Effects of Stimulus Class Established by Response Differentiation on a Conditional Discrimination

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"Conceptual behavior" has been usually defined as generalization within each classes of stimuli and discrimination between classes of stimuli (Keller & Schoenfeld, 1950). In view of the behavior analysis, both of such generalization and discrimination are represented in terms of stimulus control. There are many studies of conceptual behavior in which stimuli within a given class shared certain physical features (for example, color, size, shape, and so on) in common with each other. There are some studies of conceptual behavior, however, which come under the control of the stimuli without the common physical features.

It seems that the latter type of conceptual behavior may be explained in terms of mediation of the response differentiation (Motoyoshi, 1980; Motoyoshi & Sakane, 1979; Torii, 1979). An experiment referring to such mediational process was reported by Nakagawa (1978). That experiment consisted of two stages. In the first stage of the experiment, all animals were trained to discriminate between black and white, and between horizontal and vertical stripes. After reaching the learning criterion in the first stage, half of the animals - the non-overtrained group - were immediately transferred to the second stage: a reversal task of the first stage, and the other half of the animals - the overtrained group - were overtrained on the original task and then transferred to the second stage. In the second stage, both the non-overtrained group and the overtrained group were divided further into two subgroups: a whole reversal task group and a

partial reversal task group. In the whole reversal task, a positive and negative relation between black and white, and that of between horizontal and vertical stripes were reversed. In the partial reversal task, a positive and negative relation between either black and white, or between horizontal and vertical stripes was reversed. His results indicated that the non-overtrained group learned the partial reversal task faster than the whole reversal task, while the over-trained group learned the whole reversal task faster than the partial reversal task. The author interpreted that the facilitative effect of the overtraining on the whole reversal task was attributed to the cue associations between two positive stimuli, and/or between two negative stimuli established during the overtraining.

No obvious evidence of the cue associations, however, was found in the overtrained group data. Further, effects of overtraining were ambiguous in the reversal learning procedure. The present experiment was designed to overcome above mentioned difficulties. Thus, instead of the reversal learning, a successive conditional discrimination task was used in the second stage of the experiment and a new criterion was applied to clarify the overtraining effects.

Method

Subjects

Twenty experimentally naive female albino rats approximately six months old at the start of the experiment were used as subjects. They were maintained at the 80–85 % of their free-feeding weight (150–215 gr.) through the experimental sessions. Water was always available.

Apparatus

A straight runway and a discrimination box were used, which are illustrated in

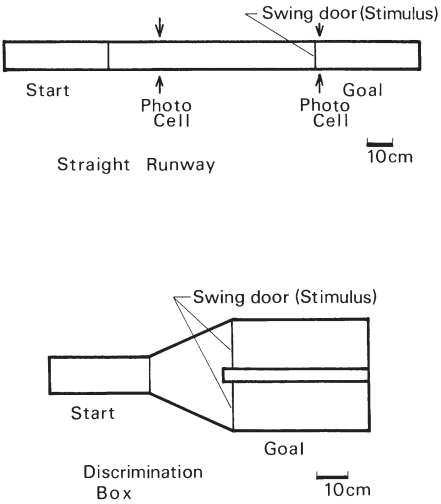

Figure 1 The floor plans of the apparatus

Figure 1. They were made of plywood and painted mid-gray inside. The ceiling were transparent Plexiglas. The only source of illumination was two 20 W fluorescent lamps for the straight runway, and one 20 W fluorescent lamp for the discrimination box, with fluorescent lamps were settled 45 cm above the floor of the apparatus.

Stimuli

The goal box doors, 9 cm square, were themselves stimulus objects which consisted of black (B), white (W), vertical stripes (V), and horizontal stripes (H). The stripes consisted of black and white bars of 15 mm in width.

Preliminary training

Subjects were handled for three minutes per day for ten days. On the last three days of handling, subjects were trained to run through the straight runway and to enter the goal box by pushing the mid-gray swing door.

