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A Change in Orientation: Recognition of Rotated Patterns by Bumble Bees

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In three experiments, bumble bees were trained to discriminate between a reinforcing pattern (S+) and a nonreinforcing one (S−) which differed only in the configuration of four artificial petals. They were subsequently tested for recognition of the S+ rotated by 90° (S + 90). Experiment 1 used petals of four colors, and the other experiments used four symbols. The symbols either remained unchanged when the whole pattern was rotated (e.g., "+" in Experiment 2) or changed appearance (e.g., "<" in Experiment 3). The bees failed to recognize the S + 90 in the first two experiments, but in Experiment 3, the choice proportion for S + 90 in the presence of a New pattern was significantly higher than chance. Bumble bees can recognize a rotated pattern, possibly by using mental rotation, provided that a cue as to the extent of the pattern transformation is given.

KEY WORDS: bumble bees; *Bombus impatiens;* cognition; mental rotation; pattern learning; pattern recognition.

INTRODUCTION

This paper addresses a problem in pattern learning by bumble bees: how bees treat a transformation of a learned pattern. The general ability to treat transformations of a learned pattern as similar to that pattern may well be advantageous in nature if, for example, a pattern has been transformed (reoriented;

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partly obstructed or destroyed) between the time of learning and that of recognition (as suggested by Gould, 1988a). For reasons described below, we investigated the ability of bumble bees to recognize a pattern which was rotated by 90°, though recognition of a 90° rotation is not intended to simulate any particular naturally occurring task. Whether or not bees can recognize such transformed patterns is relevant to the debate of whether patterns can be represented in pictorial form (Gould, 1988b, 1990; for review see Srinivasan, 1994) or not (Horridge, 1999). One way in which recognition of a transformed pattern can be achieved is by mental transformation of a stored pattern (Gould, 1988a), though much research on bee vision has focused on recognition mediated by a variety of cues such as orientation (van Hateren *et al.*, 1990), radiating elements (Lehrer *et al.*, 1995), and bilateral symmetry (Horridge, 1996).

Our previous research on recognition of transformed patterns (Plowright, 1997) has revealed that bumble bees can recognize a left–right reversal of a pattern (where the left and right sides have been transposed) but not a mirror image (where the whole pattern has been "flipped" around a vertical axis), unless the mirror image corresponds to the left–right reversal (Korneluk and Plowright, 1995). This recognition is perhaps better termed a left–right confusion, and it may indeed be a special case. It certainly does not entail that bumble bees can recognize any other sort of transformation. Indeed, in a previous investigation on honey bees, Gould (1988a) reported a failure to recognize a 90° rotation as being similar to the original pattern. Our aim in this paper was, first, to attempt a replication of Gould's study using bumble bees (Experiment 1) and, then, to determine whether recognition of the rotated patterns might be achieved under more favorable experimental conditions (Experiments 2 and 3), described below.

The method used here is based on the logic of Gould (1988a) and used previously with bumble bees (Korneluk and Plowright, 1995; Plowright, 1997). Bumble bees are trained to discriminate between two vertically mounted artificial flowers: an S+ (rewarding pattern) and an S− (unrewarding pattern) that differ only in the spatial configuration of the same four artificial petals (see Figs. 1–3). Following training, the bees are tested with flowers containing no sugar to check whether they have learned the discrimination. Following this test of learning are the two key testing conditions, using non-reinforcing flowers again: (1) the bees are presented with an S+ vs an S+ rotated by 90° (heretofore referred to as S + 90) to see whether the two are confused or discriminated; (2) the bees are presented with S + 90 vs a New pattern consisting of a new configuration of the same artificial petals. Even if there is no confusion between S+ and S + 90, the bees still might view S + 90 as similar to S+ in the absence of S+ (Gould, 1988a)—in other words, they might accept S + 90 as a substitute for S+. Above-chance choice proportions

