Spatial strategies of oriented travel in *Callicebus moloch* and *Saimiri sciureus*

MICHAEL W. ANDREWS

State University of New York Health Science Center, Brooklyn, New York

The behavior of 9 titi monkeys (*Callicebus moloch*) and 12 squirrel monkeys (*Saimiri sciureus*) was examined with respect to three categorical strategies of spatial orientation: direction, turn, and place strategies. Individual animals were initially trained to travel to a fixed location from a constant release point. Following the initial training, each animal was tested by releasing it a number of times from three other release points and analyzing its travel paths. During testing, most individual subjects tended to be highly consistent in their spatial behavior, typically following travel paths consistent with one of the three spatial strategies. No one spatial strategy, however, characterized the behavior of either species.

Callicebus moloch (the titi monkey) and *Saimiri sciureus* (the squirrel monkey) are two species of New World monkeys that contrast markedly in their daily ranging patterns. *Callicebus* live in small family groups whose individuals travel together over comparatively short distances, following habitual pathways and remaining within a small home range; *Saimiri* live in relatively large groups whose individuals travel in a widely dispersed manner over comparatively long distances, following no set pathways and ranging over a large area (Mason, 1968; Thorington, 1968; Terborgh, 1983). Considerable effort has been directed towards providing functional, ecological explanations of such interspecies differences; for example, ranging pattern differences among primates are often related to the foraging consequences of the various patterns (e.g., Clutton-Brock, 1977). The behavioral mechanisms that determine ranging pattern differences, however, have remained largely unexplored.

Among the possible behavioral mechanisms that contribute to species differences in ranging patterns are strategies of spatial orientation. A preliminary, though not necessarily exhaustive, characterization of strategies of spatial orientation may be derived from the work of Blodgett and his associates (Blodgett, McCutchan, & Matthews, 1949). Elaborating on earlier studies of rat behavior in the T-maze, these investigators distinguished direction, turn, and place dispositions as potential bases of successful performance. More recently, O'Keefe and Nadel (1978) have discussed three strategies that are quite consistent with those proposed by Blodgett. In the terminol-

ogy of Blodgett et al., an animal with a *direction disposition* will select an arm of the T-maze so as to travel in a particular direction within the test environment. This is similar to O'Keefe and Nadel's description of a strategy in which the individual maintains a particular relationship to a landmark or small set of landmarks (e.g., "move towards window at end of room"). An animal with a *turn disposition* would make a particular turn (i.e., right or left) in accomplishing the maze task. This is similar to the second strategy described by O'Keefe and Nadel, in which the individual merely performs a sequence of responses in an order that leads to a particular spatial outcome (e.g., "two steps forward, turn right," etc.). Finally, an animal with a *place disposition* would travel to a particular location within the test environment. O'Keefe and Nadel suggest that a third strategy, which they fittingly refer to as a *place strategy*, is based upon an individual's response to the relations among multiple landmarks; this strategy permits the flexibility of traveling to a particular location in the environment from any other location, by any available route.

The objectives of the present study were to determine the adequacy of direction, turn, and place strategies in accounting for the performance of titi monkeys and squirrel monkeys in a simple spatial task, and to compare the spatial behavior of the two species for possible clues as to the determinants of their different natural ranging patterns. To achieve these ends, a situation was created in which the initial spatial task for all animals was to find food at a fixed point after starting from a fixed location. Once the subjects had mastered this task, they were tested using novel start locations. The evident travel patterns beginning from these novel locations provided the principal basis for inferring spatial strategies.

METHOD

Subjects

The subjects were 9 adult *Callicebus moloch* monkeys (4 males and 5 females) and 12 adult *Saimiri sciureus* monkeys (6 males and 6 females, Colombian and Peruvian mix). Each animal was housed

I would like to thank L. P. Acredolo, G. Anzenberger, A. G. Butler, W. A. Mason, S. P. Mendoza, C. R. Menzel, and L. A. Rosenblum for invaluable suggestions and comments at various stages in the development of this manuscript. Some of the results reported in this paper were presented at the 6th annual meeting of the American Society of Primatologists in Arcata, California. The research was supported in part by USPHS Grant RR00169 and funds from the Department of Psychology, University of California, Davis. Correspondence may be addressed to Michael W. Andrews, Department of Psychiatry, Box 120, State University of New York, 450 Clarkson Avenue, Brooklyn, NY 11203-2098.