Experimental procedure

First stage - Original learning: A successive go/no-go discrimination task was trained to half of the subjects with four kind of discriminative stimuli, B (+), W (−), V (+), and H (−), and to the other half of the subjects with B (−), W (+), V (+), and H (−), in the straight runway. On the positive stimulus trials subjects were given two 45-mg pellets as reward in the goal box. On the negative stimulus trials subjects were confined in the goal box without reward for 15 seconds when they entered the goal box within 30 seconds after the start box guillotine door was opened. The running time from the start guillotine door to the swing door of the goal box (Figure 1) was measured within 0.01 second of accuracy by electric timer. If subjects failed to enter the goal box within 30 seconds after the start guillotine door was opened, the running time was recorded as 30 seconds.

Twelve trials of successive go/no-go discrimination training were given each day. Four kind of discriminative stimuli were presented in a random order determined previously. The intertrial interval was from 150 to 180 seconds.

Animal were trained to reach the learning criterion that the median running time on the positive stimulus trails was shorter than all running times on the negative stimulus trials for two consecutive days. This criterion was applied to each discrimination task of B vs. W, and V vs. H, respectively, and original learning was continued until the criterion was satisfied in both discrimination tasks according to Nakagawa's (1978) procedure.

After reaching the criterion on the original learning, eight of twenty subjects were immediately transferred to the second stage, and the remaining twelve subjects were given additional 25 day's overtraining on the original task for a total of 300 trials.

Second stage - Transfer learning: A successive conditional discrimination task (Lawrence, 1949) was trained in the discrimination box. One of the four stimuli (B, W, V, and H) was presented on both left and right swing door (Figure 1), and subjects had to make a different response to either left or right side door. Each of two

non-overtrained and two overtrained groups in the original learning was divided into following two subgroups, the same response condition group and the different response condition group. In the same response condition, a response to both of two positive stimuli in the original learning was reinforced on one side (L or R), and a response to both of two negative stimuli in the original was reinforced on the other side (R or L). In the different response condition, a response to one of the positive stimuli and one of the negative stimuli in the original learning was reinforced on one side (L or R), and a response to the remaining positive stimulus and the negative stimulus was reinforced on the other side (R or L).

Twelve trials of the successive conditional discrimination training were given each day. A non-correction procedure was used: Subjects were rewarded by two 45-mg pellets for entering into the correct side of the goal boxes, and were retained for 15 seconds without pellet reward in the wrong side of the goal boxes. The order of the presentation of four kinds of stimuli was randomized according to the previously determined sequence. The intertrial interval was from 150 to 180 seconds. The criterion of learning was eleven or more correct choices in twelve daily trials for two consecutive days. A response was recorded as correct when subjects entered into the correct side of the goal box without pushing the swing door of the wrong side, whereas a response was recorded as an error when subjects pushed the wrong side swing door at least once on a trial.

Results and Discussion

Table 1 shows the means and SD's of the number of days to the criterion in the original learning for four groups: non-overtrained same response condition group (NOS), non-overtrained different response condition group (NOD), overtrained same response condition group (OS), and overtrained different response condition

Table 1 Means and SD's of the number of days to reach the criterion in the original learning

Condition of transfer	Original learning			
	Non-overtrained		Overtrained	
	Mean	SD	Mean	SD
Same Resp	22.0	5.8	21.3	4.9
Different Resp	31.8	10.5	20.7	5.1

group (OD). None of the differences among the means was statistically significant $F(3, 16) < 1$, $p > .05$. Therefore the four groups were supposed to be equivalent in terms of performance in the original learning.

In the transfer learning, none of the animals in the non-overtrained groups reached the criterion within 50 training days. In the overtrained condition, however, only two out of six animals of the different response condition failed to reach the learning criterion. The means and SD's of the number errors during 50 transfer learning training days are shown in Table 2. The error response data were transformed into square

Table 2 Means and SD's of the number of errors during 50 training days in the transfer learning

Condition of transfer	Original learning			
	Non-overtrained		Overtrained	
	Mean	SD	Mean	SD
Same Resp	291.8	8.1	48.3	38.8
			(47.0)	(42.4)
Different Resp	300.3	3.7	228.8	49.1

Note. Mean and SD of the number of errors of the subjects which reached the new criterion are shown in parentheses. See text.

root scores prior to analysis of variance. A two-way ANOVA revealed significant main effects for overtraining $F(1, 16)=56.62$, $p< .01$, and for transfer condition $F(1, 16)=26.23$, $p< .01$, and significant their interaction $F(1, 16)=23.33$, $p< .01$. Specifically, a facilitative effect in the same response condition on the transfer learning was found only when animals were overtrained in the original learning.

