Stimulus generalization in simultaneous visual discrimination learning by autistic children

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Ten autistic and ten normal children were given a stimulus generalization test following simultaneous visual discrimination learning. The present experiment consisted of two tasks. In the first task, the subjects were instructed to discriminate parallelograms differing in degrees of angular displacement. In the second task, the number of hearts arranged like the spots on a die was manipulated as the discrimination stimuli. There were six generalization testing stimuli used in both tasks. In the first task, no generalization gradient was found in either group, while in the second task, a mild generalization gradient was found in both groups. Unexpectedly, it was revealed that there was no difference in the stimulus generalization gradient between the autistic and the normal group. The important finding was that the autistic children were also capable of generalizing stimuli, if adequate stimuli and an appropriate procedure were used, suggesting that it is possible to enhance training effects for autistic children.

Key words: autistic children, stimulus generalization, simultaneous discrimination, figure stimuli.

Clinical observation has revealed that autistic children have rigid, persistent behaviors, such as stubbornly sticking to the same route or the same store despite the existence of alternatives. This phenomenon is referred to as "insistence on sameness", one of Rutter's (1978) four criteria for identifying autistic children. It may be that unfamiliarity is so disruptive to their learning that autistic children may be confused by even a little environmental change. In experimental situations, this problem is attributable to their undergeneralization or poor stimulus reception. Rimiland (1964) suggests that such behavioral rigidity results in the impairment of the stimulus generalization ability. It is hypothesized here that in the stimulus generalization experiment, autistic children exhibit a steeper generalization gradient than do normal children.

Previous studies of stimulus generalization with autistic children have been conducted only from the view points of therapy and treatment (e.g., Lovaas, Koegel, Simmons, & Long, 1973; Zifferblatt, Burton, Horner, & White 1977; Handleman, 1979). Results of these studies indicate that generalization effects can be obtained from autistic children if training and test environments are similar (Koegel, Egel, & Williams, 1980) and that it is necessary to teach them new responses in various situations and to alter their daily environments so as to make them experience the appropriate contingencies (Margolies, 1977). However, there is little research on stimulus control by autistic children in the stimulus generalization paradigm.

The purpose of the present experiment was to examine stimulus generalization following simultaneous discrimination learning and to demonstrate stimulus control by autistic children. There were two tasks used with the first requiring subjects to discriminate two parallelograms differing in angular degrees and the other to discriminate die-look dot arrangements differing in dot numbers.

Method

Subjects

Subjects were ten autistic and ten normal children. There were two girls in the autistic group and seven girls in the
normal groups. The autistic children were drawn from the clinic of Osaka Prefectural Institute of Public Health. They were diagnosed as autistic by child-psychiatrists utilizing the Rutter's criteria (1978). These autistic children attended a special class for emotionally disturbed children at a public school. The language development of all the autistic subjects had been delayed. They had demonstrated echolalia and had not communicatory language, though they were able to utter two- or three-word sentences. The autistic group had a mean CA of 11 years, 9 months (range, 8: 8-14: 6), a mean DA (Developmental Age) of 5 years, 7 months (range, 4: 1-7: 5) and a mean DQ of 48.2 (range, 40-59). The New-K-Infant Developmental Test\textsuperscript{1} was used as a measure of the DA and the DQ. The normal control group, consisting of normal nursery school children, had a mean CA of 6 years, 1 month (range, 5: 7-6: 5), a mean DA of 5 years, 10 months (range, 5: 5-6: 5) and a mean DQ of 96.5 (range, 89-104).

**Apparatus**

The discrimination learning apparatus for this experiment was devised by the author. The apparatus consisted of three panels (12 cm×14 cm) and magnetic stimulus materials which were to be placed on the panels. The three panels were turned 180 degrees by the experimenter after every trial. As this experiment utilized a two-choice simultaneous discrimination procedure, two panels were used. When subjects pushed a correct panel, lamps lined up on the panels lit up and the subjects received a chocobit from the plate placed under the apparatus.

**Stimulus Materials**

The present experiment consisted of two tasks. The discrimination stimuli of the first task (TA 1) included six parallelograms differing in degrees of angular displacement (130°, 110°, 90°, 80°, 60°, 45°). Each shape had an area of 25 sq. cm (e.g., 5×5 cm in a square). A square (90°) served as the S+ and a parallelogram with the angle of 45° as the S−. These stimuli were magnetic materials colored light-blue. The second task (TA 2) was to discriminate the number of red hearts pasted on a white magnetic panel. There were six different stimuli with 1, 2, 3, 4, 5 or 6 red hearts arranged like the spots on a die. One and six hearts served as the S+ and the S− respectively, and the others were used as generalization stimuli.