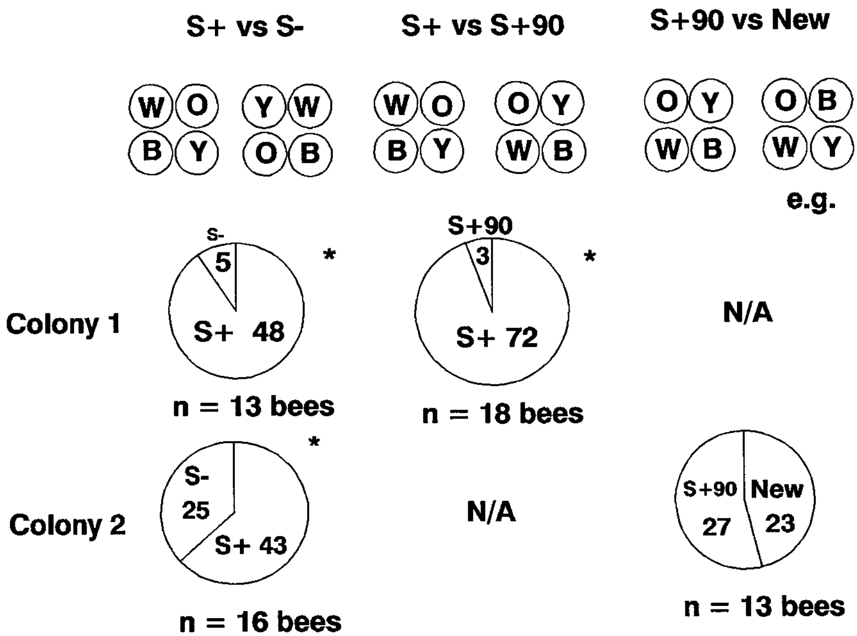

Fig. 1. Choice proportions in three testing conditions in Experiment 1 together with number of landings and number of bees observed in each condition. The size of each pie chart is proportional to the number of landings. The S + 90 is rotated counterclockwise. Two New patterns were used, only one of which is shown. W, white; O, orange; B, blue; Y, yellow. *Group proportions differed significantly from 50:50. N/A: Condition was not run for that colony.

in the latter condition would show that the bees do not view the S + 90 as a new pattern. Note that with this procedure the bees are not trained to make a discrimination based on orientation (as by van Hateren *et al.*, 1990; Zhang and Srinivasan, 1994): a new orientation is presented to the bees for the first time in the testing conditions.

The three experiments differed in the nature of the patterns used. Experiment 1 was an attempt to replicate Gould's (1988a) results using artificial petals of four colors. In Experiment 2 symbols which do not change appearance when rotated by 90° (e.g., "+") were used instead of colors. In Experiment 3, symbols were used again but some of them (e.g., "<") took on a different appearance (e.g., "$\wedge$") when the flower was rotated by 90°. We hypothesized that the orientations of these individual symbols might provide the bees with an "alignment key" (Huttenlocher and Ullman, 1987; Ullman, 1989): a cue as to the pose of the pattern, i.e., a cue as to the extent of the pattern transformation. For bees to recognize a rotated pattern as an old familiar pattern, it might be necessary for them first to detect the change

