an example of switching perspective without signaling and simultaneous use of survey and route perspective from a description of the Convention Center. Notice that perspective switches from route to survey and back to route again. "As you enter, the water fountain is on the left side. As you head west down the hallway in front of you there is a bulletin board on your left and at your right is a cubicle at the center of the building which is divided into four sections. The NW corner is the TV area, the NE corner is the VCR area, the SW corner is the 35mm camera area and the SE corner is where the VCR cameras are kept. Continuing west down the hallway past the bulletin board, directly ahead is the office area."

Analysis of Perspective Phase 2: Language Use

In order to validate the aspects of language use distinguishing the perspectives, we tallied various indices of perspective, type of relational term, referent, and verb, by perspective category. Using language categories that can be easily counted avoids the issue of subjective coding. However, the categories can be noisy. Noise would act to blur the perspective types. We also counted changes of orientation for each description type.

Relational terms. Terms relating the location of a landmark to a referent were primarily of two types: terms relating a landmark to a viewer, that is, *left, right, front,* and *back;* and terms relating a landmark to the environment, that is *north, south, east,* and *west.* These were not pure indices. Although in the majority of cases, environmental relational terms were used to describe one landmark relative to another, there were cases where an environmental relational term was used to describe a landmark relative to a viewer, as in "north of you." As we coded, we noticed a third way of locating landmarks that used neither personal reference nor environmental reference terms, for example, "across Mountain Rd. from this gazebo is the town hall" or "next to the stereo room is the CD room." Note that these are not intrinsic uses even though they use an object (landmark) as a referent. They are not intrinsic because they do not depend on the intrinsic sides of the referent for locating another landmark. Thus, they are neutral with respect to the description styles, and appropriate for any. These were also counted. They appeared relatively infrequently, and did not differentiate the description styles. Although prepositions like *across* and *next to* could have the addressee as an object rather than another landmark, as in "across from you," there were no cases like this.

These data were submitted to a Cochran-Mantel-Haenszel Test of General Association comparing relational term by sentence perspective, route, mixed or survey. The Cochran–Mantel–Haenszel Test of General Association is appropriate when data fall into discrete categories and subjects make repeated responses. In this instance the data can be arrayed as a set of q: (s × r) contingency tables. For more information on this test, see Landis, Heyman, and Koch (1978). Route descriptions should favor viewer-relational terms and survey descriptions should favor environment-relational terms. This was the case, as can be seen in Table 3, part A, showing use of relational terms both in absolute numbers and percentages ($Q(4) = 196.64$, $p < .001$ for all maps together Qs for each map separately significant at $p < .001$). The mixed perspective descriptions did not favor either set of spatial relation terms. Landmark-relational terms were used infrequently, and their frequency did not vary with perspective.

Referent. Locations of landmarks are described with respect to three kinds of referent: the current position of the addressee, another landmark, or the canonical directions. For each first mention of a landmark, we coded the type of referent used to specify its location. These data were submitted to a Cochran–Mantel–Haenszel Test of General Association comparing referent type by sentence perspective. As is evident from Table 3, part B, showing use of referents, route descriptions in fact favored the addressee as a referent and survey descriptions favored another landmark or the canonical di-

TABLE 3
FREQUENCY OF DIFFERENT LANGUAGE USE BY SENTENCE PERSPECTIVE

	Route	Mixed	Survey
A. Frequency of use of relational terms by sentence perspective			
Viewer-relational	294 (71%)	32 (18%)	21 (6%)
Landmark-relational	48 (12%)	64 (36%)	42 (12%)
Environment-relational	71 (17%)	80 (46%)	298 (82%)
B. Frequency of referent used for locating landmark by sentence perspective			
Viewer ("you")	288 (57%)	57 (29%)	12 (3%)
Landmark	133 (26%)	101 (51%)	209 (47%)
Cardinal directions	86 (17%)	39 (20%)	220 (50%)
C. Frequency of use of active and stative verbs by sentence perspective			
Active verbs	373 (64%)	115 (55%)	122 (36%)
Stative verbs	206 (36%)	93 (45%)	213 (64%)

rections ($Q(4) = 118.347$, $p < .001$ for all maps together, *Q*s significant at $p < .001$ for each map separately).

