*PIGEONS CAN DISCRIMINATE LOCATIONS
PRESENTED IN PICTURES*

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The present experiments were designed to teach pigeons to discriminate two locations represented by color photographs. Two sets of photographs were taken at two distinctive locations on a university campus. These sets represented several standpoints at each location. For the true-discrimination group, pictures from the two locations were differentially associated with reward; for the pseudodiscrimination group, half of the views from each location were arbitrarily but consistently associated with reward. The former group acquired the discrimination much more rapidly. These birds also showed good transfer to new views from the standpoints used in training and to a new standpoint at each location not used in training. In a second experiment, another group of pigeons could terminate any training trial by pecking an "advance" key. Three of 4 subjects used this option to reduce the duration of trials in which pictures from the negative location were presented. These data suggest that pigeons can integrate views shown in pictures into a "concept" of a location. The method used here may be the experimental analogue of a common, natural process by which animals learn to identify locations.

Key words: location, visual discrimination, concept attainment, transfer, panel pecking, pigeons

Most research on spatial memory in animals has been restricted to circumscribed experimental environments. Typically, a radial-arm maze (Olton & Samuelson, 1976), a group of feeding stations (Spetch & Edwards, 1986), or a pool filled with opaque water (Morris, 1981) is placed in a room with several distinguishing features. The subject approaches the feeding locations in succession, or escapes from the water onto a hidden platform. Various studies have shown that the "distal" stimuli in these settings, and the relationships among them, are critical for spatial memory. For example, Suzuki, Augerinos, and Black (1980) showed that the rat requires a constant relationship among extramaze cues for efficient performance. Mazmanian and Roberts (1983) restricted the views of the environment from the arms of a four-arm radial maze to varying degrees, and found that spatial memory for the rat was greatly impaired. Sutherland and Dyck (1984) showed that rats used very different strategies for finding the hidden platform in a pool when

external cues were or were not available. Spetch and Honig (1988) found that spatial memory in pigeons was impaired when prominent spatial cues were rearranged in an environment with several feeding stations (for a more general review of this issue, see Honig, 1987).

These studies, and many others, suggest that subjects integrate different "views" of their environment into a more coherent "concept" of a particular location. But the restricted laboratory environment makes it difficult to determine how animal subjects discriminate among different locations in their natural settings. In the present experiment, we tried to simulate different environments by presenting photographs of different locations. We used these to train pigeons to discriminate between these locations. Pigeons readily acquire conceptual discriminations based on pictures of natural objects such as people, fish, or water (Herrnstein & Loveland, 1964; see Herrnstein, 1984, for a review). Of particular interest with respect to the present research is an experiment by Vaughan and Herrnstein (1987) that involved a discrimination of the presence of one or more trees in pictures of various natural settings. These authors used a modified concurrent-schedule procedure, in which pigeons could alternate between scenes in which trees were displayed and scenes without trees. Many instances of each kind were presented in the course of training. The pigeons obeyed

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Fig. 1. A portion of the Dalhousie University campus pictured in a sketch map, showing the locations discriminated in this experiment. The numbers refer to the standpoints from which photographs were taken.

the familiar matching law with respect to this categorical discrimination: they divided the time spent in the presence of scenes with trees and without trees according to the ratio of the densities of reinforcement associated with each category.

EXPERIMENT 1

The present experiments were designed much like a concept-attainment task. Different "instances," or aspects, of two different locations were presented in training. For the true-discrimination (TD) group, all views of one location were associated with food reinforcement, whereas those of a different location were associated with extinction. After the subjects acquired this discrimination, they were tested for transfer to new instances not presented in training. The acquisition of this true discrimination was compared to the performance of a pseudodiscrimination (PD) or control group. For these subjects, half of the views from each location were arbitrarily associated with reinforcement and the rest with extinction. To master this discrimination, the pigeons had to memorize the reinforced instances from each location.