with an opposite-sexed conspecific adult and any immature offspring, in an indoor-outdoor living cage ($2.3 \times 1.1 \times 1.1$ m, indoors; $1.8 \times 1.1 \times 3.6$ m, outdoors). Of the 12 *Saimiri* monkeys, 11 were born wild, and of the 9 *Callicebus* monkeys, 2 were born wild. All the animals had resided at the California Primate Research Center for at least four years prior to the beginning of the study. One newborn *Callicebus* was allowed to remain on its father's back during daily sessions, since this was judged to be less disruptive than separation.

Design

The present study utilized a "double cross" maze with elevated runways (Figure 1). The maze included three goals arranged in a straight line, and four release locations, with two of the release locations on each of the opposite sides of the goals. Each release location presented a choice between two potential goals, one to the right and one to the left. In effect, the situation consisted of four interconnected T-mazes, with the Ts on the same side of the goals sharing the middle goal only, and with the Ts on directly opposite sides of the goals sharing the middle goal and one of the outside goals. Only the middle goal was part of all four Ts and thus accessible from all four release locations.

The experimental design included a pretraining phase, a training phase, and a testing phase. The purpose of the pretraining phase was to habituate the animals to the test setting and to counteract any initial spatial biases. In the training phase, the animals were trained to go from a single release location to the middle goal. Finally, the goal selections from the release locations not used in training were examined in the testing phase, to ascertain any spatial pattern of goal selections.

Apparatus

The double cross maze was located in an outdoor cage ($10.8 \times 18.0 \times 2.1$ m), set apart from the subjects' living areas. Fields, trees, and various man-made structures were visible from the maze. Each of the four release locations of the test maze (see Figure 1) consisted of a platform on which a carrying cage ($32 \times 33 \times 36$ cm) could be placed. This cage had an opaque back, two opaque sides, and (when properly placed) a front consisting of two remotely operated guillotine doors, one of clear plastic and one, immediately behind it, of opaque plastic. Each release platform was connected to a removable runway (3.7 m long, 9 cm wide, 2 cm thick, and 85 cm above ground level) leading to a choice point, from which similar runways (3 m long) led to the two goal cages. By definition, an initial goal choice occurred when a subject passed

one of the black marks placed 0.6 m from the choice point on each runway section leading to a goal. The goal cages ($1.2 \times 0.8 \times 1.8$ m) consisted of a light wooden frame covered with 2.5 cm poultry wire; there was a 68×38 cm opening at each end of the cage at the height of the runway system, which provided animal access to the cage. The drawbridge style doors of these entry ways rested on the runways when open, and they could be closed simultaneously from behind a release platform, by means of a rope-and-pulley system. Within each goal cage, a wooden perch ran down the center at the same height as the runway system, and held an opaque food cup (6 cm in diameter $\times 4$ cm deep) at its midpoint. All wooden surfaces, including the runways, were painted flat gray. A short segment (approximately 1 m) of blind runway was placed on the far side of each of the two outside goals to make the appearance of all goal areas as similar as possible.

Procedures

General. Each session for an individual subject consisted of 12 trials, and all sessions occurred prior to early afternoon feeding. The sessions were conducted only on dry days with calm to mild winds (< 10 mph), and only when the temperature was between 12.5° and 35.0° C. Weather permitting, each subject was given one session per day, five days per week, until all phases were completed. Daily testing was accomplished by separating the subjects into small cohorts, which were balanced for species and sex within species; individual subjects from only one cohort at a time were advanced through the experimental procedures. The order in which the subjects were tested was counterbalanced across sessions in each phase.

Each subject was transported to the experimental area in the carrying cage/startbox immediately prior to the session. Before each trial, the carrying cage was secured on the appropriate release platform. The food cups were baited while the subject's view of the experimental area was blocked by the opaque walls of the startbox. In order to minimize differential auditory cues when only one goal cage was baited, the second goal cage was sham baited. The food reward on all trials was a single half-piece of miniature marshmallow (with exception made for one *Saimiri* female that preferred Fruit Loops). To maintain a high level of subject interest in the task, on four randomly selected trials in each session a small piece of peanut or banana was placed in the food cup in addition to the regular reward.