Verbs. Route descriptions take addressees on a mental tour but survey descriptions tell where landmarks are. Thus, route descriptions should use more active verbs and survey descriptions should use more stative verbs, especially forms of "to be." Each verb was coded as active or stative using the strict criterion that only forms of "to be" were considered stative. These data were submitted to a Cochran–Mantel–Haenszel Test of General Association comparing verb type by sentence perspective. As Table 3, part C, shows, route descriptions used more active verbs and survey descriptions used more stative verbs ($Q(2) = 33.01$, $p < .001$ for all maps together; *Q*s significant at $p < .001$ for each map separately). Some of the active verbs used frequently in route descriptions include: *enter, walk, head, find, turn, go,* and *continue.* These verbs were used to describe the hypothetical movements of "you." Although survey descriptions used primarily stative verbs, they also used some technically active verbs, such as *run, border, cross, turn,* and *intersect,* used to describe the path of a road, or *flow* and *run,* used to describe the course of a river. These verbs, though active, were not used to describe movement, and belong to a class of verbs described by Talmy (in press) as fictive motion.

Orientation changes. In route descriptions, the orientation changes every time the addressee is turned in the environment. In contrast, survey descriptions adopt a single orientation, from above. In mixed descriptions, the orientation changes during the route portion as well as when the perspective is switched. Thus, there should be more changes of orientation in route descriptions and mixed descriptions than in survey descriptions. This prediction was supported by the data. Across environments, subjects made an average of 3.9 orientation changes on route descriptions, 3.4 on mixed descriptions and 0.6 on survey descriptions. Planned contrasts showed that route descriptions had significantly more orientation changes than survey descriptions, $t(65) = 6.29$, $p < .001$; mixed descriptions also had significantly more orientation changes than survey descriptions, $t(65) = 5.61$, $p < .001$, but route and mixed descriptions did not differ, $t(65) = 1.18$, $p > .25$.

Hierarchical Structure

It has been claimed that survey descriptions are more likely to be hierarchical and route descriptions linear (Levelt, 1982b; Taylor & Tversky, 1992b). To check whether survey and route descriptions differ in hierarchical information, we examined two aspects of hierarchical structure, the amount of overview information contained, and the degree of hierarchical organization.

Overview information. Many of the descriptions contained overview information, for example, "The convention center has a section of rooms along its wall (outside section) and another section of rooms in the middle (inner section)." Overview information appeared in 74% of the route, 68% of the survey, and 63% of the mixed descriptions, so that quantity of overview information was not related to perspective. The frequency of providing overview information seemed to depend on the environment. Overview information was included in 55% of the Town descriptions, 78% of the Convention Center descriptions, and 82% of the Amusement Park descriptions. The frequency of overview information is higher in the environments that more easily decompose. The Convention Center divides into the outer and inner cores, and the Amusement Part into the Arctic North, the entrance/service area, the Wild Wild West, and the Mississippi Delta Area.

Hierarchical organization. In a hierarchical description, some features are reliably described before others. In the case of these environments, large or functionally important features were described earlier (Taylor & Tversky, 1992a). We checked whether survey descriptions were more likely to follow the accepted hierarchy for each environment. Although the numbers are small, there was not even a trend for survey descriptions to adhere to the accepted order more than route descriptions. Thus, there is no evidence here that survey descriptions are more hierarchical than route descriptions. Perspective seems to be independent of hierarchical organization.

Description Organization

Given/new locations. Do the descriptions first provide a known location and then a new landmark, or vice versa? For each new landmark mentioned, we coded whether the known location information preceded mention of the new landmark, followed it, or both preceded and followed it. Following are three examples. The first is from a survey description of the Town, and relates known location information before introducing a new landmark: "On the east side of Mtn. Rd. across from the park is the town hall." The second is from a route description of the Convention Center, and provides known spatial information both before and after introducing the new landmark (the cafeteria): "If you turn right at the end of the hall (which is the only way you can turn), the cafeteria will be on your left." The third example is from a route description of the Amusement Park in which the new landmark is introduced prior to the known spatial location information: "A Theatre, The North Pole arena, is to your right and around the corner." Note that, irrespective of order, the known spatial location information is typically expressed using an already mentioned landmark plus additional spatial information locating the new landmark, whereas the landmark is referred to simply by its name. For additional examples, see those used previously for perspective switching. In all but the first sentence of the Town description, at least some of the known spatial information was given prior to the new landmark.