METHOD

Discriminative Stimuli

About 90 color transparencies were taken with an Olympus 35mm camera on sunny, later summer days, on the campus of Dalhou-

sie University in Halifax, Nova Scotia. Two locations were used for this research. One is a grassy courtyard surrounded by three large buildings and connecting covered walkways of the Life Science Building (LSB) complex. The other is the area on the main part of the campus in front of the Arts and Administration (A & A) building. This included the large A & A building and several somewhat smaller ones in two parallel rows extending beyond the front of this building. The photographer took pictures at different standpoints within each location. At each standpoint, she photographed several views by turning herself and the camera to cover 360°. Close-ups as well as wide-angle shots were included at several standpoints. There was considerable overlap among some of the views taken at particular standpoints. Particular areas, features, or buildings in each location were photographed from different angles. No part of the LSB complex was visible from the A & A location, but the back of the A & A building can be seen from a few places in the LSB location and appeared in some of the pictures taken there.

A portion of a "sketch map" of the Dalhousie University campus is shown in Figure 1. The two locations are shown there, as are the approximate standpoints from which the pictures used in the present experiment were taken. The LSB complex, built in 1970, is made of poured concrete. The courtyard is grassy, and contains few open walkways. The trees are young and rather small. There is a large round tower that contains a pool for oceanographic research, and covered walkways between some of the buildings. The A & A building is older, and blocks of sandstone were used in its construction. The trees are larger, and there are some flower beds. There are concrete sidewalks between the buildings. One view taken from each of the eight standpoints that provided the training slides is reproduced in black and white in Figure 2. This figure therefore provides four views from each location.

Subjects

Eight White Carneau pigeons served as subjects. They had been used for other research, but none involving discriminations between complex visual stimuli. They were maintained at approximately 80% of their free-feeding weights.

Fig. 2. Eight views used in discrimination training. The lower four were taken in the A & A building location, each from a different standpoint. The upper four were taken in the LSB location, each from a different standpoint. In one of these, part of the back of the A & A building is visible.

Apparatus

Two operant behavior chambers were used. Each contained a ground-glass vertical plate, 5 cm square, as the response panel. This panel was hinged at the top. Key pecks interrupted the contact between two leaves of a micro-switch. One leaf was attached to the back of the panel and the other to the main frame of the box. Food was presented for 4 s at a time in a feeder near the floor of the chamber. This feeder contained a magazine light that was illuminated during the magazine cycle. Experimental events were controlled and recorded by an Apple IIe® computer.

Procedure

Training was carried out in sessions of 32 trials. Each trial lasted for at least 20 s. Negative trials ended at that time. On positive trials, the first response after 20 s was immediately rewarded with food for 4 s, and the trial then ended. If the pigeon failed to make a response within 10 s after a reward became available, the trial ended without reinforcement. This rarely occurred. Only the responses emitted during the first 20 s of any trial were counted.

Sixty-four slides were used for discrimination training. These were taken at eight different standpoints, four in each location. Each standpoint provided eight slides, or eight different views. These views from each standpoint were divided equally between two trays. Each session consisted of 32 trials, divided into four blocks of eight trials each. In each block, one view from each of the eight standpoints (four from each location) was presented. The order of these views was randomized in each tray of slides, and these orders were changed about every seven training sessions.

Each block of trials contained four positive (reinforced) trials, and four negative (unreinforced) trials. For the four true-discrimination (TD) birds, scenes from one location were shown on positive trials, and scenes from the other location were shown on negative trials. The positive location (A & A vs. LSB) was counterbalanced between subgroups of two subjects each. Within those subgroups, 1 bird was trained with Tray 1 and the other bird was trained with Tray 2. Therefore, the sets of training slides (from the two different trays) were counterbalanced between subjects. The other set was reserved for testing.

