GOAL SPECIFICITY AND THE ACQUISITION OF SURVEY KNOWLEDGE

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ABSTRACT: Studies of route and survey knowledge have been inconclusive regarding whether survey knowledge is an inevitable outgrowth of extensive route knowledge. The current study examines one factor affecting the development of survey knowledge from route knowledge: goal specificity. Goal specificity refers to the extent to which an explicit goal exists to which problem-solving activities are directed. Past studies have shown that goal specificity inhibits the development of schematic representations. Using computer-simulated navigation about a novel campus environment, goal specificity was found to interfere with the acquisition of survey knowledge. Practically speaking, this implies that when getting to a goal is of primary concern, the development of survey knowledge may be inhibited even after extensive direct experience.

Spatial knowledge is commonly divided into landmark, route (or procedural), and survey knowledge (Siegel & White, 1975; Thorndyke & Goldin, 1983). Route knowledge typically refers to one's knowledge about how to navigate from one place to another, whereas survey knowledge refers to a more integrated understanding of the configuration of an environment. When

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one's spatial knowledge is acquired primarily from direct experience of the environment, most theories agree that survey knowledge is constructed in a piecemeal fashion often by relating separate elements of route knowledge (Garling & Golledge, 1989; Golledge, 1978; McDonald & Pellegrino, 1993; Siegel & White, 1975; Thorndyke & Goldin, 1983). Some empirical studies have confirmed a general route to survey knowledge progression in the development of spatial knowledge. For example, Foley and Cohen (1984) found that subjects with more experience in an environment were more likely to use a maplike (configurational) image when solving spatial problems, whereas less experienced subjects used a more route-based imagery strategy. Kirasic, Allen, and Siegel (1984) found more experienced subjects were more accurate on tests of configurational knowledge compared to less experienced subjects. In his study examining strategies of spatial thought, Kitchin (1997) found that subjects often construct a primitive configurational representation (a minimal map) based on route knowledge.

Other studies, however, have questioned whether this route to survey progression is inevitable with increasing experience. In a developmental study comparing first, fifth, and eighth graders, Curtis, Siegel, and Furlong (1981) found that even the youngest subjects had moderately explicit survey knowledge. With adult nursing students, Moeser (1988) found evidence of excellent route knowledge of a complex building but little evidence of any survey knowledge even after 2 years of experience. Giraudo and Pailhous (1994) found that when an environment is learned through navigation, increased familiarity did not necessarily lead to increased accuracy on a map location task. Recently, Anooshian (1996) has argued that different forms of spatial knowledge are relatively independent of one another. She based this notion partially on her own study where subjects were tested on different forms of spatial knowledge (including configurational knowledge) after having navigational experience where either locations (place knowledge) or route procedures (turn knowledge) were emphasized. Subjects who were required to concentrate on route procedures showed little evidence of acquiring survey knowledge.

These inconsistent findings highlight the fact that the relationship of route and survey knowledge is neither simple nor straightforward. It is likely that a variety of factors, including the nature of the environment to be learned, the goals and intentions of the learner, and the processes used to encode, store, and retrieve spatial information, all affect the extent to which route knowledge coalesces into a configurational representation. The current study represents a first step in attempting to isolate and assess one potentially relevant factor: goal specificity.

Goal specificity refers to the degree to which a clearly defined goal or "end state" exists to which problem solving is directed (Sweller & Levine, 1982). Using a maze-learning paradigm, Sweller and Levine manipulated goal specificity by either concealing or revealing the maze's end point as the subject attempted to navigate through the maze. When the goal point was visible (goal-specific condition) the subject's understanding of the overall plan of the maze was inhibited. In a later study, Sweller (1988) extended this principle to the learning and understanding of geometric problems.