For each description, we tabulated the number of occurrences of each known location/new landmark order. These data were submitted to a paired *t*-test. Subjects were more likely to mention the known location before the new landmark than either of the other orders, $t(66) = 8.58$, $p < .001$ for known location before new landmark ($M = 8.2$) compared to new landmark before known location ($M = 2.8$) and $t(66) = 8.45$, $p < .001$ for known location before new landmark ($M = 8.2$) compared to known location before and after new landmark ($M = 2.7$). There was no difference in mention of known location after new landmark compared to known location mentioned both before and after new landmark. These results held for all three description perspectives.

Definite articles. One way to signal old information is by use of a definite article, "the" or "that." Our analysis of definite versus indefinite articles proved inconclusive. Subjects used definite articles to describe new locations as often as to describe old locations. This was due to the fact that subjects introduced unique landmarks with definite articles, and a large proportion of

the landmarks were unique. Subjects did use indefinite articles to introduce non-unique landmarks.

Discussion

In this study, we analyzed the language of spatial descriptions in detail. The analysis pertains to two issues in particular, the organization of the descriptions and the perspective of the descriptions. Maps of environments consist of landmarks and the spatial relations among them. This is the spatial information in the maps. Maps may also include other information, such as information about the landmarks themselves, their shapes, orientations, and relative sizes. In the majority of cases, the spatial information in the descriptions was organized into components. Each component consisted of a specification of a spatial location and the landmark associated with it, usually in that order. Because the spatial location was specified in terms of previously described elements of the scene, that order corresponds to the given/new order known to be preferred by speakers and to be better comprehended by listeners (e.g., Haviland & Clark, 1974).

As for perspective, the results of this study contradict two widely held beliefs about spatial descriptions: that descriptions of environments typically take addressees on mental tours (Ehrich & Koster, 1983; Levelt, 1989; Linde & Labov, 1975) and that descriptions of environments adopt a single reference frame consistently (Levelt, 1982a). In this study, subjects used survey perspectives as often as route perspectives, and used mixed perspectives as well (see also Schober, 1990). Moreover switches in perspective were in no way signaled in the descriptions, so describers apparently thought they would cause no confusion.

Putting together these findings with previous ones suggests that there are three primary styles of describing environments: gaze, route, and survey. Each of the styles reflects a natural way of experiencing an environment: a gaze description to scanning a scene from a fixed viewpoint outside an environment; a route description to exploring an environment; and a survey description to scanning a scene (or map) from a fixed viewpoint above an environment (Tversky, in press a). Each of the styles primarily uses one of the canonical reference frames summarized by Levinson (in press) and others. The three styles and their properties are outlined in Table 4. The characteristics of the description styles and frames of reference are for ideal or prototypic cases; there are less conventional uses where the distinctions break down. A gaze description, as analyzed by Ehrich and Koster (1983), Ullmer-Ehrich (1982), and Levelt (1989), has a stationary viewpoint outside the environment, from which the entire scene can be viewed. Objects are described with respect to each other from the external viewpoint in terms of *left, right, front,* and *back.* Usually, but not necessarily, the viewpoint is of a person, implicit or explicit. Because many of the locative statements in a gaze description contain three

TABLE 4
PROPERTIES OF TYPES OF DESCRIPTION PERSPECTIVES

	Description perspectives		
Properties	Gaze	Route	Survey
Viewpoint	fixed, external	changing, internal	fixed, external
Verbs	stative	active	stative
Referent	object (or person)	person	object
Terms of reference	LRFB	LRFB	NSEW
Frame of reference	relative	intrinsic	extrinsic
World analog	View entire scene from fixed point, horizontally displaced	View while exploring	View entire scene from fixed point, vertically displaced (map)

terms, the viewpoint, the object being located, and a reference object, a gaze tour prototypically uses a relative frame of reference, in Levinson's terminology. A route description is analogous to viewing an environment by exploration. It has a changing viewpoint from within the environment, ordinarily that of the addressee, and locates objects with respect to the viewer in terms of the viewer's *left, right, front,* and *back.* Route descriptions correspond to Levinson's intrinsic frame of reference, but with an addressee rather than objects as origin. A survey description is analogous to viewing an environment from a height. It takes a fixed external viewpoint and locates objects with respect to each other in terms of *north, south, east,* and *west.* It corresponds to an extrinsic frame of reference.