Observations were made from immediately behind the startbox, outside the subject's field of view. Fifteen seconds before each trial, the opaque door of the startbox was raised, permitting the subject to view the experimental area through the clear door; following this, the clear door was raised, beginning the trial and allowing the subject to exit from the startbox.

Three latency intervals were measured on each trial. (1) *Exit latency* was defined as the elapsed time from the opening of the clear door until the subject exited. The subject was allowed 30 sec to exit from the startbox. If it failed to do so, a latency of 31 sec was recorded, and a coaxing procedure was initiated. The animal was first vocally coaxed from behind the release platform, but if this was not sufficient, a panel at the back of the carrying cage was slowly moved forward, forcing the animal to exit. (2) *Choice latency* began as soon as the subject had exited; it terminated when the subject passed the black mark 0.6 m from the choice point on a runway section leading to a goal. The subject was allowed a maximum of 45 sec from the time of exit to make a choice. If it failed to do so within this time, a latency of 46 sec was recorded, and a vocal coaxing procedure was initiated, as described above. If this was ineffective, the observer began walking directly from the release platform toward the subject, taking care not to bias it in favor of either goal cage. (3) Following a choice, the *goal latency* began. This interval terminated when the subject entered a goal cage. The subject was allowed up to 30 sec to enter a goal cage following

Figure 1. Diagram of the test area, showing the runways, goals, and animal release locations.

an initial goal choice, after which a latency of 31 sec was recorded if it failed to do so, and a coaxing procedure similar to that described for the choice interval was initiated.

After an animal had entered a goal cage, the goal doors were closed; it was allowed up to 1 min to take any available food or to inspect an empty cup, whereupon it was retrieved and transported to the appropriate release location, or, following the last trial, to its home cage.

At the end of each experimental day, the runway sections were cleaned and interchanged, to minimize the possibility of animals' obtaining extra cues from the runways.

Observers were trained to a reliability criterion of 0.90 or better on at least four consecutive sessions before recording experimental data. Two observers were present for most sessions.

Pretraining phase. The subjects were assigned to one of two groups, defined by release from Location 1 or Location 2 (see Figure 1) and balanced for species and sex within species. Only one goal cage was baited and accessible on a pretraining trial. This was accomplished by closing the goal doors of the opposite goal cage and removing the runway section that lead to it. Each of the two goal cages associated with each release location was accessible on half of the trials in a session, in an order determined by a pseudorandom Gellermann series (Fragaszy & Frigaszy, 1978). When a subject had achieved the pretraining criterion of traveling to the available goal in the allotted time without observer intervention on at least 20 trials in two consecutive sessions (24 trials), the subject advanced to the training phase.

Training phase. In this phase, the subjects were released from the same release location as in pretraining, but with both goals simultaneously accessible. Only one goal, the middle goal (Goal B in Figure 1) for all subjects, contained a food reward. The training sessions continued until the correct goal (the middle goal, with the reward) was selected on at least 20 trials in two consecutive sessions. Upon meeting this criterion, the subject advanced to the testing phase.

In the event that a subject made 20 or more selections of the incorrect goal cage (the goal cage with no reward) in two consecutive sessions, the subject was considered to have a side preference. Such a subject was given special training sessions consisting of six free choice trials (as in training) and six trials in which it was forced to the correct (nonpreferred) goal cage by the closing of the goal doors of the opposite goal cage. Forced and unforced trials occurred in a pseudorandom order, as determined by a Gellermann series (Fragaszy & Frigaszy, 1978). This procedure was continued until at least 10 unforced correct selections occurred in two consecutive sessions, whereupon the subject was returned to the regular regimen and trained to criterion.

Testing phase. This phase consisted of a total of 12 test sessions, in each of which the subject received three probe trials and nine training trials. On the probe trials of a session, the subject was released once from each of the locations not used in pretraining and training; on these trials, both available goals contained a food reward.