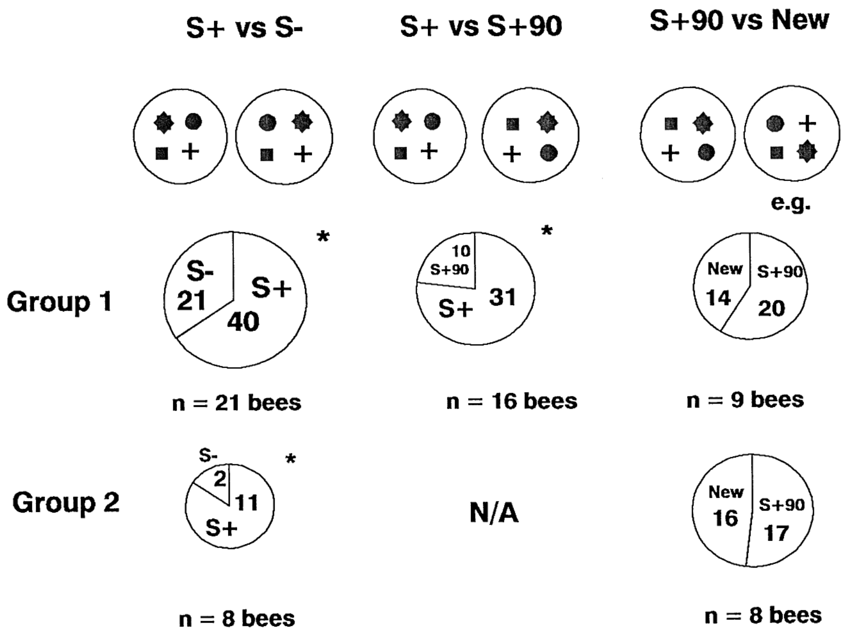

Fig. 2. Choice proportions in three testing conditions in Experiment 2 together with number of landings and number of bees observed in each condition. The size of each pie chart is proportional to the number of landings. The S + 90 is rotated clockwise. Three New patterns were used, only one of which is shown. Group 2 was a group of bees, separated from the rest, that had participated in the S + 90 vs New condition but had not participated in the S+ vs S + 90 condition. *Group proportions differed significantly from 50:50. N/A: Condition was not run for that group.

in orientation, and this detection might be facilitated by the experimenter providing some cue.

GENERAL METHODS

Subjects. Colonies of bumble bees *(Bombus impatiens)* were either reared in the laboratory or purchased from Koppert Biological Systems, Inc. (Ann Arbor, MI) and were housed in wooden containers (30 × 15 × 15 cm). New colonies were used for each experiment. Pollen was provided ad libitum. Sugar solution was supplied by a feeder. To stimulate foraging for the training and testing periods, the feeder was removed and the bees were left to empty the surface honey pots of the comb, which usually took 1 or 2 days. Workers were labeled with numbered plastic disks glued to the thorax or with distinctive marks of paint.

