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Discrimination of Video Images of Conspecific Individuals In Bengalese Finches

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Individual recognition is one of the most basic discrimination abilities in social animals. Many playback experiments suggest that auditory neighbor recognition occurs in several avian species. There have also been several laboratory experiments demonstrating visual individual discrimination in birds, for example, chickens (Howells & Vine 1940; Candland 1969; Ryan 1982), budgerigars (Trillmich 1976) and pigeons (Poole & Lander 1971; Watanabe & Ito 1991; Watanabe 1992). The Bengalese finch generally has a high level of variation in feather coloring, although in *Urolonchura striata paethontoptila* (the original wild type of this species) it is moderate. Individual differences in appearance in Bengalese finches suggest that this species can use visual cues for individual discrimination. The present experiments examined individual discrimination based on visual cues in Bengalese finches using operant conditioning.

Colored photo slides or still images have been used in the operant conditioning experiments of individual discrimination, but stimuli through such media lack several aspects of live animals. Trillmich (1976) found failure of transfer of budgerigars's individual discrimination of live birds to their pictures in the T-maze. This result suggests that movement or behavioral cues play an important role in individual discrimination. Video images involve movement cues but few studies have employed video images in such experiments (Evans & Marler 1991). In the present experiments we tried to train Bengalese finches individual discrimination with video stimulus in order to examine movement cues.

Experiment 1

Subjects

Four male and 4 female Bengalese finches (*Lonchura striata domestica*) of about 90-day-old age were used. The birds did not have any experimental history. They lived in individual cages (22 × 15.5 × 30 cm) and had no chance to see birds used as discriminative stimulus. They were deprived of food for 5 to 8 h before the start of daily training.

Apparatus

The experimental chamber was a mesh cage for a small bird (25 × 15 × 35.5 cm). The front wall was removed and a color TV (21.5 × 15.5 cm, National TH11-S71, horizontal resolution, 350 scanning lines) was attached. There were 3 perches in the chamber. The distances from the TV screen to the perches were 10, 18 and 26 cm, respectively. The first perch was a response perch and the second was an observing perch. A photo-sensor (Omron E3v-R2C43S) detected perching response on the first and second perches. Perching on the third perch was not recorded. There was a food magazine between the screen and the first perch. The food magazine contained mixed seeds for reinforcement.

Behavior of the subjects was monitored using a video camera and TV and continuous noise was broadcast during the experiments. The experiment was arranged by a microcomputer (Sanyo Wavy 70 FDM). Figure 1 shows arrangement of instruments.

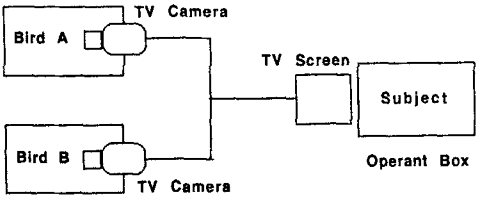

Fig. 1. Two TV cameras continously monitor two stimulus birds (Birds A and B). A computer selects one of these two lines to display a stimulus on the TV screen in the operant chamber.

Stimulus

Stimuli were video images of 2 live male Bengalese finches. One (bird A) had a mixture of dark brown and white feathers. He had dark brown feathers spread from the head to the upper arm and from wing-coverts to tail-coverts, and his back and rump also contained dark brown feathers. His crown was white. The other bird (B) also had dark brown feathers but the area of the brown feathers was restricted to the dorsal part of the body. His breast, belly and tail were white. These males were placed in individual cages in which a side wall was made of transparent acrylic. The cages were placed in a grey wooden box (45 × 45 × 80 cm) in which a video camera (SONY CCD-G100ST, horizontal resolution, 320 scanning lines) and a fluorescent ceiling light (10W) were fixed. The distance from the camera to the side wall of the individual cage was 40 cm. The TV camera in each box continuously monitored the birds. A computer controlled a circuit to display an image (provided by of one of 2 cameras) on a TV screen attached to the operant chamber. No line for auditory signal was transmitted. For still images of birds, still video images of stimulus birds were taken using a floppy disk camera (Canon Q-PIC, horizontal resolution, 350 lines) and the images were displayed on the TV screen with a floppy disk player (Konica KR400, horizontal resolution, 350 scanning lines).

Procedure

After adaptation to a feeder, every subject was trained to stay on the observing perch for more than 1 s before it jumped to the response perch to get reinforcement. During this preliminary training no stimulus was displayed on the TV screen.

Then the subjects were trained GO-NOGO type discrimination. Bird A was a stimulus associated with reinforcement (S +) and bird B was not associated with reinforcement (S −) for half of the subjects. The other subjects were trained on reversed discrimination.