Sweller has argued that these findings can be understood in terms of cognitive load theory (Sweller, 1994; Sweller & Chandler, 1994). When the goal to a problem is explicit in nature, the problem solver often engages in a means-end strategy where at every step of the process he/she is trying to reduce the distance between the current state and the desired goal. This leaves few cognitive resources available to construct a more schematic representation of the problem. Thus, a more integrated and generalized understanding of the problem is sacrificed for the attainment of a salient goal.

Applied to spatial knowledge, this implies that when navigating about an environment, if one's mental effort is focused exclusively or primarily on the location of a certain goal point, the development of a more integrated understanding of the environment (survey knowledge) may be inhibited. This is especially relevant in light of the fact that an individual's spatial knowledge often develops around "anchor points"—important environmental nodes or landmarks that are used as reference points for the location of other elements (Couclelis, Golledge, Gale, & Tobler, 1987; Ferguson & Hegarty, 1994; Golledge, 1978; Holding, 1992). For example, a college freshman may learn how to navigate the campus by means of a system of routes that extend outward from his/her dormitory to the different buildings where classes are held. Focusing on getting to and from these specific goal points may prove highly functional but may not be as effective a strategy for acquiring a survey understanding of the campus compared to simply touring through the environment with no specific destination in mind.

The current study manipulated goal specificity in the context of computer-simulated navigation. Past studies have demonstrated that configurational knowledge can be acquired from computer-simulated navigational experience (e.g., O'Neill, 1992; Regian, Shebilske, & Monk, 1992), however, the quality of the knowledge can vary. Golledge, Dougherty, and Bell (1995) found that map learners were generally better than computer learners on tests of survey knowledge, however, the differences were not significant. Rossano and Moak (1998) found that map and computer learners were the same on an initial test of survey knowledge, however, map learners outperformed computer learners on subsequent tests. Once again, the quality of the survey knowledge acquired by computer learners may depend on a variety of factors including goal specificity. The hypothesis of the current study flows logically from Sweller's model in that it was predicted that when subjects navigate through an environment with a specific goal point in mind their acquisition of survey knowledge will be impaired compared with the those who navigate in a goal-nonspecific manner.

METHOD

SUBJECTS

Fifty subjects participated in the experiment. Subjects were evenly divided into the experimental conditions with equal numbers of males and females in each condition. All subjects were recruited from the Psychology Department subject pool and received course credit for their participation. No subject had any previous experience with the to-be-learned campus environment.

CAMPUS ENVIRONMENT

The environment depicted was the western end of the University of California–Riverside (UCR), which included five academic buildings and a tall bell tower. Along with the buildings, other aspects of the campus such as trees, sidewalks, and lawns were also present in the area. The buildings were all two or three levels in height and of various shapes and sizes.

COMPUTER MODEL

The to-be-learned environment was represented using a computer model. The computer model was created using the Virtus WalkThrough Pro software. This program is especially designed to create realistic three-dimensional representations. All relevant aspects of the campus were represented including the buildings, trees, sidewalks, open green spaces, and courtyards. The model was quite realistic with vivid colors, building textures, shading, and other visual elements present that gave the strong impression of a real campus. The model was run on a 60-MHz Pentium PC with a 15-inch full-color monitor and 16 megabytes of RAM.

The Virtus software also allows for ground-level walk-paced movement through the represented environment. In the passive experimental conditions (described below), this movement was preprogrammed as a tour through the campus. This tour took 15 minutes to complete and started at a point north of the campus facing south. It then went around the perimeter of the area before winding between and around the various buildings to give experience of the environment from different perspectives. Care was taken to ensure that the tour was balanced in terms of the amount exposure to the different buildings and the different subsections of the area. At no time did the tour present an overhead, maplike view of the environment.

EXPERIMENTAL CONDITIONS

Four experimental conditions were created as a result of the factorial combination of two independent variables (IVs). IV(1) was called goal and it had two conditions: goal specific (GS) and goal nonspecific (GNS). In the GS condition, subjects were required to keep a specific goal location in mind as they toured through the campus. In the GNS condition, there was no campus location designated as a goal. In both conditions, subjects were given the same instructions, indicating that they were to learn as much as possible about the campus from the tour and that their knowledge would be tested immediately after the tour was done.