The first 2 trials in a test session were always training trials; 1 probe trial occurred in Trials 3 to 6, 1 in Trials 7 to 9, and 1 in Trials 10 to 12. The order in which the three probe release locations were presented during a session was balanced across subjects by species and sex within species, and counterbalanced within subjects across days. At least 2 training trials occurred between successive probe trials. A subject failing to select the correct goal (i.e., the middle goal) on at least 7 of the 9 training trials in a test session was given daily training sessions until it reached a criterion of 10 correct trials in a 12-trial session before being advanced to the next test session. Thus a total of 36 probe trials were administered to each subject, 12 from each of the three release locations not used in training.

Analysis

For the testing phase, the two-tailed binomial test was used to determine if the consistency exhibited by an individual subject in goal selections after starting from a probe release location represented a statistically significant preference for one of the two available goals. A repeated measures analysis of variance was used for all other analyses. The criterion for significance on all tests was $p < .05$.

Because two different release locations were used in the training phase, the physical locations from which animals were released on probe trials were not the same for all subjects. Therefore, for purposes of analysis, the release locations on probe trials were defined relative to the release location used in training, as follows: (1) *beside* refers to the release location facing the goal cages on the same side as the training release location (i.e., right of Release Location 1 or left of Release Location 2; see Figure 1); (2) *across* refers to the release location directly opposite the training release location; (3) *diagonal* refers to the release location located diagonally across from the training release location. Latencies for these locations on probe trials were compared using difference scores for each latency interval, derived by subtracting the latency for a particular interval on the immediately preceding training trial from the latency for the same interval on the probe trial.

In accordance with the spatial strategies outlined previously, goal selections were classified as follows (refer to Figure 1). When a monkey selected the middle goal (Goal B) after starting from any probe release location, this was designated a *place* response. When a monkey selected a goal that lay in the same compass direction from the probe release point as the middle goal did from the training release location, this was designated a *direction* response (e.g., choosing Goal C after starting from Probe Location 3 when training was from Location 1). Finally, when a monkey selected a goal that was in the same position relative to the probe release location (right or left) as the middle goal was relative to the training release location, this was designated a *turn* response (e.g., choosing Goal A after starting from Probe Location 4 when training was from Location 1). It should be noted that a goal selection made after starting from any one probe release location did not necessarily point to an exclusive classification. For example, if an animal trained at Location 1 went to the right (Goal C) from Release Location 2, this would be a response consistent with both turn and direction strategies; if the same animal went to the left (Goal B) from Release Location 4, this would be a response consistent with both place and direction strategies. Responses consistent with any two strategies, however, stood in opposition at two of three probe release locations, and no response from any probe release location was consistent with all three strategies. Further details on the analysis of strategies are presented subsequently.

RESULTS

Pretraining and Training

The *Callicebus* monkeys were slower at completing the pretraining and training phases than the *Saimiri*. It took them significantly more sessions (5.1 vs. 2.8) to reach the pretraining criterion of traveling to the available goal in the allotted times without coaxing on at least 20 trials in two consecutive 12-trial sessions [$F(1,19) = 6.25$, $p < .05$], and significantly more sessions (8.6 vs. 3.3) to reach the training criterion of selecting the middle goal on at least 20 trials in two consecutive sessions [$F(1,19) = 5.38$, $p < .05$]. Sex differences were not significant on either measure, although the *Callicebus* males required nearly three times as many sessions as the females did,

on average, to reach the training criterion. Three *Callicebus* males, one *Callicebus* female, and one *Saimiri* female required special training sessions with forced trials before achieving the training criterion.

Testing Phase: Goal Selections

In general, the subjects showed a high degree of individual consistency across trials in their preference for one of the two goals presented for each probe release location. From the beside location, 8 of 9 *Callicebus* monkeys and 10 of 12 *Saimiri* showed statistically significant consistency as judged by the binomial test (10 or more trials out of 12 in which the same goal was selected); from the across location, 5 of 9 *Callicebus* and 9 of 12 *Saimiri* showed a significant consistency of goal selection; from the diagonal location, 6 of 9 *Callicebus* and 8 of 12 *Saimiri* showed a significant preference. Because consistency was not significantly influenced by species, sex, or initial training location, the data from all the subjects were combined for further analysis. On average, there was 91.3% consistency for the beside location, 80.9% for the across location, and 82.9% for the diagonal location. The difference in consistency among the locations was significant [$F(2,40) = 3.74, p < .05$], with the greatest consistency found for the beside location.