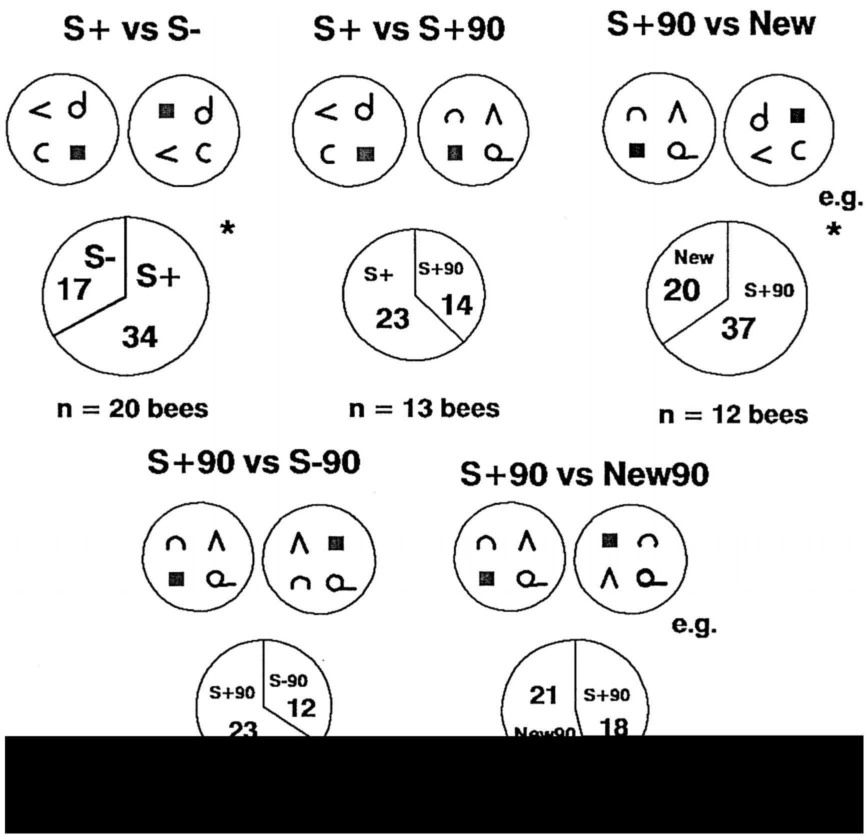

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Fig. 3. Choice proportions in five testing conditions in Experiment 3 together with number of landings and number of bees observed in each condition. The size of each pie chart is proportional to the number of landings. The S + 90 is rotated clockwise. Three New patterns were used, only one of which is shown. For purposes of comparison, the top three charts show the conditions that occurred also in the first two experiments, and the bottom two charts show the additional conditions. *Group proportions differed significantly from 50:50.

Flight Cage. The colony was connected, by a wooden corridor 33 cm long covered with square glass plates, to a clear Plexiglas chamber (63 × 63 × 63 cm) with a removable lid. The cage was illuminated by a 60-W incandescent lamp placed on the lid and by fluorescent lights in the room on a 12:12-h light: dark cycle.

Patterns. Each pattern consisted of four artificial petals (with distinctive colors or symbols) covered in plastic. Each pattern was mounted on a circular plastic backing 12 cm in diameter. Through the center protruded a glass tube which was full of honey or sugar solution (training on the S+) or full of water colored with yellow food coloring. The pattern was fixed vertically onto a pole (38 cm high) resting on a stand. A different set of identical materials was used for the training patterns and for the testing on S+ vs S−.

The patterns were located 42 cm from the entrance to the flight cage. The bees often flew back and forth between the patterns before landing on one, and so choice was not made from afar, as in many Y-maze studies of pattern recognition in honey bees (reviewed by Srinivasan, 1994; Horridge, 1997).

Training. Two S+ and two S− were placed in the flight cage. Their positions were changed at least once but as often as every 10 min during a training session to prevent memorization of a particular location. At first the S+ was filled with a honey solution (2:1 honey:water, by volume) so that the bees would be drawn to the S+ and land on it. One problem arose with the use of honey: it seemed that the bees would subsequently not land on any flower when it contained no honey—perhaps because of the lack of odor emanating from the flower. This problem was resolved in Experiment 1 by masking any odor or lack of it with the use of rose oil. In Experiments 2 and 3, a different tact was adopted: once bees were observed landing on the S+, the solution was changed to a sugar solution so that bees would learn to land on the flower in the absence of the odor of honey.

Stimuli were wiped clean at the end of each day. The whole colony was allowed to forage over 6 days for 2–5 h per day. An observer noted the identity of bees observed on the patterns (usually probing the S+) during training.

Testing. During testing, the feeder tubes were filled with colored water. The positions of the test stimuli (two S+ and two S− in Experiments 1 and 3, only one of each in Experiment 2) were regularly alternated. If a bee made repeat foraging trips on 1 day, the stimuli were usually presented in a different position each time she was tested. The first testing condition, S+ vs S−, tested for learning of the discrimination. The second tested for discrimination between S+ and S + 90, and the third between S + 90 and a new arrangement of artificial petals. Each day, before proceeding to the testing, the bees were given a “refresher” training period of about 1 h, in case the memory for the S+ and S− had begun to wane (Keasar *et al.*, 1996). Any new bees that foraged during these training sessions were labeled and their data were recorded if they appeared in the testing sessions.

Only bees that had been observed previously in a training period (either the original period before the experiment or a “refresher” period before a test) were allowed to pass through the tunnel to gain access to the flight cage. Once a bee exited the hive, its first landing on a pattern was counted as a response, whereupon the bee was captured and returned to the hive. Some bees appeared in several conditions, while others appeared in only one. Within a condition, the range of the number of landings made by a bee was 1–15 (where the landings were separated by returns to the colony).