IV(2) was called control and it also had two conditions: active and passive. In the active condition, subjects directed themselves about the campus using the mouse. In the passive condition, movements about the campus were directed by the computer program.

Goal Nonspecific: Active and Passive Conditions

In both the active and passive goal-nonspecific conditions, subjects were exposed to the same computer tour of the UCR campus. In the passive condition, the tour was preprogrammed and subjects simply watched the screen as the tour progressed. As the tour went along, the experimenter acted as tour guide, naming the buildings as they were passed.

In the active condition, subjects used the mouse to direct themselves through the tour. To ensure that subjects in the active condition were facile at using the mouse to direct movements, practice was provided prior to their exposure to the UCR campus. A second campus environment was created that was roughly equal in complexity to the UCR campus (e.g., it also contained six buildings with trees, sidewalks, lawns, parking areas, etc.). It was used as a practice campus so that subjects could get comfortable using the mouse to move through the environment. Subjects were allowed to freely roam through the practice campus until they felt confident in their ability to control movements with the mouse and the experimenter was assured that they could move about at a pace comparable to the programmed tour without losing control or running into the buildings. Because most subjects had some prior experience using computers and mice in this fashion (e.g., computer games), most mastered the skill within 5 minutes or less. If subjects proved to be unable to master using the mouse to move about the campus, they would be dismissed from the experiment without exposure to the UCR campus (this, however, proved unnecessary as no subjects failed to master the mouse).

After completing the practice campus, subjects in the active condition moved themselves along the tour route. As in the passive condition, the experimenter acted as tour guide naming the buildings as they were passed and guiding the subject along the route. Subjects were allotted 15 minutes to complete the tour, thus equating their total exposure time to that of the passive subjects. If subjects completed the tour before time was up, they began the tour again and continued until 15 minutes had elapsed. All subjects completed the tour in the allotted time and most were somewhere in their second run of the tour when time expired.

Goal Specific: Active and Passive Conditions

In both the active and passive goal-specific conditions, a specific campus location (the bell tower) was designated as the goal. Along with the general instructions mentioned earlier, subjects were also told that they would be intermittently asked about the location of the bell tower during the course of the tour.

In the passive condition, subjects viewed the same programmed tour as was used in the goal-nonspecific condition, however, at eight preestablished points during the tour the subject was asked to indicate the direction from that point to the bell tower. The eight points were selected based on the following criteria: (a) they represented a roughly uniform spread across the range of the campus, (b) they were ones where the bell tower was not visible, and (c) they were points where the movement of the tour either stop or slowed sufficiently so that the location task could take place with minimal distraction. To respond, subjects extended an arm in the general direction of the bell tower. The experimenter then recorded whether the response was correct. To be considered correct, the subject simply had to point in the appropriate general direction of the bell tower. So if the bell tower was to the northwest, the subject had to point in a northwesterly direction. An incorrect response would have been one pointing due north, east, or south, etc.

The active condition was the same as the passive one, except that subjects used the mouse to direct themselves through the tour. As before, subjects were provided pretraining using the practice campus to ensure their facility with the mouse. Exposure time was again limited to 15 minutes. All subjects completed one run through the campus and were somewhere into their second run when time expired.

CONTROL CONDITION: PASSIVE, GOAL NONSPECIFIC WITH SECONDARY TASK

It might be argued that a difference between the two goal conditions was simply that of a secondary task load. In this view, the goal-specific requirement of monitoring a certain location is not a spatial processing difference (relative to the goal-nonspecific condition) but just an additional task that distracts from the learning of the campus. To assess this, a control condition was included where an additional task was added onto the passive/goal-nonspecific condition described earlier. This task required subjects to learn the names of buildings as the tour progressed. (Recall that the names of the buildings were announced by the experimenter during the course of the tour.) Because there were six building names to keep in mind, this represented a substantial amount of working memory capacity and theoretically a sufficiently challenging (though nonspatial) task. At the same locations where the goal-specific subjects were required to locate the bell tower, subjects in the control condition were required to name two buildings that were currently not visible. At the start of the tour, subjects were given the same instructions as always, and they were told that during the tour they would be intermittently asked about the names of the buildings.