Four pigeons were trained with a pseudo-discrimination (PD) procedure. The same training slides were presented in the same order, but reinforcement was provided for pecking at half of the scenes that represented each location. Any particular slide was associated arbitrarily but consistently with reward or no reward. This association was counterbalanced between subgroups of 2 subjects. Not more than three positive or negative trials occurred in a row in any training condition. For both groups, the slide order was rearranged after each set of eight training sessions to prevent the subject from memorizing the order of reinforced trials.

Sequence of conditions for the TD group. Three pigeons were trained for 23 to 25 sessions prior to the first transfer test. The fourth pigeon (S4838) was tested after 33 sessions of training because of a temporary decline in performance. The birds reached a high level of discrimination much sooner than the number of training sessions would suggest (see Results), but we overtrained them to ensure a stable performance before transfer tests were carried out. In the first transfer test, or *new views test*, which lasted two sessions, the slide trays used for training were simply interchanged, together with the associated sequences of reinforced trials. The pigeons were therefore tested with new views photographed from the standpoints used in training. These new views overlapped to varying degrees with the training stimuli. The degree of overlap depended on various factors, such as the "scope" available to the photographer at each location and the lens used for particular pictures (normal, "zoom," or wide-angle). Training and transfer slides were never identical, but there were certainly marked similarities among them, not only "within" the same standpoint but also between pictures of the same part of a location taken from different standpoints.

After nine additional training sessions for the pigeons tested after 23 to 25 training sessions (and after four training sessions for S4838) all pigeons were given a second transfer test of two sessions, the *new standpoint test*. The slides from one standpoint in each location were replaced by slides from a fifth standpoint not used in training. The other training slides were not changed. After six or seven additional training sessions, each pigeon was given a third transfer test, the *inversion test*, with the regular training slides inverted in the projector for two

sessions so that the scenes appeared upside down on the pecking screen. Normal reinforcement contingencies were maintained during test sessions.

Sequence of conditions for the PD group. After 20 sessions of regular training, 2 birds discriminated well between the positive and negative slides, and they were given the inversion test for two sessions. The other 2 birds did not reach a sufficient level of discrimination to justify such a test. Because this was a memorization control group, it made no sense to conduct the other transfer tests with the new instances.

RESULTS

Discrimination Training

The discrimination ratio (DR) used to assess performance on the successive discrimination is the proportion of total responses emitted to the set of positive slides during a training or test session. The pigeon's "default" tendency is to peck, and this ratio increased as the rate of responding to the negative instances declined. All of the TD birds acquired the discrimination quite quickly, as shown in Figure 3. Three subjects attained a rather stringent DR of .90 within nine training sessions. S4568 barely missed this criterion on the seventh session and reached it on the 12th. All birds were biased to respond to pictures involving the LSB; those with this location positive started with a DR over .50; for the others, the DR was less than .50. The reasons for this preference are not known, and it was rapidly eliminated as the subjects acquired the discrimination. Changes in the slide order usually had little effect upon performance. The DRs from training sessions following the sessions in which they first reached a DR of .90 are not graphed. Occasionally there were unexplained declines in performance, especially for S4838, and the first transfer test was delayed for this bird until performance was stable. No other transfer tests were postponed.

Transfer Tests

The data from the first transfer test with new views from the same standpoints, and from the inversion test, are presented in Table 1 for individual subjects. The total responses to positive and negative instances are shown for the transfer sessions and for the two preceding "baseline" training sessions. Responding to the

Fig. 3. Session-by-session acquisition by individual pigeons of the true discrimination between the two locations, up to the attainment of a DR of .90.

positive stimuli was well maintained during the transfer sessions with new views; this is not surprising, because pigeons are biased toward responding in a successive discrimination. Responding to the negative transfer stimuli was largely suppressed, although it was about twice as frequent as with the negative training stimuli. The DRs reflect this modest reduction in the discrimination. Because the "baseline" performance preceding the transfer tests was high, data from these tests are compared to a stringent criterion.