**Procedure**

Subjects were initially trained to push a panel by hand. When they could not properly push the panel to operate the switch, they were guided by the experimenter. The subject were instructed to chose and push either panel even when they could not figure out the correct panel. If their choice was incorrect, neither the light signal nor the chocobit reward was delivered. As soon as the subjects made a correct response, the experimenter turned the panels to present the stimuli of the next trial. A non-correction procedure was used so that no errors were corrected. The correct stimulus was placed either on the right or left panel according to a Gellermann's series and with no more than three consecutive rewards placed on the same side. Discrimination learning was administered to the criterion of ten consecutive correct responses. If, given 50 trials, the subjects failed to meet the criterion, the task was terminated. Upon their attainment of the criterion, generalization testing was given. As simultaneous discrimination procedure was used in this experiment, two stimuli were presented simultaneously in the generalization test as well (Sutherland, Mackintosh, & Mackintosh, 1963). Five pairs of test stimuli which

\textsuperscript{1} This test was composed of one part of Gesell's developmental diagnosis and another part of Binet intelligence scale, which was performed at the Kyoto Guidance Clinic in 1962 and was modified in 1980 and 1983.
consisted of stimuli adjacent to each other on the degrees of angular displacement (i.e., 130°–110°, 110°–90°, 90°–80°, 80°–60°, 60°–45°) were used in this generalization test. Thirty generalization test trials included five original trials (the pair of the S+ and the S−), and 25 generalization stimulus trials that five pairs of test stimuli were presented five times each. The five original trials were intermingled with the 25 generalization stimulus trials. While the generalization trials were not reinforced, the original trials continued to be reinforced. In TA 2, six hearts were used as the S+ and one heart as the S− and vice versa. The generalization test procedure was the same as that in TA 1.

Results

For TA 1, the mean number of trials to criterion was 23.2 in the autistic group and 14.9 in the normal control group, respectively. The difference between the two groups was found to be nonsignificant. Two autistic children needed 50 trials to reach the criterion, whereas in the normal group, the number of maximum trials to the criterion was 26. For TA 2, the difference between the groups in the mean number of trials to the criterion (14.2 for the autistic and 11.7 for the normal group) was also nonsignificant. One autistic subject was excluded from the experiment in TA 2 because of her failing to meet the criterion within 50 trials. Therefore, the data of the autistic group in TA 2 were from the remaining nine subjects. The differences in the mean number of trials to the criterion between TA 1 and TA 2 were nonsignificant for both the autistic and normal groups. Unlike the normal group, however, the autistic group showed a tendency that learning of TA 1 was slower than that of TA 2. (But, there was no statistically significant difference between the two tasks.) Then, there is no need to consider the original learning rate with regard to results of generalization because of no statistical difference of original learning trials between the two groups.

Figure 1 shows mean percent of correct responses to each stimulus during the generalization test for the autistic and the normal control group. The results of an analysis of variance of Groups-by-Test Stimuli indicated that the main effect of stimuli was significant in both tasks: $F(5, 90)=13.60, p<.005$, for TA 1, and $F(5, 85)=23.57, p<.005$, for TA 2. This statistical calculation utilized an arcsine
transformation. The results of the simple-
main-effect analysis applied to the differ-
ence between one stimulus and the next
revealed that for TA 1, the difference of
the S+ and the parallelogram with 110°
or 80° was significant in both groups,
whereas the differences among the other
stimuli (excluding S+) were all nonsigni-
ficant. Only the difference between the
S+ and the other stimuli was evident,
that is, no generalization gradient was
found in TA 1. As in TA 1, the two
groups showed similar generalization in
TA 2. However, the generalization pro-
file in TA 2 was different from that found
in TA 1. Namely, there were significant
differences between the S+ and each of
the 2, 3, and 4 spot stimuli and between
these three stimuli and each of the 5 and
6 spot stimuli. In other words, a mild
generalization gradient was found in TA 2.