BUILDING PLACEMENT TEST

By definition, a key element of survey knowledge is an understanding of interelement relations (McDonald & Pellegrino, 1993; Thorndyke & Goldin, 1983). A test directly measuring this was created and referred to as the building placement test. For this test, subjects were provided an 8.5-inch by 11-inch sheet of paper on which two 3-centimeter by 5-centimeter rectangles were drawn. The rectangles served as representations of two campus buildings and were in the appropriate relationship to one another as determined by an official campus map. Subjects were told which buildings the two rectangles represented and that they should use them as reference points for the placement of the third building. They were then given a 3-centimeter by

5-centimeter rectangle cut out from white posterboard and told that it represented another building. Their task was to place this rectangle on the sheet in the correct position relative to the reference points. For example, once a sheet with two rectangles was placed before the subject the experimenter would point to each rectangle and say "this is the library, and this is the administration building." Then the experimenter would hand the subject a rectangle and say, "this is Watkins Hall. Place it on the sheet where it belongs relative to the other buildings." The subject then placed the rectangle on the page and traced around it with a pencil to record the location.

Five pairs of reference points (buildings) were used. Each pair was a unique combination of two buildings, with all the buildings except the bell tower being included across the five pairs. (The bell tower was never used as a reference point.) Pairs were chosen to maximize their spread across the campus, and thus those buildings on the perimeter of the campus were more frequent members of reference pairs than those more centrally located. One building occurred in three pairs, three buildings occurred in two pairs, and one building occurred in just one pair.

Each subject received a single reference point pair and was required to independently plot each of the four remaining buildings with reference to that pair. Furthermore, the reference point pair was presented from four different facing directions, and each facing direction required four plots. The particular reference point pair that a subject received was determined randomly, as was the order of both facing directions and building plots.

For example, after a subject's exposure to the computer model was completed, he/she was presented with a booklet containing four pages. Each page showed the same reference point pair from a single facing direction. The experimenter would then say, "Here are buildings A and B viewed from the X-facing direction. Take this rectangle and plot where building C should be located relative to A and B." After the subject had made the first plot, the page was turned and the next building was plotted. When all four buildings had been plotted on separate pages, a new four-page booklet was produced that depicted the same reference point pair from another facing direction. This process continued until four plots had been completed for all four cardinal facing directions (a total of 16 plots). At this point, the subject was completed with the building placement test.

Because 10 subjects (5 female, 5 male) were assigned to each condition, each reference point pair occurred twice in each condition, once for a male subject and once for a female subject. Which male or female subject received what pair was determined randomly with the constraint that no pairs were repeated in a condition.

DEPENDENT MEASURES

Two dependent measures were taken from the building placement test. The first was called the angle error, and it was calculated in the following way: First, the centerpoint of each rectangle (building representation) was determined. Vectors were then drawn from the centerpoints connecting each reference point building to each plotted building. The angle of each vector was compared with the correct vector connecting those buildings. For each plot, an average error score (measured in degrees) was calculated across the two building reference points. These scores were then averaged across the four plots for each facing direction. Thus, each subject contributed four average angular error scores, one for each facing direction.

The second dependent measure was the distance error. This was the difference between the length of each vector connecting a reference building to a plotted building and the length of the correct vector (measured in centimeters). This measure was averaged across buildings and plots in the same manner as the angle error. In total then, each subject produced eight error scores—four distance errors across four directions and four angle errors across four directions.