Inversion of the slides reduced the quality of the discrimination, although the mean DR of .77 is still quite respectable. The pigeons reduced their responding to the positive stimuli by about 10% but increased responding to the inverted negative stimuli by a factor of about 12.

The data from the test with photographs from one new standpoint in each location are shown in Table 2. These are compared to the mean data obtained during the same test sessions with pictures from the remaining three standpoints. In this table, the data represent total responses per standpoint (rather than per test session), so the numbers are lower than in Table 1 (and Table 3, below). The data from the old standpoints reflect the well-trained discrimination, with a mean DR of .90. Responding to the new standpoint from the positive location was hardly affected. This is not a par-

Table 1
Transfer data from the discrimination of locations (Test 1 and Test 3).

Subject	Prior training sessions		DR	Transfer sessions		DR
	Total positive responses	Total negative responses		Total positive responses	Total negative responses	
Test 1: Same standpoints, new views						
4181 (LSB +)	790	22	.97	432	57	.88
4568 (LSB +)	1,189	67	.95	1,450	185	.89
4947 (A & A +)	2,605	212	.92	2,266	242	.90
4838 (A & A +)	1,362	103	.93	1,295	330	.80
Mean	1,486	101	.94	1,361	204	.87
Test 3: Inversion of training stimuli						
4181 (LSB +)	1,112	83	.93	2,015	419	.83
4568 (LSB +)	2,152	46	.98	1,032	378	.73
4947 (A & A +)	3,028	42	.99	2,868	1,341	.68
4838 (A & A +)	1,584	19	.99	1,357	251	.84
Mean	2,059	48	.97	1,818	597	.77

ticularly striking finding, because, as indicated above, pigeons “default” to responding. When pictures from a new standpoint were presented, the pigeons responded less often to slides from the negative location than to slides from the positive location. Subjects 4181 and 4568, for which the new negative standpoint was in the A & A location, showed a small increase in responding with these new stimuli. For the other pigeons (trained with the LSB area negative) the increase was much larger, and the DRs were correspondingly reduced. Only 1 subject failed to provide a convincing discrim-

ination between the locations seen from a standpoint not used in training.

Pseudodiscrimination Training

The training and test data for the PD group are shown in Figure 4. These are plotted in blocks of two sessions. Only 2 subjects came close to a DR of .90. They presumably memorized the various instances. The other birds made little progress. The PD birds that did learn the discrimination took about 20 sessions to do so—twice as long as the average of the TD subjects.

Table 2
Substitution of new standpoints (Test 2).

Subject	Old standpoints		DR	New standpoints		DR
	Total positive responses	Total negative responses		Total positive responses	Total negative responses	
Prior sessions						
4181 (LSB +)	219	7	.97			
4568 (LSB +)	596	76	.89			
4947 (A & A +)	713	42	.94			
4838 (A & A +)	325	20	.94			
Mean	463	36	.94			
Median	460	31	.94			
Test sessions						
4181 (LSB +)	241	6	.98	267	7	.97
4568 (LSB +)	472	90	.84	457	130	.78
4947 (A & A +)	664	132	.83	646	482	.57
4838 (A & A +)	386	20	.95	413	138	.75
Mean	441	62	.90	446	189	.70
Median	427	55	.90	435	134	.76

Inversion Test

When the training slides were inverted for the PD subjects, this resulted in a decline in performance much greater than the corresponding decline for any of the TD birds (see Table 1). It appears that the pigeons were able to memorize the sets of positive and negative slides to some degree, but transfer to inverted views was poor. This difference in the transfer performance is rather interesting, because exactly the same change in the stimuli was involved for the two groups. This supports a functional distinction between the conceptual and the arbitrary discriminations. The former seem to provide some flexibility in subjects' evaluation of altered stimuli, whereas memorization is more restrictive.