Typically the testing period extended over about a week of testing sessions lasting an afternoon or even a whole day with a training session in the middle.

Statistics. Because the data were frequencies, with replication within individuals, a replicated goodness-of-fit test (*G* statistic) was used (Sokal and Rohlf, 1981). Two *G* values are reported and they are compared to chi-square values in the tests of significance: (1) G_P (P for pooled), which compares group choice proportions to a chance level of 50:50; and (2) G_H (H for heterogeneity), which tests for individual variation—a significant G_H means that the individuals cannot all be treated as replicates. In the presence of significant individual differences, the total *G* value was further partitioned into contributions due to individuals. In this way, we could determine which of the individual choice proportions differed significantly from the group choice proportion.

EXPERIMENT 1

This study used patterns consisting of four differently colored artificial petals, as by Gould (1988a). A larger group than Gould's four bees was used. The experimental design included two aspects which allowed us to exclude two "nuisance" interpretations of null results. The first is that the nature of the new stimuli chosen by Gould was responsible for the null results: for half the bees, the new stimulus in the S + 90 vs New condition included two "petals" which were in the same place in the S+ [blue at the top right and orange at the bottom right (Gould, 1988a, Fig. 4)]. So the new stimulus might have been attractive to the bees, which might be why the S + 90 was not chosen more frequently. To obviate this difficulty, two versions of a new stimulus were used, one of which had no petals in the same place as the S+. The second interpretation is that learning in the test conditions may have carried over [even though van Hateren *et al.* (1990) have argued that bees do not learn within brief testing conditions]: if the bees learned that S + 90 was unrewarding in the S+ vs S + 90 condition, then they might avoid the S + 90 in the subsequent condition in which S + 90 vs New was presented. For this reason we used two colonies, each of which was used in only one of the two key testing conditions (Fig. 1). In this way, choice behavior in the S + 90 vs New condition could not possibly be influenced by previous experience with the S + 90.

Methods

The methods were as described under General Methods. Each pattern consisted of a different arrangement of four artificial petals: one white, one blue, one orange, and another yellow. The petals were 2 cm in diameter,

Table I. For Each Condition in Experiment 1, the Test (G_P) for the Group Choice Proportion Against Chance (50:50) and the test (G_H) for Individual Differences

Condition	G_P	df	P	G_H	df	P
S+ vs S−						
Colony 1	40.35	1	<0.001	7.85	12	N.S.[a]
Colony 2	4.82	1	<0.05	19.21	15	N.S.
S+ vs S + 90						
Colony 1	78.78	1	<0.001	18.60	17	N.S.
S + 90 vs New						
Colony 2	0.32	1	N.S.	27.78	12	<0.05

[a]Nonsignificant.

painted with Testors Enamel paint. The S + 90 was rotated counterclockwise, in accordance with Gould (1988a).

Results and Discussion

Figure 1 shows the choice proportions for the stimuli in each testing condition. The numbers of landings on which the proportions are based are given within the pie charts. Because a small deviation from 50% can be significant with a large enough sample, but nonsignificant with a smaller sample (compare, for example, 300:200 vs 3:2), the pie charts have been drawn so that the area of the pie reflects the sample size. The number of individual bees responsible for the landings is given below each chart.

The results of the statistical analyses are reported in Table I. The bees in both colonies discriminated between S+ and S−, and no individual differences were detected. The discrimination between S+ and S + 90 was also significant, and again, no individual differences were detected. The group choice proportion in the S + 90 vs New condition revealed no significant difference from a chance value of 50:50. Individual differences were, however, significant: the group was not homogeneous. Partitioning the total G into individual contributions revealed that for 10 bees, the choice proportion did not differ from chance. Two bees showed a significant preference for the S + 90 and one showed a significant preference for the New.