PROCEDURE

Subjects were brought to the lab and informed that they were participating in an experiment to determine how well people could learn a campus by viewing a computer model of it. In the passive conditions, once subjects were ready, they were immediately exposed to the test campus. In the active conditions, subjects were first exposed to the practice campus and then they proceeded to the test campus. When their exposure time was completed, subjects were given the building placement test, after which they were dismissed from the experiment. The entire procedure took approximately 45 minutes.

RESULTS

REFERENCE POINT PAIRS ANALYSIS

A preliminary analysis was undertaken to determine if there were any differences among the five reference point pairs that were used. Across the five experimental conditions, 10 subjects received each of the five different reference point pairs (2 subjects per each condition). Analyses comparing these five pairs on both angle error and distance error measures were done. On the angle error measure, there were no significant differences among any of the reference point pairs ($p = .56$; scores ranging from 21.7 to 13.3 degrees). On the distance error measure, there was a significant difference among the pairs $F(4, 45) = 4.35$, $p = .005$, $MSE = 1.6$. Generally speaking, a shorter distance between pair members produced smaller error, whereas longer distances produced greater error. Tukey post hoc comparisons indicated that only the extreme values (2.1–1.2 centimeters) significantly differed. Though there was a difference on the distance error measure, this does not represent a confounding factor because reference point pairs were balanced across the experimental conditions.

ANGLE ERRORS

Initially, analyses were run excluding the passive/goal-nonspecific/secondary task control condition. This control condition was then included in a later round of analyses.

Angle error scores were submitted to a $2 \times 2 \times 2 \times 4$ mixed ANOVA. The first three factors of sex, control (active vs. passive), and goal (goal specific vs. goal nonspecific) were all between-subjects manipulations. The fourth factor of facing direction (N, S, E, W) was within subjects. Only one significant effect emerged from the analysis. There was a significant main effect of the variable goal $F(1, 32) = 10.04$, $p = .003$, $MSE = 633.1$. Figure 1 shows the average angle error scores for the goal-specific and goal-nonspecific conditions across both the active and passive conditions. As can seen from the figure, the pattern of results was the same for both active and passive conditions: The goal-nonspecific condition produced roughly half the magnitude of errors compared to the goal specific condition. The overall averages for the two conditions were: goal nonspecific = 10.5, goal specific = 23.1. Figure 1 also shows that, somewhat surprisingly, there was no effect of the variable control. No other significant main effects or interactions were found in this analysis.

DISTANCE ERRORS

Distance error scores were submitted to the same $2 \times 2 \times 2 \times 4$ mixed ANOVA previously described. The same main effect of the variable goal was found $F(1, 32) = 5.38$, $p = .03$, $MSE = 1.7$. Figure 2 shows the average distance error scores for goal-specific and goal-nonspecific conditions for the active and passive conditions. The pattern was the same as that observed for

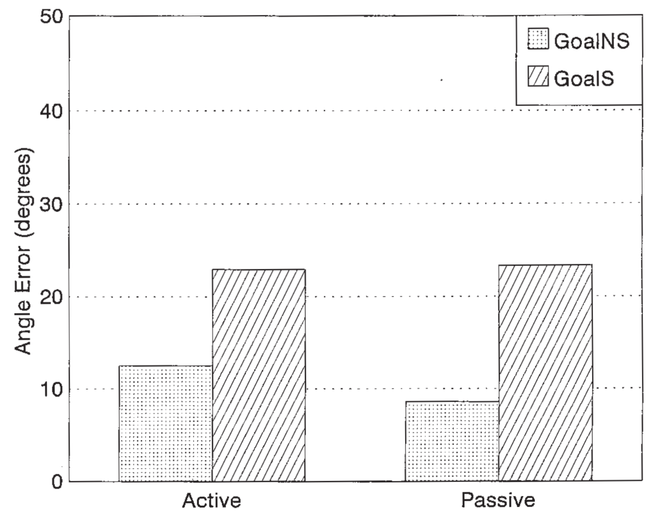

Figure 1: Graph Depicting the Average Angle Errors for Goal-Nonspecific (GoalNS) and Goal-Specific (GoalS) Subjects in Both Active and Passive Conditions

the angle error scores. In both the active and passive conditions, the scores for the goal-specific condition were well above those of the goal-nonspecific condition. The overall averages were goal nonspecific = 1.49, goal specific = 2.00.