If cue associations between two positive stimuli and two negative stimuli were formed during overtraining in the original learning as mentioned by Nakagawa, the running time on all positive stimulus trials should be shorter than those on negative stimulus trials in the original learning. Thus, a new criterion to satisfy just mentioned requirement was applied to the data. Re-analysis showed that all subjects of the non-overtrained condition groups (NOS and NOD) and one subject of the overtrained same response condition group failed to attain the new criterion in the original learning. As for the remaining overtrained subjects, the mean numbers of days to reach the new criterion were 29.4 for the same response condition group and 28.8 for the different response condition group. The mean numbers of days of overtraining that was corrected by the new criterion was 17.6 for the same response condition group and 17.0 for the different response condition group, respectively. There was no difference in the performance between two overtrained groups in the original learning, and the number of overtraining sessions corrected by the new criterion between two overtrained groups. Thus, the mean and SD of the number errors for the overtrained same response condition group in the transfer learning was presented in Table 2 in parentheses excluding a subject which failed to reach the new criterion. Statistical analysis revealed a significant difference $t=5.80$, $df=9$, $p< .001$ between the mean errors of two overtrained groups.

The median speed on the last day before reaching the criterion of the original

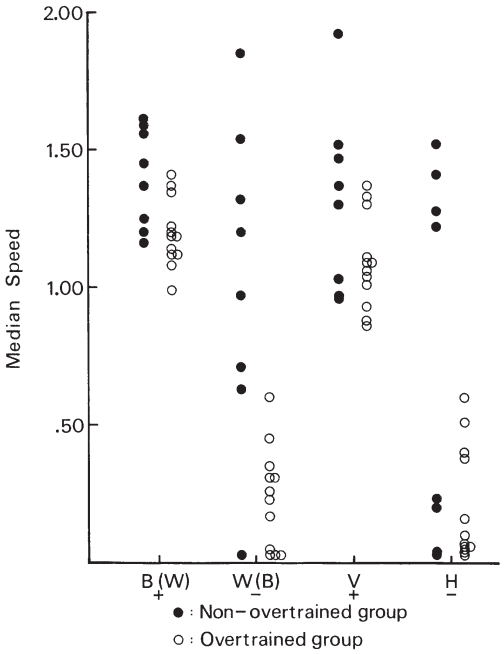

figure 2 The median speed of each animal on the last day before reaching the criterion of the original learning

learning are illustrated for each animal of all groups in Figure 2. It shows that the difference between running speed of all positive stimulus trails and that of all negative stimulus trails of the overtrained groups is greater than that of the non-overtrained groups. Statistical analysis of each subject revealed that the difference between the median speed on positive stimulus trials and that on negative stimulus trials of the overtrained groups was significant χ^2=48.00, df=1, p< .001, whereas that difference of the non-overtrained groups was not significant χ^2=3.14, df=1, p> .05.

Present data demonstrates that the overtraining during the successive go/no-go discrimination learning facilitated response differentiation by a positive reinforcer and a negative reinforcer. It is suggested that some sort of stimulus classification mediated

by above mentioned response differentiation produced the different performance between the same and different condition in the successive conditional discrimination learning.

Summary

In a successive go/no-go discrimination learning, subjects were trained to discriminate among four stimuli (black, white, vertical stripes and horizontal stripes) representing two positive stimuli and two negative stimuli, respectively. After reaching a criterion one of two groups was immediately transferred to successive conditional discrimination learning and the other was transferred to the same situation after receiving additional 25-days overtraining. In the successive conditional discrimination learning, half of subjects of each group were trained to discriminate among four stimuli used in the original learning under 'SAME' condition in which responses to two positive stimuli or two negative stimuli in the original learning were reinforced at the same side, respectively. The other half of subjects were trained to discriminate among the four stimuli under 'DIFFERENT' condition in which responses to one positive and one negative stimulus were reinforced at one side, and responses to remaining stimuli were reinforced at the other side.

In the latter discrimination learning, subjects in 'SAME' condition performed better than 'DIFFERENT' condition subjects only when they had received overtraining during the original learning. The results suggest that some sort of stimulus classification mediated by the response differentiation through overtraining might facilitate the progress of the transfer learning.

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