Some bees were included in the testing conditions which had been observed foraging only during the "refresher" training periods, and not during the extended training period before the beginning of the experiment. This raises the question of whether the failure to find a significant discrimination in the S + 90 vs New condition was due to the presence of a few bees which, by virtue of not having had the benefit of the original extended training period, had perhaps not learned the original S+ vs S− discrimination. To address this possibility, we examined the behavior of a restricted group of 10 bees from Colony 2 that appeared in both the S+ vs S− and the S + 90 vs New conditions. Their results reflected those reported above for the complete sample: the discrimination between S+ and S− was significant (choice proportion, 34:19; $G_P = 4.30$, df = 1, $P < 0.05$), and the discrimination between S + 90 and New was still not ($G_P = .028$, df = 1).

In summary, in spite of (1) having used a larger number of bees than Gould (1988a), who tested only four bees (2) having used two New stimuli; and (3) having used two groups of bees to preclude carryover effects in the testing conditions, Experiment 1 replicated the results of Gould (1988a): No evidence was obtained in favor of recognition of a pattern rotated by 90°, though the rotated pattern was discriminated from the original.

EXPERIMENT 2

Experiment 2 was a further check on the generality of the results of Experiment 1. Instead of using different arrangements of four colored circles, the petals consisted of individual symbols (a star, a circle, a square, and a vertical cross) on a single-colored backing (Fig. 2).

Methods

The symbols for the artificial flowers were printed using Corel Presentation software. They were about 1.5 cm in height and were printed on a light purple disk (6.5 cm in diameter). Once the patterns were covered in plastic, they were mounted on the same sorts of disks as in Experiment 1. Unintentionally, the S+ and S− differed only in the top half of the stimuli—the bottom halves were identical. If anything, this would bias against any discrimination between S+ and S−. The S + 90 was rotated clockwise. Three New stimuli were used. In all other respects, the methods were as described under General Methods.

Results and Discussion

Once the data were collected, one group of bees (Group 2) was separated out from the rest of the bees (Group 1). Group 2 consisted of eight bees that had participated in the S + 90 vs New condition but had not participated in the S+ vs S + 90 condition. We could compare the two groups to examine any possible role of carryover from the S+ vs S + 90 condition to the S + 90

Table II. For Each Condition in Experiment 2, the Test (G_P) for the Group Choice Proportion Against Chance (50:50) and the Test (G_H) for Individual Differences[a]

Condition	G_P	df	P	G_H	df	P
S+ vs S−						
Group 1	6.02	1	<0.025	26.99	20	N.S.[b]
Group 2	6.86	1	<0.01	6.16	7	N.S.
S+ vs S + 90						
Group 1	11.28	1	<0.001	21.54	15	N.S.
S + 90 vs New						
Group 1	1.06	1	N.S.	19.02	8	<0.05
Group 2	0.03	1	N.S.	13.47	7	N.S.
Combined	0.73	1	N.S.			

[a] Group 2 was a group of bees, separated from the rest, that had participated in the S + 90 vs New condition but had not participated in the S+ vs S + 90 condition.
[b] Nonsignificant.

vs New condition. In the S + 90 vs New condition, all bees in both groups had participated in the S+ vs S− condition.

Figure 2 shows the choice proportions for the stimuli in each testing condition. The results of the statistical analyses are reported in Table II. Both groups of bees learned the discrimination between S+ and S−. Discrimination between S+ and S + 90 was significantly better than chance. Individual differences in both conditions were nonsignificant. For neither group of bees, however, was the discrimination between S + 90 and a New stimulus evident. Because Group 2 had never participated in S+ vs S + 90, the null results cannot be due to carryover from that condition. When the two groups were combined, the results were still nonsignificant. Significant individual differences emerged in Group 1: while six of the eight bees showed choice proportions that did not differ significantly from chance, one showed a significant preference for the S + 90, and another showed a significant preference for a New pattern.

In summary, even though different sorts of stimuli were used in this experiment, the results of this Experiment 2 paralleled those of Experiment 1 in every respect: (1) learning of S+ vs S−; (2) no confusion between S+ and S + 90; and (3) no recognition of the rotated pattern as being similar to the S+ in its absence—S + 90 is treated as a new stimulus.