Thus there is a correspondence between natural ways of interacting with environments and prototypical ways of describing them. This need not be the case. There are many other possibilities formed from conjoining the essential features of spatial descriptions, viewpoint (fixed or moving), referent (person or object), and terms of reference (cardinal or personal directions). For example, there could be a style like a gaze or route tour that used the cardinal direction terms instead of the intrinsic direction terms, or a survey that used intrinsic direction terms instead of cardinal direction terms. There were isolated examples of these mixtures in the corpus. Significantly, none of the mixture was used consistently or exclusively. For the most part, the descriptions categorized as mixed switched between pure route and pure survey perspectives. Mixed descriptions did not consistently use a new combination of viewpoint, referent, and terms of reference. It seems likely that the prevalence of correlated patterns of viewpoint, referent, and terms of reference is due to the correspondence of the patterns to a natural way of experiencing an environment.

Previous findings, as well as the present ones, suggest that the choice of description perspective depends on characteristics of the environments themselves. In describing networks or rooms that can be seen from one viewpoint, people prefer gaze descriptions (Ehrich & Koster 1983; Levelt, 1989). In describing their apartments, people prefer route descriptions (Linde & Labov, 1975). In describing our Convention Center, people typically used a route for the entire place, or a route for the outer core and a survey for the inner core. In describing our Town, people typically used a survey consistently, or else used a survey for the larger features and a route for the buildings. There are several differences among these environments, any of which may contribute to choice of perspective. The environments or parts of environments that encouraged route descriptions had a single path through the environment and had landmarks of approximately equal size. They were also small and enclosed. In contrast, the environment that encouraged survey descriptions had multiple paths or landmarks of different size scales. It was also relatively large and open.

In describing environments, then, people choose one of three perspectives; gaze, route, or survey, or a mixture of them. Selection of perspective seems to be determined by the nature of the environments, both within and between environments. The maps for the current experiment do not allow teasing apart factors that might contribute to selection of a description perspective, but the maps of the second experiment are designed to do exactly that.

Experiment 2: Environmental Determinants of Description Perspective

In the previous experiment, people used route and survey perspectives, or a mixture of both, to describe environments from memory. Because some environments elicited more descriptions of one perspective than others, it appears that characteristics of the environments may affect the selection of perspective. Inspection of the environments suggests several possible features: single or multiple paths through the environment, landmarks of a single size or landmarks of several sizes, environments that are enclosed or open, and environments that are small or large. In the first experiment, the Convention Center, an environment that is closed and small and has a single path and landmarks on a single size scale received relatively more

route than survey descriptions, and the Town, an environment that is open and large and has multiple paths and landmarks on several size scales received relatively more survey than route descriptions. In the next experiment, we constructed 16 maps varying these features factorially.

Method

Subjects

Forty-eight undergraduates from Stanford University participated in groups of four in partial fulfillment of a course requirement for introductory psychology. Approximately equal numbers of male and female subjects were recruited. All subjects were native English speakers.

Materials

Maps of 16 fictitious environments were constructed by crossing four features each of which had two levels: single or multiple paths through the environment; landmarks of the same or different size scales; environments that were enclosed or open; and small or large environments. This yielded one map for each combination of features. The environments depicted by the maps included: a state park; a science museum; a prep school; a county fair; and a dolphin lab as examples. They were similar in style to the ones in the previous experiment, and contained from 11 to 16 landmarks. The maps were drawn using Macpaint software on an Apple Macintosh, and printed on standard 8.5 × 11 in. paper.

A three-item questionnaire was created to obtain gender and handedness information about the subject and the subject's family members because gender and handedness have been found to be related to spatial thinking by previous investigators.

Design and Procedure

Subjects were told that they would study 4 maps for 5 min each. After studying each map, they would be asked to write a description of the map so that someone who was unfamiliar with the environment and had never seen the map would know where all the landmarks were. Subjects were then given a packet containing four maps interleaved with four blank sheets of paper.

Based on the previous findings, we predicted the predominant perspective subjects would use to describe each map. Landmarks at different size scales, multiple paths, openness, and large size should encourage survey descriptions, whereas landmarks on the same size scale, a single path, a closed environment, and small size should encourage route descriptions. Maps containing more of the features predictive of one perspective should more frequently be described with that perspective. Subjects each received two maps which predicted a survey perspective and two which predicted a route perspective. The order of maps in each subject's packet was randomized.