The goal selections on probe trials were analyzed with respect to the three designated strategies: (1) selecting the middle (training) goal after starting from any probe release location was compatible with a place strategy; (2) selecting a goal in the same compass direction from any probe release location as the middle goal was from

the training release location was compatible with a direction strategy; (3) selecting a goal in the same relative position with respect to any probe release location as the middle goal was with respect to the training release location (i.e., right or left) was compatible with a turn strategy. The percentages, on probe trials, of an individual subject's goal selections that were compatible with each of these hypothesized spatial strategies were analyzed by species, by sex within species, and by training location. Because none of these factors yielded significant effects, the data from all subjects were combined for analysis of place, direction, and turn strategies. Although there was a slight predominance of the direction strategy, followed closely by the turn strategy, the differences among strategies were not statistically significant ($M = 61.5\%$ of goal selections for direction, 57.5% for turn, and 45.9% for place). The sum of the percentages exceeds 100% because more than one strategy could be inferred from some goal selections.

Although these results fail to support a hypothesis of generally preferred spatial strategies at either the within- or between-species levels, analysis at the level of individual performances revealed considerable consistency (individual performances are summarized in Table 1). Attention was first focused on 12 individual subjects that showed a reliable goal preference after starting from each of the three probe release locations, as determined by the binomial test. In theory, a subject responding consistently after starting from each of three probe locations could have displayed any one of eight unique patterns of goal selections. For example, one possibility for an animal trained

Table 1
Number of Selections of the Central Training Goal Made after Starting from Each of the Release Locations in the Test Phase (Maximum Possible = 12)

Subject Name	Sex	Training Location	Number of Central Goal Selections from Release Location		
			Beside	Across	Diagonal
Callicebus moloch					
Samantha	Female	1	0	10	2
Melanie	Female	1	11	10	12
Conchita	Female	1	1	3	8
Donna	Female	2	5	6	8
Marijka	Female	2	0	3	6
Rainer	Male	1	12	6	12
Don	Male	1	0	2	10
Chico	Male	2	1	12	0
Delmonte	Male	2	2	11	1
Saimiri sciureus					
Cora	Female	1	0	11	10
Hope	Female	1	0	12	2
Elsie	Female	1	11	6	9
Rock	Female	2	0	2	12
Alta	Female	2	3	7	7
Chris	Female	2	2	0	12
Troy	Male	1	0	5	2
Seth	Male	1	1	11	0
Guy	Male	1	3	12	8
Fred	Male	2	1	11	4
Otto	Male	2	0	12	2
Art	Male	2	1	2	12

from Location 1 was to consistently choose to go right from Probe Location 4, left from 3, and right from 2; another possibility was to consistently choose to go left from Probe Location 4, left from 3, and right from 2, etc. (see Figure 1). Only one unique pattern corresponds to each spatial strategy, and these patterns are mutually exclusive; five patterns do not correspond to any one of the spatial strategies defined here. Of the 12 individuals having a reliable goal preference after starting from each of the probe release locations, 11 exhibited a pattern of goal selections consistent with a single spatial strategy. Two *Callicebus* males, one *Callicebus* female, two *Saimiri* males, and one *Saimiri* female exhibited a direction strategy; one *Callicebus* male, one *Saimiri* male, and two *Saimiri* females exhibited a turn strategy; and one *Callicebus* female exhibited a place strategy. The one animal having a pattern of reliable goal preferences that did not correspond to a single spatial strategy was a *Saimiri* female, whose pattern of preferred goals revealed that after starting from each probe release location, she consistently chose the goal that represented a response compatible with two strategies.