EXPERIMENT 3

To human observers, the rotated stimuli in Experiments 1 and 2 do not look rotated, in comparison with, for example, a letter R that has been rotated by 90°. Even the experimenters who worked with the stimuli for weeks on end had great difficulty in categorizing the stimuli, and great care had to be taken not to mix them up. Experiment 3 used patterns from a previous study (Plowright, 1997), which had been selected previously because the left–right transformation differs from its mirror image. Here they were used because the rotated pattern "looks rotated" because of the characteristics of some of the symbols. For example, the stem of the "d" is vertical in the unrotated stimuli, and horizontal in the rotated stimulus (see Fig. 3). In contrast, an orange circle (Experiment 1) or a square (Experiment 2) does not change when the whole floral pattern is rotated by 90°. We hypothesized that the orientation of the individual symbols might provide the bees with a cue that the pattern was rotated, in what direction, and by how much. Recognition might thereby be facilitated.

Methods

The new stimuli were constructed as in Experiment 2, but different symbols (<, c, d, ■) were used. Three New stimuli were used. In addition to the three basic conditions for Experiments 1 and 2, two other conditions were interspersed: S + 90 vs S − 90 following S+ vs S + 90 and S + 90 vs New90 following S + 90 vs New, where New90 was a new stimulus with symbols oriented 90° from the upright (but note that it was not a 90° rotation of the upright New stimulus, in which case New90 would not have been a new stimulus). In other respects, the methods were the same as described under General Methods.

Results and Discussion

The choice proportions for each condition are shown in Fig. 3. The results of the statistical analyses are reported in Table III. The bees learned the original S+ vs S− discrimination. Contrary to Experiments 1 and 2, though, the discrimination of S+ vs S + 90 was nonsignificant, though the choices of the S+ preponderated, as in the previous experiments. Most importantly, the S + 90 was recognized in the absence of the S+: the choice proportion of the S + 90 over the New stimuli was significantly above chance.

Because the tests for heterogeneity (individual differences) were all nonsignificant there is no reason to suppose that some individuals were more or less adept than others. Nonetheless, to be consistent with Experiments 1 and 2, we restricted the analysis to a group of bees that appeared in both S+ vs S− and S + 90 vs New. This lead to the exclusion of two bees in the S + 90 vs New condition. The choice proportion remained in the right direction (31:19) but did not differ significantly from chance ($G_p = 2.91$, 1df, $0.05 < P < 0.1$).

Table III. For Each Condition in Experiment 3, the Test (G_P) for the Group Choice Proportion Against Chance (50:50) and the Test (G_H) for Individual Differences.

Condition	G_P	df	P	G_H	df	P
S+ vs S−	5.77	1	<0.025	24.65	19	N.S.[a]
S+ vs S + 90	2.21	1	N.S.	14.26	12	N.S.
S + 90 vs S − 90	3.51	1	N.S.	21.03	12	N.S.
S + 90 vs New	5.15	1	<0.025	14.24	11	N.S.
S + 90 vs New90	0.23	1	N.S.	21.24	13	N.S.

[a]Nonsignificant.

In the two conditions which pitted the S + 90 against another pattern that was rotated (S − 90 and New90), there was no evidence of a discrimination between the stimuli.

The results confirmed the hypothesis: the rotated pattern was recognized in this experiment, as it was chosen over a New pattern. This was true in spite of any possible learning that S + 90 was nonreinforcing in the previous testing condition (though no evidence was found for this possibility in the previous two experiments). Moreover, there was a tendency to confuse the rotated pattern with the original: the discrimination between S+ and S + 90 was nonsignificant.

The recognition of the rotated pattern cannot be due to the use of symbols per se, because no recognition of the rotated pattern was achieved in Experiment 2. Rather, it is the use of these particular symbols that seems to have been the driving force. The orientation of the individual symbols provided the bees with the key to the problem. In this light, the null results in the conditions pitting the S + 90 against S − 90 and New90 are informative: perhaps the information as to the direction and magnitude of the rotation can be used only in the presence of a properly oriented comparison.