Subjects studied a map for 5 min and then turned to the blank sheet and wrote a description without referring back to the map. Subjects had 10 min to write each description. This procedure was repeated for each of the four maps. After subjects had completed all four descriptions, they answered a brief questionnaire. Finally, subjects were debriefed on the nature of the experiment.

Results

Coding. The first author and a research assistant coded each description for perspective. The research assistant was given the following instructions for coding. "You can describe an environment either as if you are within it, walking around, or like it is on a map, a bird's-eye view. The perspective walking around the environment is called a route perspective and the bird's-eye or map view is called a survey perspective. A description could also combine these two perspectives. Please read each description carefully and write down which perspective the author is taking on the environment. If a description is mostly one perspective, except for one or two sentences, code it as the dominant perspective, otherwise code it as a mixed perspective description." The research assistant then read two example descriptions and coded those for perspective to insure she had understood the in-

structions. The coders agreed on all but seven of the descriptions, and those ties were broken by the second author.

Perspective. Overall, 78 of the descriptions used a survey perspective, 74 used mixed perspectives, and 40 used route perspectives. The data were analyzed to compare our predictions for each of the features included in the environments using Cochran–Mantel–Haenszel Tests of General Association and the results of those features which influenced perspective are displayed in Table 5. Overall size and enclosure had no effect on perspective. Perspective choice was influenced by the number of paths present, $Q(2) = 6.93$, $p < .05$. Specifically, there were relatively more route descriptions and fewer mixed descriptions when the environments contained a single path rather than multiple paths, $Q(1) = 10.52$, $p < .005$. Choice of perspective was also influenced by landmark scale, $Q(2) = 6.42$, $p < .05$. Similarly, there were relatively more route and fewer mixed descriptions when the environments contained landmarks on a single size scale than when the landmarks varied on several size scales, $Q(1) = 4.13$, $p < .05$.

Individual differences. Although each subject wrote four descriptions, there was no way to unconfound map features to know whether there were individual preferences for styles of description which couldn't also be attributed to map features. However, only 13 of the subjects consistently used one perspective; 8 a survey, 3 a route, and 2 mixed perspective. Moreover, none of the maps was described using only one perspective, though a few received a strong majority for or against one perspective or another. Thus, the majority of subjects used more than one perspective in their descriptions, and the majority of environments were described, at least in part, from more than one perspective.

Although previous work has found differences in spatial ability based on both gender (e.g., Halpern, 1986) and handedness (Levelt, 1982a), this study did not. Neither the gender nor the handedness of the subject or subject's family members led to differences in choice of perspective.

Discussion

People wrote descriptions of 16 environments that varied systematically on 4 features surmised to influence perspective in descriptions. Two of these features in fact affected perspective selection. When there was a single path through the environment rather than multiple paths, more subjects wrote route descriptions, and fewer wrote mixed descriptions. When there were landmarks at a single size scale, more people wrote route descriptions and fewer wrote mixed descriptions. Neither enclosure nor overall size of environment had any effect on perspective selection. Overall, people wrote more survey and mixed descriptions and relatively few route descriptions. The effect of both successful manipulations was to move more descriptions toward route perspectives and away from mixed perspectives along the route-mixed-survey continuum.

Although the dominant mode of description was survey, followed closely by mixed, having a single path and a single size scale of landmarks encouraged route descriptions. None of the environments used here was as extreme as New York City apartments used by Linde and Labov (1975), which are typically a series of rooms entered from a single hallway. Ninety-

TABLE 5
PERSPECTIVE USE FOR DIFFERENT MAP FEATURES

	Route	Mixed	Survey
A. Number of descriptions in each perspective based on paths			
Single path	26	27	43
Multiple paths	17	42	37
B. Number of descriptions in each perspective based on landmark sizes			
Single size scale	27	29	40
Multiple size scales	16	40	40

seven percent of those descriptions used a route. When there is a single path that passes by all the landmarks in an environment, constructing a route description is easier than when there are multiple paths. When there are many possible routes and a complex route is required to reach all the landmarks, route description becomes awkward. When environmental features are all about the same size, it seems more reasonable to give them equal treatment, as points of interest on a route. On the other hand, when some landmarks are clearly more prominent than others, the prominent ones seem to demand special treatment, and may serve as natural reference points for the less prominent landmarks.