Examination of the results from the 9 animal subjects that did not show a statistically significant goal preference after starting from all three probe release locations also supports the position that there was individual consistency in spatial strategies. First, 3 of the 9 subjects showed a significant preference after starting from two probe release locations; an additional 4 subjects showed a significant goal preference after starting from only one probe release location, but approached significance after starting from another (the same goal was selected in 9 of 12 trials). Second, 5 of these 7 subjects showed 75% or more of their goal selections to be consistent with one of the three posed strategies (turn for 2 *Callicebus* females; direction for 2 *Saimiri* males; place for 1 *Callicebus* male). Third, closer examination of the 2 animal subjects that did not appear to be consistent in goal selections after starting from even two release locations revealed that they appeared to switch strategies partway through testing. One, a *Callicebus* female, exhibited over 75% of her goal selections in one direction in her first 7 sessions, and 100% of her goal selections in the opposite direction in her last 5 sessions. The other, a *Saimiri* female, exhibited goal selections consistent with a turn strategy on over 75% of her first 5 sessions, but selected goals consistent with a direction strategy on over 75% of her last 7 sessions.

Testing Phase: Latencies

The *Callicebus* monkeys had significantly longer latency scores than did the *Saimiri* on all three measured latency intervals. They required an average of 2.7 sec to exit the startbox as compared to 0.5 sec for the *Saimiri* [$F(1,19) = 8.24, p < .01$], 15.5 sec to make an initial movement towards one of the goals, as compared to only 5.8 sec for the *Saimiri* [$F(1,19) = 10.74, p < .01$], and 7.4 sec between making an initial choice of a goal and entering

the goal cage, as compared to 3.3 sec for the *Saimiri* [$F(1,19) = 5.83, p < .05$].

To determine if a change of release location from that used in training affected the latency measures, the scores on the probe trials were tested against those on the training trials. This was accomplished by utilizing the latency scores from only the training trials that immediately preceded a probe trial. Although startbox exit latencies were somewhat longer on probe trials than on training trials for the *Callicebus* monkeys, they did not differ significantly for either species (for the *Callicebus* monkeys, $M=3.2$ sec vs. 2.2 sec; for the *Saimiri* monkeys, $M=0.5$ sec vs. 0.5 sec). They did differ significantly for both species, however, in latency to make an initial goal choice [for the *Callicebus* monkeys, $M=18.4$ sec vs. 12.6 sec; $F(1,8) = 11.19, p < .05$; for the *Saimiri* monkeys, $M=6.8$ sec vs. 4.8 sec; $F(1,11) = 15.98, p < .01$]; and the magnitude of the increase was significantly greater for the *Callicebus* monkeys than for the *Saimiri* monkeys [$F(1,19) = 5.62, p < .05$]. Latency to enter a goal also differed reliably between probe and training trials for the *Callicebus* monkeys [$M = 8.6$ sec vs. 6.3 sec; $F(1,8) = 10.89, p < .05$], but not for the *Saimiri* monkeys ($M=3.8$ sec vs. 2.8 sec).

Latency difference scores (latency on probe trial minus latency on immediately preceding training trial) were analyzed to determine if the magnitude of latency change varied with probe release location; only those measures for which differences between probe trial and training trial latencies were statistically significant were examined for each species. Although no statistically significant effect of probe release location was found for either species for any measure, the effect on initial goal choice latency did approach significance for the *Callicebus* monkeys (Figure 2). Their latency in this interval tended to be increased more by release from the across and diagonal locations than it was by release from the beside location.

Figure 2. Mean difference in choice latency between a probe trial and the immediately preceding training trial (i.e., probe latency-training latency), for the beside, across, and diagonal probe release locations.

DISCUSSION

The three spatial strategies operationally described in this study (place, direction, and turn) appear adequate to account for the patterns of goal selections observed in the testing phase. For most of the subjects, a majority of goal selections were compatible with a single strategy. Furthermore, 11 (92%) of the 12 individual subjects that had a statistically significant goal preference after starting from each of the three probe release locations exhibited a consistent spatial strategy across locations; in view of the 38% probability (3 out of 8) that a pattern of preferred goals consistent with one of the three spatial strategies would occur by chance, this can be regarded as a highly reliable result.

Turn and direction strategies were particularly evident. The percentages of all goal selections compatible with direction and turn strategies were 62% and 58%, respectively (recall that some goal selections were compatible with more than one strategy). In addition, of the 12 individual subjects that showed consistency in goal selections, 6 exhibited a direction strategy and 4 exhibited a turn strategy.