GENERAL DISCUSSION

In all three experiments, bumble bees learned the discrimination between two patterns (S+ and S−) which differed only in the spatial configuration of four artificial petals. Learning of this discrimination, however, was not the result of interest in this study, though it was a prerequisite for the subsequent testing conditions which were of interest. The principal findings from the subsequent key testing conditions were that the rotated pattern was not recognized in Experiments 1 and 2, which used artificial petals that could be rotated by 90° with no change in appearance. In Experiment 3, however, which included some petals with asymmetrical symbols such as "d"and "c," bumble bees recognized the rotated pattern, favoring it over a New one. The rotated pattern was accepted as a substitute for the original. Precautions, described previously, were taken to rule out several possible artifacts: use of odors, place learning, particularities of the New stimuli, and carryover effects between testing conditions.

It is possible that the bees viewed the rotated pattern, prior to the testing conditions, by approaching the S+ obliquely (i.e., they might have wobbled a bit as they flew). From a purely behavioral point of view, this does not affect the conclusion of our paper. Note that this explanation, however, would not account for the results of Experiment 3 differing from those of the other two experiments.

One alternative explanation for our results is that even though the patterns in each experiment consisted of the same features in a different configuration, there is still the remote possibility that we chose patterns such that the S + 90 was inherently attractive in Experiment 3, relative to the New upright pattern, but not so in Experiments 1 and 2. While we cannot exclude this possibility, we can find no a priori principle [such as bees weight the bottom part of their visual field (Wehner, 1972) or bees prefer radial patterns (Lehrer *et al.*, 1995] in support of it either.

Changing the orientation of a pattern between learning of the pattern and a memory test usually impairs recognition (Rock, 1973), and this study is no exception: recognition of the S + 90 was nonexistent in the first two experiments, and, while significant, it was still weak in the last. Nonetheless, the significant results of the third experiment raise the question of the mechanism underlying the recognition. Particularly interesting from a cognitive point of view is the following: in the first two experiments, there was no cue as to the magnitude and direction of the rotation, but in the third experiment, such a cue triggered recognition. How did it trigger recognition? One possible mechanism which accounts well for our data is mental rotation, which presupposes an image-based representation (Neiworth and Rilling, 1987)—a controversial notion in the bee literature. For some pattern discriminations, human subjects seem to "mentally rotate" a pattern which is presented to them prior to making a judgment as to whether it is identical to or different from one that has already been learned [for reviews of the circumstances under which this occurs see Jolicoeur (1990) and Tarr (1995)]. The classic example is deciding whether a pattern is either a letter R or its mirror image when the pattern is presented at various angles from the upright position: decision times are an increasing function of the angle of rotation from the upright position (Cooper and Shepard, 1973). For instance, it takes longer to decide that an upside down "R" is an "R" than it does to make the decision for an "R" at 45 or 90° from the vertical. To rotate the pattern mentally back to the upright position, however, it is necessary to locate the top of the figure in its new orientation—this is the information that was lacking in Gould's (1988a) experiment and that was provided to the bees in our present study. If not mental rotation, then perhaps our results reflect an orientation invariant recognition mechanism (whether or not it be image based) whereby parallel rather than serial processing is used, and recognition times are independent of orientation [as demonstrated for pigeons (Hollard and Delius, 1982; Delius and Hollard, 1995)]. The point of all of this is not to argue that bumble bees either are or are not capable of mental rotation. Indeed it would be an intractable task to rule on this issue because reaction times for free foraging bees would be difficult to measure, though perhaps, as suggested by an anonymous reviewer, it might be done using a maze test or a proboscis extension response procedure. The notion of mental rotation has been invoked previously (Gould, 1990) to account for recognition of patterns rotated by 180° on a horizontal plane ["the forager's nervous system needs to perform some sort of mental rotation" (p. 91)] and our point here is to raise it again as a possibility for consideration.

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