Many other factors may affect choice of perspective, including properties of environments, characteristics of language (Levinson, in press), task demands, and mental set. More complex environments may encourage mixed descriptions, as they may encourage describers to first subdivide the larger environment into regions and then describe each region separately, using a perspective appropriate to each region. There are indications of that in the present data. One index of complexity is the sheer number of landmarks. The number of descriptions with mixed perspective correlated with the number of landmarks in the environment, $r = 0.636$, $p < .01$. Familiarity with the environment may also affect description perspective. Although most accounts of environmental learning assert that survey knowledge is built out of route experience (e.g., Thorndyke & Hayes-Roth, 1982), only a well-learned environment can be described with a route. An unfamiliar environment, however can be described by a schematic survey. Both complexity and familiarity were controlled rather than varied in the present studies. Having a natural starting point may encourage a route perspective. A natural starting point is related to having a single path, which did encourage route descriptions. Having a natural external frame of reference may encourage survey descriptions. In the present experiments, and in many real-world environments, the canonical direction terms, *north, south, east,* and *west,* serve that function. In situations where the canonical directions are not known, the communicator must establish an external reference frame. Often relatively large environmental features can be used to serve that purpose; for example, many island dwellers use *inland* and *seaward* as a reference frame.

Experiment 3: Natural Environment Acquired by Navigation

Thus far, we have collected descriptions of environments learned from maps. This was a convenient way of insuring that all subjects knew the environments well. Given that subjects regarded the maps as representing environments rather than as marks on paper and given that the descriptions were, for the most part, complete and accurate, the technique was successful. The technique did lead to a preponderance of survey descriptions, in contrast to previous research. Some of the previous research that obtained a preponderance of route descriptions, notably that of Linde and Labov (1975), used descriptions of environments learned by exploration rather than by maps. The next experiment is designed to see if people use survey perspectives to describe environments learned by exploration.

In this experiment, we asked students to describe one of three environments they would have learned by navigating through them regularly. Two of these were campus locations: the Main Quad, containing academic departments, an open area with sculptures, and the church; or White Plaza, an open area used for talks or demonstrations, surrounded by the Post Office, Bookstore, Student Union, a fountain, and an auditorium. The third location was the subject's home neighborhood.

Method

Subjects

Subjects were 67 students in the introductory psychology class at Stanford who received credit in partial fulfillment of a course requirement.

Procedure

Subjects were asked to describe one of three locations: the Main Quad at Stanford; White Plaza at Stanford; or their neighborhood at

home. They were given a blank sheet of lined paper, with the following instruction at the top: "Please describe the Main Quad (White Plaza; your neighborhood at home) so that someone who has never been there or never seen a map of it will know where the most important things are." This was part of a booklet of unrelated questionnaires that students completed at their own pace.

Results

The descriptions of 16 subjects provided no spatial information so they could not be analyzed for perspective and were eliminated. These descriptions contained merely lists of landmarks. Two coders scored the remaining descriptions as route, survey, or mixed as in the previous experiment. The coders agreed on 92% of these remaining 51 descriptions and discussed the disputed descriptions until reaching a consensus. Overall, the descriptions were not as complete as in the previous experiments. Most of them would not have allowed a naive person to locate the important landmarks correctly.

Route, survey, and mixed perspectives were represented in the sets of descriptions. Thirty-three of the fifty-one descriptions had a route perspective, eight had a mixed perspective, and nine had a survey perspective. Approximately 33% of descriptions contained some information in a survey perspective, 17% taking a pure survey perspective and 16% mixing route and survey. Results of this study are shown in Table 6.

Discussion

Unlike the previous two experiments, the majority of descriptions of the campus and neighborhood environments, all learned by navigation, took a route perspective. Mode of acquisition seems to contribute to choice of description perspective. Mode of acquisition, however, is not the sole contributor to choice of perspective. It is important to note that survey and mixed descriptions were also used. While 66% of the present descriptions used a pure route perspective, this contrasts to 97% of apartment descriptions (Linde & Labov, 1974). This difference could be attributed to different features in the environments. In the campus environments, the landmarks were on a single size scale and there was a single dominant path through the environment, factors that encouraged use of route perspective in Experiment 2. It is also possible that subjects chose route perspectives they did not know the local directions to apply to a survey perspective or because the environments did not lend themselves to survey descriptions.