A significant main effect of sex was also found in this analysis. Females were generally more accurate in their distance estimates (M = 1.49) compared with males (M = 1.97). There were no other significant main effects or interactions.

PERFORMANCE ON THE GOAL

The analyses so far indicate poorer survey knowledge acquisition on the part of the goal-specific subjects compared with the goal-nonspecific subjects. A possible reason for this was that remaining consciously aware of the direction of the bell tower during the tour was a rather difficult task that required nearly all of the subjects' mental energy, thus leaving few cognitive

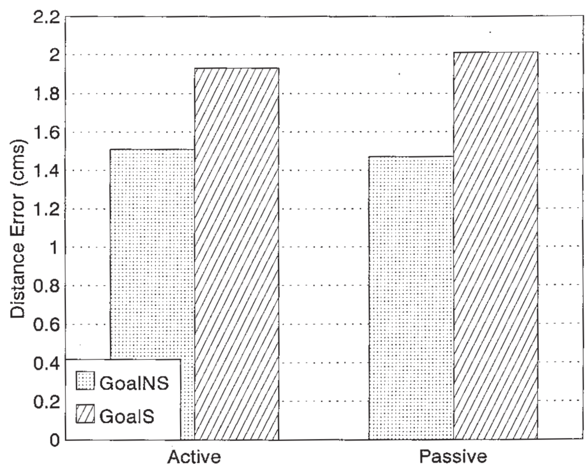

Figure 2: Graph Depicting the Average Distance Errors for Goal-Nonspecific (GoalNS) and Goal-Specific (GoalS) Subjects in Both Active and Passive Conditions

resources available to learn anything more about the campus. The data, however, did not support this argument.

As was mentioned earlier, the experimenter kept a record of each subject's accuracy in pointing to the bell tower during the course of the tour. There were no errors in the passive condition and only two errors (one each by two different subjects) in the active condition. This generally good performance suggests that subjects found the task relatively easy. In addition, if subjects' attention was narrowly focused on the bell tower one might expect their angle and distance error scores to be substantially reduced for that landmark compared to the other buildings. For the goal-specific subjects, the average angle error score on the bell tower was 19.7 degrees, only 3.4 degrees less than the overall average (23.1), whereas their distance error average on the bell tower was 2.4 centimeters, .4 centimeters higher than the overall average. Thus, there was no evidence that subjects found the goal-specific task inordinately difficult or that they traded global knowledge for more precise knowledge of a specific point.

CONTROL CONDITION: PASSIVE, GOAL NONSPECIFIC WITH SECONDARY TASK

It was possible that the increase in error observed in the goal-specific condition was not due to goal specificity per se but was the result of a secondary task load imposed by having to monitor a specific location during the course of the tour. By this reasoning, when attentional resources must be allocated to a secondary task, performance on a primary task (such as learning a campus layout) will be negatively affected. To test this possibility, an analysis was run comparing the three passive conditions: passive goal nonspecific, passive goal specific, and passive goal nonspecific with secondary task (for simplicity, this will be referred to as the control condition). The rationale of the analysis was as follows: The previous analyses showed that the passive goal-specific condition had significantly higher errors than the passive goal-nonspecific condition on both the angle error and distance error measures. If this difference was a secondary task effect, then the control condition should also show significantly higher errors than the passive goal-nonspecific condition. If, on the other hand, the control condition replicates the goal-nonspecific condition, then the goal effect found earlier cannot be attributed to a secondary task effect.