DISCUSSION

The present research has much in common with concept attainment in animals, if the many possible "scenes" from a location are considered equivalent to the many instances of a conceptual class. The pigeons were trained to discriminate between two such classes, and they were tested with new instances from these classes. Furthermore, because the number of instances from each class was limited for training (unlike the many possible instances of "person," "tree," or "fish"), we could compare the true-discrimination group to a memorization control. Edwards and Honig (1987) used a similar strategy in their research on the concept of a person in a picture, and their memorization control group also learned the discrimination much more slowly than the true-discrimination group. In the present experiment, the true discrimination was "robust" when new instances were presented, although there was some decline in performance when the standpoints were altered and when the pictures were inverted. In short, the performance described here is similar in many respects to the more traditional research on concept attainment in pigeons.

The successive presentation of single instances may not be the most sensitive method for assessing conceptual discriminations. In our procedure, subjects could not directly compare scenes from different locations and choose between them. This would be possible with simultaneous presentation of pictures from the two locations. Because pigeons move between different locations in nature, such a choice pro-

Fig. 4. Acquisition of the pseudo-discrimination by individual pigeons in blocks of two sessions. The DRs from the test sessions with inverted scenes are also shown for the 2 birds that reached a reasonable level of discriminative performance.

cedure may be more appropriate than the successive presentation of single pictures.

Concurrent schedules with a changeover option could also be associated with views from different locations. As indicated above, Vaughan and Herrnstein (1987) used such schedules to study a conceptual discrimination between trees and their absence. Over a wide range of conditions, the pigeons responded in accordance with a matching law in the presence of positive and negative instances. This procedure provides an experimental analogue to foraging in patches yielding different densities of food, and it may be particularly suitable for the study of discrimination of different locations. Experiment 2 provided an opportunity for choice between locations that differs somewhat from either of these traditional procedures.

EXPERIMENT 2

In a natural setting, a bird or animal can usually leave one location in order to spend time in another, more favorable setting. This is not possible in our experimental procedure, but the second experiment provided an approximation of this kind of opportunity. The nature of the discrimination was the same as in Experiment 1, but the pigeon could peck at an "advance key" to terminate any training trial and initiate the next one. This response always produced a "change of scene" to a new

view, most often to a new standpoint, and about half the time to a different location. With this method, the time spent in the presence of stimuli from different locations becomes a dependent variable that can support the data based on total responses.

METHOD

Subjects and Apparatus

Four different pigeons were used for this experiment. They had a prior history of discrimination procedures, but none of these was related to the current problem. The apparatus was the same as in Experiment 1, except that a small key in the box to the right of the main response panel was used as the advance key. This key was illuminated by a white light when the "advance procedure" was in effect.

Procedure

Training without the advance procedure was carried out as in Experiment 1. When the advance procedure was in effect, the advance key was illuminated throughout each trial, but it was inoperative during the first 2 s. This delay was imposed to prevent the bird from "pecking through" a training session by using the advance key repeatedly without looking at the main response panel. An advance response at any other time terminated the current trial immediately and initiated the next trial, after an intertrial interval (ITI) of approximately 2.5 s (the time required to advance the slide projector to the next position). The shortened ITI provided the bird with reinforcement for the advance response as quickly as possible. Because the positive and negative trials occurred in a randomized order, an advance out of a negative trial could produce another negative trial or a positive trial equally often; the same was the case for advances out of a positive trial. A strict alternation between positive and negative trials would have provided unequivocal outcomes for advance responses, and perhaps more consistent data, but this would have confounded the sequence of trials with the discriminative categories.

Sequence of Conditions

The pigeons were trained on the discrimination without the advance procedure until they reached a DR of .80. The advance procedure was then introduced and remained in

effect throughout the rest of the experiment. In the course of training, the same transfer tests were carried out as in Experiment 1: transfer to new views from the same standpoints, use of a new standpoint in each location, and inversion of the training slides. These tests were always carried out for two sessions, with the standard reinforcement contingencies in effect. At least three training sessions intervened between the sets of test sessions.