TABLE 6
NUMBER OF DESCRIPTIONS IN EACH PERSPECTIVE IN EXPERIMENT 3

	Route	Mixed	Survey
White Plaza	10	2	5
Main Quad	14	1	1
Neighborhood	9	5	3

GENERAL DISCUSSION

Constructing Spatial Descriptions

Constructing spatial descriptions is like constructing any other discourse and illustrates many of the phenomena of message generation. Because spatial environments have an objective reality and because languages are rich in spatial expressions, it is a particularly good arena for studying discourse. Now we review what we have learned about message generation, placing the findings in the framework developed by Levelt (1989). The process of constructing a spatial description can be divided into organization of the environment and organization of the description.

Organization of Environment

In relating an environment, the describer begins with the representation of the environment in memory. Environments are organized hierarchically in memory, with features that are larger or functionally more significant having priority over those that are less so (e.g., McNamara, 1986; Stevens & Coupe, 1978; Taylor & Tversky, 1992a). They consist of landmarks and the approximate spatial relations among them, plus other, nonspatial information (e.g., Tversky, 1992; in press b). Several lines of evidence indi-

cate that perspective is not typically part of spatial mental models of environments. In research on comprehension of spatial descriptions, subjects learned route or survey descriptions of environments similar to those produced here (Taylor & Tversky, 1992b). They were able to answer inference questions from the perspective they had not read as quickly and accurately as inference questions from the perspective they had read, indicating that the mental representations were flexible with respect to perspective. In a production task, subjects' organization of environments was the same whether they expected to draw them or to describe them or whether they actually drew them or described them (Taylor & Tversky, 1992a).

Organization of Description

With the environment in mind, the process of organizing the discourse can begin. Levelt (1989) distinguishes two aspects of generating messages, macroplanning and microplanning. Macroplanning consists of deciding on the information to be expressed, in this case, the landmarks and their spatial relations, and ordering the information for expression. According to Levelt, ordering messages follows the *principle of connectivity*, that is, each utterance has a direct connection to previous and subsequent utterances if possible. Ordering messages also follows the *principle of natural order*. What a natural order is depends on the content. The examples Levelt gives use temporal order to describe events and source-to-goal order to give route directions. In the case of environments, the natural order observed in descriptions proceeds hierarchically, from features that are more salient or important perceptually or functionally to features that are less so (Taylor & Tversky, 1992a).

According to Levelt (1989), determining perspective is part of microplanning. This is consistent with our observation that perspective switches occurred frequently and without signaling, presumably in order to better convey location of a particular landmark or groups of landmarks. Determining perspective in microplanning is also consistent with our finding that the order of describing landmarks, determined in macroplanning, tends to be the same for different perspectives. In Levelt's analysis, topicalizing and focusing are also part of microplanning. These processes would seem to include the description of a known location prior to a new landmark that we observed here. Spatial descriptions, then, illustrate many of the qualities of linguistic messages.

Summary

Describing space is a relatively simple task that people do well. They do it by organizing space hierarchically, by salience or functional significance, and by describing elements at the top of the hierarchy prior to those lower in the hierarchy. They construct the environment in segments, where each segment first describes a known location and then places a newly introduced landmark in it. A perspective is needed to convey the location of each landmark. When describing small environments that can be seen from one viewpoint, such as a doll house room, people adopt a gaze tour, describing objects relative to each other from the outside viewpoint (Ehrich & Koster, 1983; Levelt, 1982a), using a relative frame of reference. For environments too large to be viewed from a position displaced at ground level, two perspectives have been widely used: a route perspective and a survey perspective. In a route perspective, landmarks are described relative to an observer moving through the environment in terms of the observer's *front*, *back*, *left*, and *right*, using an intrinsic frame of reference. In a survey perspective, landmarks are described relative to one another as if from above, in terms of the canonical directions, using an extrinsic frame of reference. Describers frequently switch perspectives, indicating that although perspective is needed locally to define spatial relations, the same perspective is not needed throughout to insure coherence. Selection of a perspective may depend in part on how an environment has been experienced, but it also depends on characteristics of the environment, with single paths and landmarks about equivalent in size encouraging a route rather than a survey perspective. Although there are other combinations of viewpoint, referent, and terms of reference, they do

not appear regularly in descriptions. The prevalence of gaze, route, and survey perspectives is no doubt due to their capturing natural ways of experiencing the spatial world.

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