Both the angle error and distance error measures were submitted to an analysis of variance comparing the three passive conditions using a variable simply called groups. On the angle error measure, a significant groups effect was found $F(2, 27) = 10.4$, $p < .001$, $MSE = 237.2$. Figure 3 shows the average angle errors for the three groups. As can be seen in the graph, the score for the control condition is nearly the same as that of the passive goal-nonspecific condition (passive goal nonspecific = 8.60, control = 11.4) and is significantly less than that of the passive goal-specific condition $F(1, 18) = 8.6$, $p = .009$, $MSE = 329.7$.

Results from the distance error measure can be seen in Figure 4. The analysis showed that the groups effect was nonsignificant ($p = .18$). In this instance, the control condition did not significantly differ from either of the other conditions. However, as is evident from the graph, the score of the control condition was more similar to the nonspecific condition (from which it differed by only .18) than the goal-specific condition (from which it differed by .36).

It was also noteworthy that the errors committed on the control condition's naming task closely matched those committed on the goal-specific location task. Of the 10 subjects, only 2 committed errors; 1 subject made five errors and the other two. This is more than the passive goal-specific subjects where

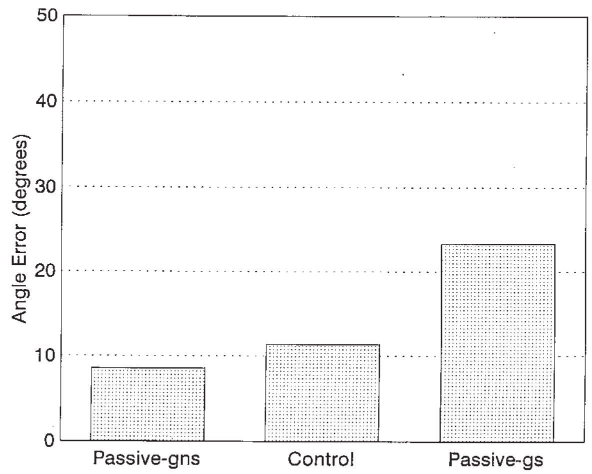

Figure 3: Average Angle Errors for Passive Goal-Nonspecific Condition (passive-gns), Control Condition, and Passive Goal-Specific Condition (passive-gs)

no errors were committed, and the same (in terms of the number of subjects) as the active goal-specific subjects. Based on errors, the naming task was, if anything, slightly more demanding than the goal-specific task.

The results of the control condition indicate that adding an additional task to the passive goal-nonspecific condition modestly degrades performance. However, the magnitude of this effect is minor compared to the effect of goal specificity. Therefore, the goal effect found earlier is not attributable to goal specificity acting merely as a secondary task.

DISCUSSION

The sensory inputs available as one navigates through an environment provide a potentially rich source of information about interelement relationships and overall configuration. However, under many circumstances much of this information is likely ignored or inadequately processed. Most human navigation is purposeful in nature, that is, we are usually trying to get

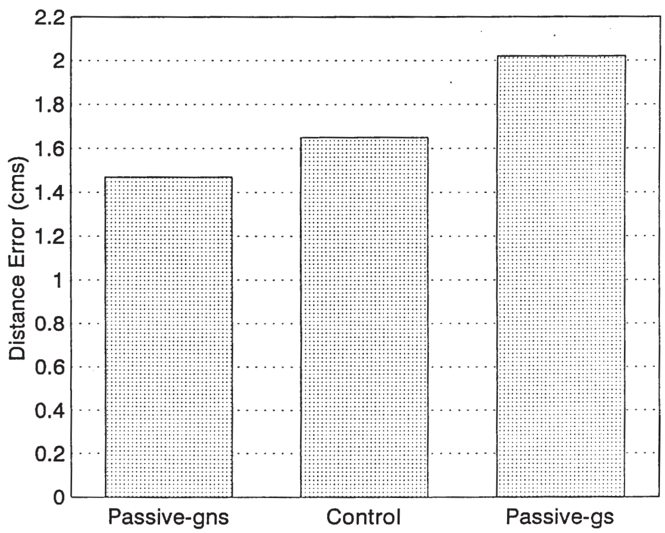

Figure 4: Average Distance Errors for Passive Goal Nonspecific Condition (passive-gns), Control Condition, and Passive Goal-Specific Condition (passive-gs)