RESULTS AND DISCUSSION

The pigeons acquired the discrimination (without the advance key) somewhat more slowly than did the true-discrimination group of Experiment 1. It took the individual subjects 4, 10, 13, and 19 sessions to reach the DR of .80 required for the introduction of the advance key. The mean of 11.5 sessions is greater than the six sessions that the TD group required to reach the same level of discrimination in Experiment 1 (see Figure 3). However, they learned the discrimination more quickly than did the pseudodiscrimination group in Experiment 1.

The principal data of interest for this experiment were obtained from the various test procedures. These data are presented in Table 3, together with the mean discrimination ratios from the three preceding "baseline" training sessions. Three ratios are shown for each session and for each bird. The DRR is the familiar discrimination ratio based on the proportion of total responses emitted to the positive stimuli. The $DRT+$ is the proportion of the available time (320 s) that the pigeon spent in the presence of the slides representing four standpoints from the positive location. Because an advance response during a positive trial cancelled the reinforcement for that trial, that response should be infrequent, and the $DRT+$ should therefore be close to 1.00. The $DRT-$ is the proportion of the available time (320 s) that the pigeon spent in the presence of slides representing four standpoints from the negative location. Because the advance response terminated such negative stimuli and led to a positive stimulus on about half of the occasions, it should have been emitted rather frequently. With consistent use of the advance key, the $DRT-$ could approach a lower limit of .10, because the advance key was inoperative for the first 2 s of any trial, or 10% of the trial duration.

Table 3

Discrimination ratios of time (DRT) and total responses (DRR) in Experiment 2: Baseline data for each test come from the immediately preceding training session.

	S4802			S4980			S4944			S4917		
	DRR	DRT+	DRT-	DRR	DRT+	DRT-	DRR	DRT+	DRT-	DRR	DRT+	DRT-
New views												
Baseline	.99	.85	.30	.87	1.00	1.00	.92	1.00	1.00	.87	1.00	1.00
Test session 1	.98	.96	.20	.75	1.00	1.00	.79	1.00	1.00	.87	1.00	1.00
Test session 2	.99	.86	.21	.89	1.00	.75	.80	1.00	1.00	.96	1.00	1.00
New standpoints												
Baseline	.99	.89	.21	.93	.92	.46	1.00	.82	.43	.97	.88	.79
Test session 1												
Old standpoints	.99	.93	.23	.97	.79	.33	.98	.93	.46	.83	1.00	.95
New standpoints	.94	1.00	.22	.87	.56	.59	.82	1.00	.59	.67	1.00	1.00
Test session 2												
Old standpoints	.94	.87	.29	.99	1.00	.34	1.00	.93	.36	.98	.86	.51
New standpoints	.99	1.00	.21	.75	1.00	.38	.95	1.00	.56	.54	1.00	.79
Inversion test												
Baseline	.93	.98	.30	1.00	.91	.19	1.00	.95	.24	.91	.98	.90
Test session 1	.99	.83	.17	.89	.95	.31	1.00	.75	.24	.62	1.00	.92
Test session 2	.70	.90	.41	.83	.95	.48	.93	.83	.31	.66	1.00	.60

Once the birds acquired the discrimination, the data were quite stable, and they are presented in Table 3 only from the three sets of test sessions and from the training session that preceded each test. The DRRs were usually high and replicate the results of Experiment 1. The comparison between the DRT+ and the DRT- in each condition is of particular interest. Subject 4802 was our "model" subject in this respect. It learned to use the advance key early in training and then selectively reduced its time in the presence of the positive and negative stimuli. The DRT+ was above .80 for all but one of the baseline training sessions and for all of the test sessions. In general, the DRT- was low, between .20 and .30. The DRT- values from the test sessions are as low as, or lower than, the values from the prior training sessions, with the exception of the second test with inverted slides. This means that the pigeon transferred the appropriate use of the advance response very well between the training and test stimuli.