Behavior consistent with a place strategy, however, was more rarely exhibited by individual subjects in this situation. Only 46% of all goal selections were compatible with a place strategy (33% would have been obtained if all the animals had exhibited strictly a turn or direction strategy), and only 1 of the 12 individual subjects that showed consistency in goal selections exhibited a place strategy. These results are somewhat surprising, considering that all three goals were less than 15 m apart, that they could be viewed simultaneously, and that they were in a spatial context that presumably provided ample locational cues.

The above findings may reflect the effect of specific aspects of the experimental situation. It is possible that the available landmarks may not have been relevant to the animals, which, as other evidence suggests, may influence the probability that a particular strategy is exhibited. For example, it has been found that young children are more likely to exhibit a turn strategy, and that they are consequently less likely to exhibit a place or direction strategy, in the absence of landmarks that readily attract their attention (Acredolo, 1977). Another factor that may have reduced the probability of following a place strategy is the training procedure employed. It has been suggested that traveling in an environment along multiple routes facilitates the development of a place strategy (Siegel & White, 1975); the fact that the animals were trained along a constant route between start location and goal may have discouraged the development of such a strategy.

Although the two species did not appear to differ in the strategies they adopted in this situation, consistent individual differences were found within each species, suggesting considerable flexibility in the ways these monkeys impose order upon their spatial worlds. Furthermore, the observation that one *Saimiri* female appeared to switch

from a turn strategy to a direction strategy supports the view that the same individual has the potential to exhibit more than one type of strategy (Acredolo, 1977). In fact, it might be suggested that conflict resulting from tendencies to use more than a single strategy may account for the failure of some individual subjects to exhibit consistent goal selection after starting from one or more release locations. A goal selection simultaneously compatible with any combination of two particular strategies was possible after a subject had started from only a single probe release location; no selection compatible with all three strategies was possible after a subject had started from any probe release location.

The *Callicebus* and *Saimiri* monkeys did differ in at least one behavioral characteristic that may contribute to differences between them in ranging patterns. In particular, the *Callicebus* monkeys appeared more reluctant than the *Saimiri* monkeys to approach available feeding opportunities when the setting was unfamiliar. This was noted during pretraining, in which the *Callicebus* monkeys required significantly more trials than the *Saimiri* did before readily traveling to the only available goal and consuming the food located there (even though the same food items were readily approached and consumed in the familiar home cage). The data on latency to make an initial goal choice after starting from the unfamiliar probe release locations also point to a greater reluctance on the part of *Callicebus*. Although both species showed a reliable increase in such latencies, relative to latencies when starting from the familiar training location, the magnitude was significantly greater for the *Callicebus* than for the *Saimiri* monkeys. Moreover, the increase in latency for the *Callicebus* monkeys was more pronounced from the presumably less familiar across and diagonal locations than from the beside location. The across and diagonal locations were on the opposite side of the goals from the training location; consequently, the monkeys faced a background completely different from that during training. In contrast, the background faced from the beside location was only slightly displaced, relative to that for training. Further support for the view that the *Callicebus* monkeys were more reluctant than the *Saimiri* monkeys were to approach a feeding opportunity in an unfamiliar setting comes from goal latency measures; the *Callicebus* monkeys showed a significant increase in latency to enter a goal from a probe release location as compared to that from the familiar training location, whereas the *Saimiri* did not.

In a previous study, involving 1-h foraging periods in an unfamiliar environment, it was suggested that the reduced foraging efficiency of *Callicebus*, relative to *Saimiri*, was partly due to the greater attention that *Callicebus* directed towards establishing familiarity with the environment (Andrews, 1986). The results of the present study confirm the greater influence of environmental familiarity on the behavior of *Callicebus* (see also Frigaszy, 1980a, 1980b). These data also suggest that the greater tendency of *Callicebus*, under natural conditions,

to follow set paths and to remain within a smaller (and presumably more familiar) home range may be due, in part, to a greater reluctance to approach feeding opportunities in an unfamiliar setting.

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(Manuscript received October 15, 1987;
revision accepted for publication April 6, 1988.)