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## Orientation of the Franklin Ground Squirrel to Environmental Objects

The tendency to live in a particular area is a familiar characteristic of many animals (Scott, 1958). Among the mammals, this phenomenon is known as home range. The attachment for specific sites is often so great that transplanted mammals will find their way home from surprising distances. Such behavior indicates that individual members of a population are intimately acquainted with their environment. Certain factors must be more significant than others and the location of each important factor, whether perceived by visual, auditory, olfactory, tactile or kinesthetic receptors, must be remembered. Thus, when a given habitat is complicated by a high number of factors per unit area, the memory is exhausted and the size of home range decreased (Orr, 1957).

The investigation of which factors of the environment are being used as orientation objects is difficult with some mammals because of their secretive and retiring nature. When it was discovered that a population of Franklin ground squirrels (*Citellus franklini*) in a picnic area at Itasca State Park has become conditioned to humans, the investigation here reported was initiated because of the ease of making direct observations. Work by Linsdale (1946) and Gordon (1943) indicated that members of this genus were suitable for studies of orientation under natural conditions. The fact that they are active during the daylight hours means that vision probably plays an important role in the localization of activity.

The specific objectives were: (1) to condition, if possible, the Franklin ground squirrel to respond to artificial objects and (2) to observe the role of these objects in the orientation of subjects to food-finding situations.

The study was conducted while the author was attending the Forestry and Biological Station of the University of Minnesota, Itasca, State Park, on a National Science Foundation Stipend, during June and July, 1957.

#### MATERIALS AND METHODS

Four locations at the edge of the picnic grounds were selected as test-sites. All were near concentrations of activities of Franklin ground squirrels. In each of the areas a tall fruit-juice can, painted flat black to reduce glare, was set in a conspicuous position. These were the objects that were to be used as environmental factors in the conduction of tests. In order to promote orientation to these markers, peanut butter was smeared on the top surface (the cans were set open-end down).

Each marker was visited at about hourly intervals between 8 AM and 6 PM every day for the five day period beginning June 21st. During this pre-baiting period, observations were made at each station to establish the degree to which food removal depended on animals other than Franklin ground squirrels. Near the end of the period it became evident that orientation to the marker-bait objects was sufficient to go with the next phase of the work.

Two of the stations were selected from the original four as being the most suitable for direct observation. One was in a stand of red pine which had little undergrowth to obscure the vision of the ground squirrels; the other was in a grassy area where vision was limited, but subject to desired manipulation and control. At each of these stations three markers were added to the original one, making a straight line of four. The line in each case was directed away from the picnic area, with the food-reward at the end marker. At first the line was short but it was gradually extended to the point that marker-to-marker intervals were as great as 15 feet. During this phase of the experiment, observations were made as often as possible to determine the way in which the squirrels responded to the changes.

Once activity with reference to the markers had reached a reasonable level of uniformity among the subjects, and nothing new or different occurred, further manipulations of the markers were implemented. These consisted of movements of the lines of markers and

observations on the reactions of the subjects to determine whether these had become important environmental objects of orientation. Fig. 1 shows a typical test situation from this phase.

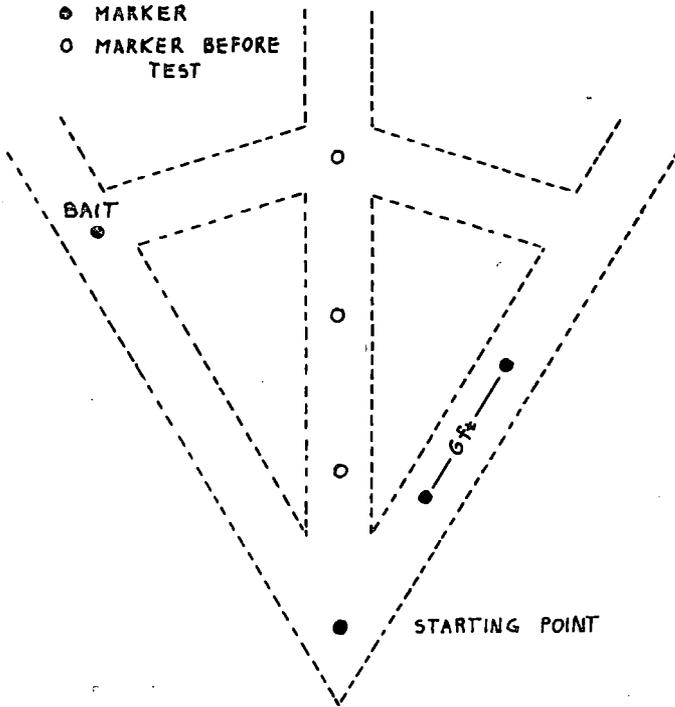


Fig. 1.