somewhere. In these instances, attention is primarily focused on the information relevant to the purpose, such as discerning the correct direction of movement, engaging in the proper sequence of turns, staying on the right path, and so forth. Without question, this goal-directed aspect of spatial cognition is functional and important. The negative consequences of failing to arrive at the goal location can range from minor inconvenience to life threatening. In our evolutionary past, those who took the wrong route or who failed to get back to familiar territory were prime candidates for selection out of the breeding population. There is even some evidence that route knowledge may have special representation at the neurophysiological level (Maguire, Frackowiak, & Frith, 1997). As significant as it is, however, goal-directedness may impair other aspects of spatial processing, namely the acquisition of survey knowledge.

In the current experiment, subjects required to keep a certain goal location in mind as they navigated about a novel environment were inferior on their measured survey knowledge compared to those for whom no goal was specified. The goal-specific subjects were also found to be significantly inferior to a control group who engaged in a naming task concurrent with their navigation. Thus, it was the nature of the goal-specific task and not the fact (or possibility) that it may have been an additional cognitive load that led to the impairment. So why might goal specificity impair the acquisition of survey knowledge?

It does not appear that focusing on the goal location enhances one's learning of that location's interrelationships to other elements. Subjects in the current experiment showed no evidence of enhanced learning of the bell tower at the expense of the other campus elements. Nor does it appear that the goal-specific task was excessively demanding, usurping all or nearly all of the subjects' cognitive resources. Subjects proved capable of carrying out an equally demanding task (naming task) while still acquiring reasonably good survey knowledge. Instead, it appears that the goal-specific task was a different type of spatial processing that was incompatible with that which is required to accurately learn interelement relations.

Goal-specific subjects simply did not acquire the interelement relationships of the campus as well as the goal-nonspecific subjects. However, if some aspect of route knowledge pertaining to the goal point had been measured (such as inquiring about the correct direction of travel or which way one should turn to get to the bell tower) goal-specific subjects may very well have shown superior learning. These results lend support to the disassociation of route and survey knowledge discussed by Anooshian (1996). Furthermore, these findings confirm the notion that when mental resources are engaged in the attainment of a specific goal, a more generalized, schematic understanding is often sacrificed (Sweller & Levine, 1982).

On a practical level, these findings helped to explain why survey representations may or may not be acquired despite extended experience in an environment. If mental resources must continually be allocated to the attainment of a goal location even after one has been familiarized with an environment, the development of a survey representation may not occur (or be may be retarded). This may happen when environments are complex and challenging to navigate and/or when one is highly motivated to get to the goal quickly and efficiently. Both of these factors probably affected the nursing students studied by Moeser (1988) who showed no evidence of a survey representation despite years of direct environmental experience. On the other hand, if after a time, getting to goals becomes routine and almost automatic, then it seems more likely that cognitive resources could be dedicated to piecing together a more integrated understanding of the environment. Even under these circumstances though, one would not expect the development of a survey representation to be inevitable. Kozlowski and Bryant (1977) have shown that a good sense of direction requires mental effort and attention to the spatial details of a new environment. If one daydreams while navigating to a goal point, the spatial details that might allow for the development of survey knowledge will probably go unnoticed and unprocessed.

The fact that survey knowledge was inhibited by goal specificity and not by a concurrent verbal task falls easily into line with theories of working memory that separate verbal from spatial processing (e.g., see Baddeley, 1986, 1992; Baddeley & Hitch, 1974). Concentrating on a goal location represents one form of spatial processing that appears to conflict with the formation of survey knowledge. Future research may investigate other forms of spatial processing that function in this same manner as well or possibly some that are facilitative of the formation of survey knowledge. What seems clear, however, is that being solely preoccupied with getting from A to B may get one to B on time, but it may not allow for A or B to be placed within a larger context.

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