The other birds approximated this good performance to a lesser extent. Subjects 4980 and 4944 were less consistent than 4802, and they did not reduce the time spent in the presence of negative stimuli to the same degree. Unfortunately, they had not started to use the ad-

vance key when the first transfer test was carried out. When they did start to use that option, appropriate differences in the DRT were obtained, except that 4980 did not transfer well to the new standpoint in the first test session. Bird 4917 rarely used the advance key. There was some modest transfer to views from new standpoints and to the inverted training stimuli.

This experiment is of interest because it provides a systematic replication of the true discrimination between pictured locations and involves an additional dependent variable. The time spent in the negative trials is a direct indicator of the relative "negativity" of the location associated with extinction. However, the present experiment probably provides a conservative estimate of the pigeon's ability to choose between locations. Because of the random order of trials, the advance response led to a positive trial only on about half of the occasions on which it was emitted in the presence of the negative stimuli. This differs from the standard changeover procedure used by Vaughan and Herrnstein (1987), in which each response to a changeover key produces the stimuli associated with the alternative reinforcement schedule.

The advance procedure has the advantage

that the same "active" response provides the measure of discrimination for both positive and negative trials. The standard DR based on total responses (without the advance procedure) increases mostly because the subjects learn to withhold responding to the food key (or panel) on negative trials while they continue to peck during positive trials. The pigeon's propensity is to peck at the stimulus, and the standard DR is probably a conservative estimate of the discrimination. In contrast, the advance procedure makes explicit the choice between stimuli that is inherent in simultaneous discrimination procedures. In the present setting, it has much in common with movement from one location to the other. We would have been wise to pretrain the pigeons on the use of the advance key with an easy discrimination involving simple stimuli. The advance responses can readily be transferred to more difficult discriminations (Honig, Beale, Seraganian, Lander, & Muir, 1972).

GENERAL DISCUSSION

The discrimination between locations acquired in the present experiments represents an accretion based on a discrimination between limited sets of specific instances. In this respect it is very similar to the attainment of a concept. However, it may be argued that the discrimination is not conceptual, because a location is not a traditional stimulus category or class (e.g., "person," "tree," or "fish") of the kind that has provided the basis of prior conceptual work with pigeons (cf. Herrnstein, 1984). The "concept" of a location is an aggregate of varied features with no single defining characteristic; it is "fuzzy" rather than "crisp." It is perhaps closer to the identification of a particular individual than a class of similar items (Herrnstein, Loveland, & Cable, 1976). But this kind of distinction may reflect our human view of the world, with our verbal labeling of items and an insistence on crisp logical distinctions. It is more likely that for animals, concepts are discriminated accretions of characteristics typical of a particular class that control the same patterns of behavior. Functionally, the pigeon's concept of a particular instance may not differ much from the control of behavior exerted by a group of similar examples of a class. In this sense, the pigeon's discrimination of humans, fish, or trees as classes of stimuli may

not be very different from its discrimination of different locations.

As human beings, we tend to adopt a template model for concepts, and spatial locations do not fit such a model. The pigeon may not achieve conceptual discriminations of any kind on the basis of a template. Such discriminations may be based on stimulus generalization between instances of the same class on the basis of specific, punctate features. This process is not well documented or well understood at this time, but it may well be responsible for the discrimination of spatial locations as well as the traditional categories of more "definable" objects. This view is supported by the work of Vaughan and Herrnstein (1987) on the discrimination of the presence versus absence of trees in a picture. Not only did the pigeons master this discrimination, but the time that they spent "in the presence of trees" obeyed the traditional matching law based on the relative rates of reinforcement in each condition.

The present research may be extended in different ways that involve less restrictive and more naturalistic materials. Videotapes of different locations may be shown, or pigeons could simply be placed in different locations associated with differential reinforcement and then tested with pictures taken from these places. Because birds in particular must have evolved with the talent of generating a sense of their location from the visual stimuli available in particular places, research of this nature may be quite interesting and productive.

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