Some tests were conducted to ascertain how subjects would react to markers in areas other than the test-sites. These areas were within the picnic areas where the probability that the subjects observed in the experimental tests would appear was high.

While some of the subjects observed were identified by fur-clipping, and others by highly different and outstanding natural marks, all of the observed animals were not identified. Although this subtracted from the study somewhat, the type of information obtained was still very useful in reaching conclusions.

### OBSERVATIONS AND RESULTS

The markers and bait stimulated positive reaction within a few days. The number of times that bait was removed during the day increased rapidly, and observation periods indicated that, with few exceptions, it was the Franklin ground squirrel which was responsible. Subjects were easily visible as they stood upright, forelimbs on the tops of markers, eating the food. Many visited or investigated even when the food was exhausted, and several times aggressive behavior developed when three or four squirrels approached markers simultaneously. Toward the end of the five day pre-baiting period the subjects would appear in numbers quite soon after baiting, indicating that they were associating me with the marker-food combination. It was also noted during this time that any appearance of visitors in the picnic area attracted squirrels. Thus association of humans with food no doubt existed before the experimental period.

*Reaction to multiple-marker situations:* When markers were arranged in lines of four, with the one at the original location serving as the starting point and the reward at the opposite end of the line, it was evident that markers had become significant objects in the orientation of the Franklin ground squirrel. The squirrels were observed in the eating position at the first marker, then at each successive marker in the line until the food was located. When left unattended for brief periods of time the non-baited cans were often tipped over, indicating that the sequence being used in the object-to-object sense. In the short period of two or so days the markers were eliminated from the food-locating process and only the marker with food was reacted to. When intervals between markers were increased, resulting in a change in the location of the food-marker, the tendency to use all markers returned temporarily. Fig. 2 summarizes more than 60 observations, beginning at the time when markers were first spread out. It was obvious that the percentage of subjects using the markers to locate the food decreased while the tendency to approach the food from paths other than the one along the marker-path increased. It was apparent that the new situation was learned by the use of the markers, but that once the location of the food was mastered, the position was approached using some other means of orientation.

There was no evidence that the wooded area differed from the grass area except that visibility was limited by the latter. Thus when

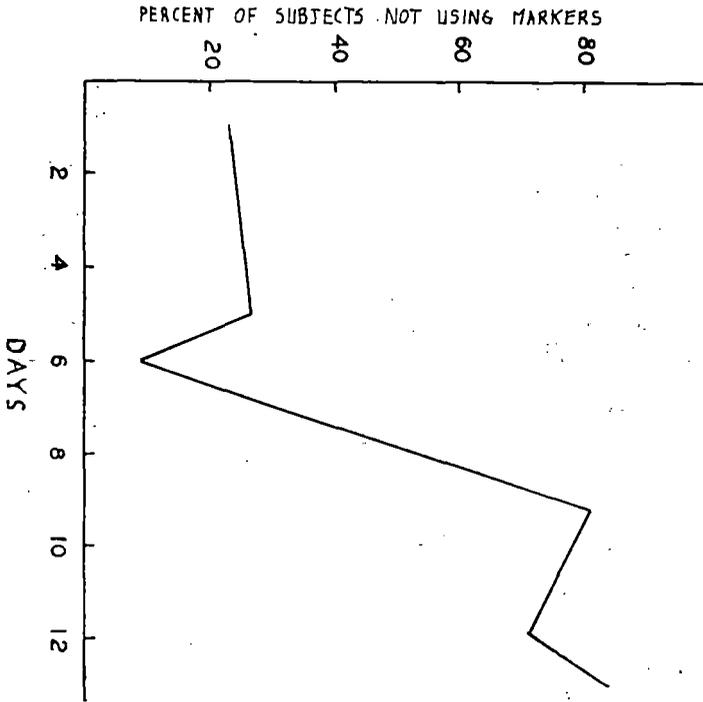


Fig. 2.

markers were spread out in the grass to the point that no marker was visible from the position of any other, success in locating food diminished. However, it is interesting that a few subjects continued in the direction of the next marker regardless. This may have been an indication that these rodents are able to retain a mental concept of the four-marker line.