Discussion

The results of the present experiment
revealed that the performance of the au-
tistic children did not differ from that of
the normal children in a generalization
testing of the present kind. In TA 2, not
only the normal but the autistic children
showed a mild generalization gradient,
which is in discordance with the expecta-
tion of a steep generalization gradient by
autistic children.

In order to discuss these results, the
author refers to the study by Fein, Tinder
and Waterhouse (1979) done on a similar
line to the present experiment. They re-
ported that autistic children showed over-
generalization in the complex stimulus
setting using figures, whereas in the sim-
ple setting using lines differing in angular
degrees, their performance was essentially
identical to that of normal children. The
present finding of no significant difference
between the autistic and the normal group
with respect to stimulus generalization is
consistent with the results of Fein et al.’s
case using simple line stimuli.

However, there are some differences be-
tween the present study and that of Fein
et al. Firstly, in contrast to the successive
procedure used in the study of Fein et al.,
the simultaneous discrimination procedure
which has shown to result in better per-
formance than the successive procedure
(North & Jeeves, 1956) used in the present
study. Secondly, the main difference can
be seen in terms of the types of stimuli
utilized in the two studies. It can be ex-
pected that the type of stimulus places an
important influence upon results. The
study of Fein et al., using simple stimuli
(i.e., line orientation), showed no sign of
the generalization gradient. In contrast to
the results of Fein et al., the present study
showed a mild generalization gradient in
TA 2, though no generalization was found
in TA 1. In fact, the S+ was a square
(90°) and the S− was a parallelogram
(45°) in TA 1. This is actually the dis-
crimination between a vertical or horizon-
tal line and an oblique one. Bryant (1969)
found that discrimination between straight
and oblique lines was easier than that be-
tween different oblique lines. Since the
S+ (i.e., a square) in TA 1 is quite dis-
criminable from other parallelograms, no
generalization may be expected to occur
in stimulus testing. It may be postulated
that the more the discriminability is, the
less the level of stimulus generalization.

TA 2 was, however, the discrimination
task for the number of spots arranged like
the spots on a die. Recognition of the
number of spots required the utilization
not only of spatial visual cues but also of
the concept of number. The difference be-
tween the S+ (1 or 6 hearts) and other
testing stimuli was not so prominent as
that of the S+ (a square) and other stim-
uli in TA 1. Therefore, unlike TA 1, a
generalization gradient, though small, was
shown in TA 2. Fein et al. (1979) con-
cluded that autistic children tended to
overgeneralization complex cartoon fig-
ures. As they suggested, this effect seems
to depend on stimulus properties and does
not represent a general response tendency of autistic children. The fact that autistic children responded only to the headless-figure stimulus at a low rate and overgeneralized other figure stimuli may be taken to mean that the head or face stimulus was processed as a special stimulus by autistic children. For example, Langdell (1978) suggested that the ability to recognize peers’ faces under the masked condition was different between autistic and normal children. Namely, older autistic children were superior to normal children in the recognition of inverted faces. Thus, the finding of Fein et al. is attributable to autistic children’s characteristic face recognition which seems to depend only on face stimuli with no processing of other parts of the figure. The overgeneralization exhibited by the autistic subjects of Fein et al. allows an alternative explanation which suggests that the overgeneralization is due to delayed development. Landau (1968) found that younger subjects exhibited a flatter generalization gradient than did adult subjects. In Fein et al.’s study, there was a large difference in mental age between the autistic and the normal group, since the two groups were matched only on the mean CA. This shortcoming in the study of Fein et al. confused the interpretation of the results in that it remained unclear as to whether overgeneralization by autistic group was due to one of autistic characteristics or simply delayed development.

In conclusion, special stimuli like cartoon figures seems to be inadequate to examine the stimulus generalization tendency by autistic subjects. The present experiment showed that autistic children were able to perform stimulus generalization, following discrimination learning, if adequate stimuli were used. In short, in TA 1, a generalization gradient may be found if any parallelogram except a square was served as the S+. The present experiment, however, reported an important fact that the ability of generalization between the autistic and the normal group was not different. The prediction of poor stimulus generalization by autistic children was not supported and the ability of generalization was demonstrated by means of selection of stimulus type and simultaneous discrimination training procedure.

References


Sutherland, N. S., Mackintosh, N. J., & Mackintosh, J. 1963 Simultaneous discrimination
training of octopus and transfer of discrimination along a continuum. *Journal of Comparative and Physiological Psychology*, 56, 150-156.


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