The subjects had to perch on the observing perch for 2 s, before a stimulus appeared on the screen. If the stimulus was S+, flying to the response perch within 3 s was reinforced by 5 s presentation of the food hopper. An intertrial interval then started. Response for S− within 3 s resulted in a 15 s time out followed by an intertrial interval. If no response occurred for 3 s for S− an intertrial interval started. The following correction procedure was employed. No response for S+ or occurrence of response for S− resulted in presentation of the same stimulus until the subject emitted response to S+ or withheld response for S−. GO response to S+ on the correction trial caused a brief (0.5 s) presentation of food. One daily training session consisted of 80 trials. The trials in which the subject showed a response for S+ and no response for S− were counted as the correct trials, and the trials with no response to S+ and response to S− were counted as error trials. Responses during the correction trials were not used for analysis. This training procedure continued until the subject showed more than 70% correct trials in 3 successive sessions. Then, a partial reinforcement schedule was adopted to maintain response under extinction tests. Reinforcement was given for every 2 or 3 S+ trials on average during the partial reinforcement schedule. This schedule continued until the subject showed more than 80% correct trials in 3 successive sessions. The training was inserted between the test sessions described below to maintain the discrimination level. If the birds did not show discrimination above 80% levels in the inserted session, the training continued until they again reached the 80% discrimination level.

Test 1. The TV monitor was tuned to produce monochromatic images to examine the effects of color. The test session consisted of 40 trials. The procedure was the same as the training procedure except that no reinforcement or correction procedure was given, nor time out after responding to S−.

Test 2. To examine effects of motion, 20 different still images of S+ and S− birds randomly appeared twice during the test (80 trials in total). No reinforcement was given during the test.

Statistical analysis

There were 2 categories of stimuli (S+ and S−) and 2 categories of response (perch or not perch), and 2 × 2 Chi square test was employed to evaluate the subjects' response.

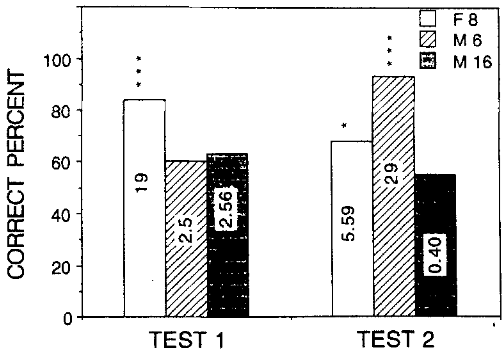

Fig. 2. Results of tests in Experiment 1. Test 1 presents monochromatic images and Test 2 still images. *P < 0.05, ***P < 0.005, χ^2, df = 1. The number in each bar indicate the Chi square value.

Results and Discussion

Three of the eight birds learned the discrimination. The numbers of sessions required to attain the 70% and 80% criteria are shown in Table 1. Bird A was S+ for F8 and bird B for M6 and M14. These results proved individual discrimination based on visual cues. The other 5 birds, however, did not reach the criterion of discrimination by the end of 30 training sessions. Their performance stayed at chance level even in the 30th session.

Figure 2 presents results of the tests. In Test 1, subject F8 maintained her discrimination for monochromatic stimuli but the other 2 subjects did not. F8 and M6 showed a significant transfer of discrimination to still images (Test 2), but M16 did not. That is, F8 could discriminate the individuals without color cues or movement cues, the color cues were important for M6, and M14 needed both cues.

Why did the subjects show such substantial individual differences in the individual discrimination? A video image is a compound stimulus that contains many elements. The subjects can select any element to discriminate between the stimuli. In fact, many operant conditioning experiments with compound stimuli have shown individual differences of element selection for compound stimuli discrimination. For example, Reynolds (1961) trained pigeons on discrimination between a red triangle and a green circle. He found that one bird used difference in form (triangle or circle) for discrimination but another used color (red or green) as a cue. The present results suggest that such cue selection occurs in visual individual discrimination in Bengalese finches. In other words, there is no speeies-specific strategy of visual individual discrimination in this species. Variablity of discrimination strategies may give animals supplementary cues when discrimination based on 1 cue is not successful. So, the variety itself may have an role in important discriminations such as individual discrimination. Bengalese finches may use auditory cues for individual discrimination in a natural setting so the visual discrimination training in the operant chamber might produce results similar to those with artificial stimulus.

Experiment 2

Five subjects failed to learn individual discrimination in Experiment 1. Continuous video image might be a complicated stimulus. In Experiment 2 a still video image instead of a moving image was used as discriminative stimulus.

Apparatus

The experimental apparatus was the same as that in the previous experiment except that the TV was connected to a floppy disk player.

Subjects

Five birds that failed to learn the discrimination in Experiment 1 were used.

Stimuli

Two different birds were used as stimuli. One stimulus bird had scattered white color on a darkbrown background. The white was on the forehead, throat, belly and tail coverts. The beak and tail were darkbrown. The other stimulus bird has darkbrown color on a white background, and darkbrown around the eyes, nape, back and rump. Other parts including the tail were completely white. The color of the beak was pinkish. Images of these birds were taken by a floppy-disk camera and 1 frame for each bird was used as stimulus. For the test with moving video images, images of the birds were monitored and displayed with a TV video camera.