*The effect of moving marker lines:* On July 10th the markers in the grass area were arranged as shown in Figure 1. This arrangement was reversed (with respect to the two outside lines) when ever it seemed that the location of the food had been learned by most of the subjects. Between July 10th and July 17th, 92 observations were made on Franklin ground squirrels relative to this type of experimental situation. Some subjects did not respond beyond coming to the starting

point, others reacted in such complicated ways that classification was impossible. These latter cases were not included in the total, nor in Table 1 which summarizes the results of this phase of the work.

The greatest number of responses fell into the category of using the original line, although no markers were then present there. Thus it would appear that markers were unnecessary to orientation at this stage and that the location of the food was in terms of the path along the marker positions or to something else entirely. With further testing the number of observations on responses in this category tended to be reduced, as might be expected because of the lack of reward as a result of the squirrels following it.

An indication of the importance of markers was the percentage of observations involving following the markers first. In addition to these 25 percent of the subjects used the markers after running down the original line. Thus a total of 42 percent of the subjects used markers in one way or another. Only 14 percent of the total used some other means to locate the food. It was later discovered that completely concealed food near to the test area could be located by subjects, if no bait existed elsewhere. It seemed safe to assume that olfaction played a role in the results, especially in those cases when subjects used the initial path of markers and did not find food by that method.

An example of the type of behavior not included in the Table was one subject that went out along the original marker line, and, after finding no food, returned to the starting point, climbed up onto the top of the marker and then followed the markers. When this failed, the subject disappeared into the grass, apparently giving up.

*Reaction to isolated markers:* On July 18th, four markers were placed in the picnic area, but as close to the grass test-site as possible. Each marker was placed so as to be as easily seen by Franklin ground squirrels as possible. None were baited. Eleven different subjects were observed passing as close as three feet from a marker without making any specific response. Some of these subjects were identified as having taken part in the grass area tests. These results indicate that markers were important only as a part of a larger situation to which the squirrels had become conditioned. Thorpe (1956) has indicated that similar results have been reported in a variety of species.

## DISCUSSION AND CONCLUSIONS

It was not surprising to find that the Franklin ground squirrel could be conditioned to respond to objects such as the markers. Using food and other rewards, rodents, not to mention animals much lower on the phylogenetic scale, have been proven capable of learning more difficult problems. It is of interest that such objects were followed in sequence during the earlier part of the investigation. Not that this was unexpected. It is simply a clue to the type of natural process which might be involved in when mammals learn new portions of their environment. These animals, and many others, probably use specific objects each time they venture into unknown areas or situations. Objects may be of many different types and sizes and may be perceived by any of the senses. If this process is the rule, it follows that the more uniform the environment is the more difficult it is for the animal concerned to orientate to it.

The subjects did not continue to use an object-to-object process if markers were left in position a few days. The tendency to use the shortest route to the food would seem to indicate that emphasis on specific objects diminishes in favor of a more general orientation. This type of result is not unlike that noted in the rat during maze performance (Munn, 1950). The poor response to markers away from conditioning areas was a further evidence that specific objects were relevant to a larger situation. The information leads to the question of what was important in the general or non-specific situation. Possibly isolated trees, the line of transition between wooded and grass associations, or any other combination of factors offering large or outstanding contrast. However, specific objects other than those provided, perceived by other than the visual sense, could have been important variables. Smell seemed to have some influence, and sound or kinaesthetic mechanisms may have had significance. Results indicated that when the general type of orientation failed, specific objects were once more used. This points out the fact that a sort of oscillation between specific objects and a more general type of orientation may be common.

Certainly these matters are open to further investigation. The basic method employed on the Franklin ground squirrel seems to be adaptable to a variety of other mammalian forms. The type of informa-

tion obtained is not only important in forming a more realistic concept of home range, it has implications within the fields of animal distribution and evolution.

TABLE 1—Number of times each type of response was observed.

| Date    | To starting point only | Used original line | Followed markers | Used markers after original line | Located food by unknown method | TOTAL |
|---------|------------------------|--------------------|------------------|----------------------------------|--------------------------------|-------|
| July 10 | 5                      | —                  | —                | —                                | —                              | 5     |
| 12      | —                      | 14                 | 1                | 9                                | 4                              | 28    |
| 13      | —                      | 6                  | 3                | 4                                | 2                              | 15    |
| 14      | —                      | 9                  | 6                | 5                                | —                              | 20    |
| 15      | —                      | 2                  | 3                | 2                                | —                              | 7     |
| 16      | —                      | 3                  | 4                | 3                                | 7                              | 17    |
| TOTAL   | 5 (5.42%)              | 34 (36.89%)        | 17 (18.47%)      | 23 (25.00%)                      | 13 (14.02%)                    | 92    |

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