Procedure

The training procedure was identical with the previous experiment. The white background bird was S+ for 3 subjects and the darkbrown background bird was S+ for 2 other birds. After the subject reached the criterion of discrimination (more than 70% correct trials in 2 successive sessions), a partial reinforcement schedule continued until the subject showed more than 80% correct response in 3 successive sessions. The training was inserted between the test sessions described below.

Test 1. Monochromatic images were displayed for 40 trials. No reinforcement was given during the test.

Test 2. Twenty different images of each stimulus bird were randomly displayed twice during the test. These images had never been used during the training.

Test 3. A moving video image was presented. The TV monitor camera transmitted the image to the TV screen in the operant chamber.

Results and Discussion

All birds learned the discrimination. As shown in Table 1, the fastest bird reached the 70% criterion within 7 sessions and needed more 3 sessions to attain the 80% criterion. The slowest bird (F11) required 21 sessions to reach the 70% criterion and 3 more sessions to reach the 80% criterion. Because all subjects failed to learn discrimination in Experiment 1, the discrimination of the still images seems to be easier for the birds than that of moving images, although facilitative transfer effects from Experiment 1 and difference of stimulus birds between the 2 experiments should be considered.

Results of the tests are shown in Figure 3. Mean correct percentage was 88.4 (ranging from 82 to 96) in the session just before the Test 1, 93.2 (range, 90 to 98) before Test 2 and 92.8 (rang, 87 to 97) before Test 3. All birds except M9 maintained discrimination when tested with the monochromatic images (Test 1).

In the test with novel still images, all birds except F11, whose performance was significant at the 10% level, showed clear discrimination (Test 2). Because different postures and angles were included in the test, these results suggest that the birds learned not the particular frames but visual discrimination of particular individuals. In other words, they showed generalization to novel images of a specific individual after training with a single image of this indi-

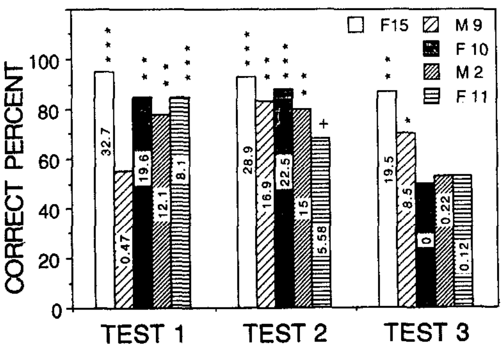

Fig. 3. Results of the tests in Experiment 2. Test 1 presents monochromatic images, Test 2 new still images and test 3 moving images. + $P < 0.10$: *$P < 0.05$: ** $P < 0.01$: ***$P < 0.005$, χ^2, df = 1. The number in each bar indicates the Chi square value.

Table 1. The number of sessions conducted to attain the criterion of discrimination

Birds	EXPERIMENT 1 CRITERION		EXPERIMENT 2 CRITERION	
	70%	80%	70%	80%
F8	12	9		
M6	14	9		
M14	30	12		
F10	30−		16	4
F11	30−		21	3
F15	30−		7	3
M2	30−		10	10
M9	30−		16	3

vidual. Cerella (1979) reported generalization to novel oak leaf patterns after training with a single pattern of an oak in pigeons. Mallot and Siddall (1972) also observed acquisition of visual discrimination of people after training with a few pictures of people in pigeon. The present results agree with these observations. The present results, however, may not agree with the results of Experiment 1 that showed no clear video-still image generalization. This discrepancy suggests that video images are not a simple summation of many still images but a stimulus of a different kind.

The moving images resulted in individual differences in discriminative behavior (Test 3). Three of five birds (M2, F10 and F11) performed at the chance level, while the remaining two (F15 and M9) showed transfer of discrimination. Because the stimulus birds were unfamiliar to the subject birds, they did not have any chance to get information about behavioral characteristics of stimulus birds. Behavioral cues added in Test 3 may have confused some birds. One interesting result about familiarity of individuals was obtained from monkeys (Dasser 1987). The monkeys showed generalization to new slides of an individual monkey after discriminative training with 1 pair of stimuli when the stimulus monkey lived in the subject's group but not when the stimulus monkey was a stranger. Thus, we may expect better transfer to new images when familiar birds are used as stimulus.

Conclusion

The present experiments demonstrated the following 2 points: 1) Bengalese finches could discriminate conspecific individuals based on visual cues even when only 1 pair of still images was used for training, and 2) they have individual differences in discriminating strategy for moving video images; in other words, there is no species-specific fixed manner of visual individual discrimination. Because no auditory cues were examined here, individual discrimination based on auditory signals should be analysed in the future.

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