Positive-stimulus information is not "positive" for indirect transfer: Influence of successive informed-reversal training on oddity learning in Japanese monkeys¹

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Three groups of male Japanese monkeys were given two block discrimination training in WGTA. Two groups of subjects were trained in modified successive reversals. Before each reversal, one group (Group PSI, $n=3$) was presented with positive stimulus for the next reversal and the response to it was rewarded. Another group (Group NSI, $n=4$) was informed of negative stimulus by being exposed to unbaited new negative stimulus. The reversals were repeated for 30 and 20 times for the first and the second blocks of training, respectively. Still another group (Group OT, $n=4$) was given two blocks of overtraining trials. Before, in the middle of, and after the two blocks of training, the subjects of all three groups were faced with a series of oddity task probes. Group NSI manifested significantly better performance on the first trials of the oddity problems ($ps<.01$) than the other groups which were not different from each other. Oddity performance of three subjects in Group NSI was significantly different from chance level ($ps<.05$). NSI reversals proved to improve oddity learning. The implications of the results were discussed with reference to the hypothesis theory and the attention theory of learning-set formation.

Key words: learning-set theories, successive reversal training, successive informed-reversals, strategy learning, attention learning, Japanese monkeys.

Successive informed-reversal training is a modified form of standard successive reversals (e.g., Schusterman, 1964). Modification consists of the addition of an informing trial or trials to the standard training. In the positive-stimulus informing (PSI) variation of the informed-reversal training (IRT), a subject is exposed to the positive stimulus of the next reversal (the negative stimulus of the prior discrimination) and the response to it is rewarded. In the negative-stimulus informing (NSI) variation of the IRT, a

subject is faced with the negative stimulus of the coming reversal (the prior positive stimulus), and the response to it is not rewarded. Usual two-stimulus training trials of standard successive reversals follow the information trial or trials. The procedure of presenting the new positive or the new negative stimulus before the start of the next training was originally devised by H. F. Harlow. He (e.g., Harlow & Hicks, 1957) attempted to test uni-process and duoprocess theories of learning by introducing the procedure to object-discrimination learning-set (LS) paradigm. And, Motoyoshi (1962), addressing to the same problem, applied it to the discrimination-reversal LS training. In successive IRT this informing procedure was introduced to every phase of *repeated* reversals.

The PSI as well as NSI trials had the effect to improve reversal choice on early trials of each reversal (Komaki, 1977). Furthermore, these information trials

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caused more important effects: The two varieties of the successive IRT produced different effects on strategy learning. Komaki (1977) gave two groups of Japanese monkeys three training blocks of either 20 PSI or 20 NSI reversals, and tested, at three different stages of training, the development of their "object win-stay, lose-shift" strategy by introducing series of two-trial task probes. They manifested different rates of strategy learning, Group NSI being significantly superior to Group PSI. When compared with other groups treated in the same way (Komaki, 1974), the strategy performance of the NSI group was comparable to that of a standard successive reversal training (SRT) group, implying that the successive NSI reversals produce the same effects of positive transfer as the standard SRT. On the contrary, the test performance of the PSI group was significantly inferior to that of the standard SRT group and was at the same poor level as an overtraining group which seemed to have profited no strategy learning from the preceding training. The addition of the PSI trials, though facilitating reversal performance, removed the positive effects which standard SRT could normally achieve on monkey's "object win-stay, lose-shift" behavior. After being presented to the informing trials, both the PSI and the NSI group learned every reversal to a same criterion. Therefore, the two groups must have been provided with the same opportunities to learn the strategy. However, their strategy performance was different. It suggests that the two varieties of the IRT have something to do with some process other than strategy learning. Komaki (1977, 1984) presented an idea that an attentional process caused and maintained by nonrewarding might have produced the difference.

The present study was designed to test the generality of the difference in the transfer effects of the two types of the IRT in the transfer paradigm in which there occurs a shift of the valid strategy or hy-

pothesis (Levine, 1959, 1965) from training to transfer learning. More specifically, two groups of Japanese monkeys were trained either on the PSI or the NSI reversals, and then shifted to oddity problems. In oddity problems the quality as well as the position of correct stimulus is altered randomly from trial to trial. Thus, when transferred to oddity problems, subjects have to learn to choose in a different way from reversal problems in which a single stimulus is uniformly correct in every problem. To reiterate in terms of the hypothesis theory by Levine (1959, 1965), subjects learn the "object win-stay, lose-shift" hypothesis during SRT. In oddity problems, however, the subjects have to learn different hypothesis. When applying his hypothesis theory to oddity learning analysis, Levine (1965, p. 119) listed "preference for the odd object" as a different hypothesis from the "object win-stay, lose-shift" hypothesis. The PSI and the NSI trials are considered to be nothing other than the occasions to provide to the subjects the "object win-stay" and "object lose-shift" strategy, respectively. Consequently, if the same difference in transfer would also appear in the present transfer paradigm, it would be treated as the evidence indicating that the process responsible for the different transfer effects is not task specific in nature and supporting the position which asserts that some *general* factor other than strategy learning needs to be assumed to account for the differential effects of transfer.

On conceptual grounds we can assume, as the Levine's analysis implies, that the IRT and oddity learning are different. However, there are no empirical studies to suspect the nature of the transfer between them. Harlow (1986, p. 41) mentioned the negative transfer from object-discrimination LS training to oddity learning. And, Shaffer (1967) found that multiple several-trial oddity training reduced object-discrimination responses in transfer learning and also that object-discrimination LS training inversely increased errors

in oddity learning. These studies suggest the existence of interference between object-discrimination and oddity learning. Because IRT is a special kind of object-discrimination training, it might interfere with oddity learning. The present study was primarily designed to compare the transfer effects of the PSI with those of the NSI reversals. However, since it seems important to assess their absolute effects of transfer to oddity learning, a third group of monkeys was added as a control (Ricciardi & Treichler, 1970) which would be provided with overtraining trials comparable in number to the training trials given to the PSI and the NSI reversal groups.

Method

Subjects

The present study was conducted in the form of two separate experiments, and two pools of six male Japanese monkeys (*Macaca fuscata*) served as subjects. Their assignment to the groups was not even as will be described later. All the monkeys were wild born and experimentally naive. Two of them were estimated as full adults. And, the remaining 10 were from seven to 14 years old. The amount of ration for each subject was adjusted so as to keep the body weight level at the start of the experiment. Reward for training was a raisin or a small piece of cookie. The monkeys were trained on five or six days a week.

Apparatus

A Wisconsin General Test Apparatus (Komaki, 1974) was used. Essentially, it was composed of two cages. A monkey was introduced into the restraining cage, and faced toward a stimulus object or objects presented on a movable stimulus tray in the opposite stimulus cage. The tray had three food wells on it, each one measuring 12 cm from edge to edge. A fence, an opaque screen and a transparent screen separated the two cages. On the other end

of the stimulus cage was mounted a one-way vision screen through which the experimenter observed the subject. A pair of curtains hung beneath the screen were closed during a trial.

One hundred and twelve pairs of stimuli, each pair being composed of two identical objects, constituted a stimulus-object pool for the oddity learning. They were paired in a quasi-random way to form 96 stimulus sets (double pairs). Other six objects, making-up four pairs of two heterogeneous objects, were discriminanda for original discrimination and informed-discrimination reversals. All the stimuli were three-dimensional wooden objects, differing in color, form and size, as are fully explained elsewhere (Komaki, 1983).

Experimental Design

Until Stage 3, all the monkeys were treated identically (Fig. 1). They were initially given preliminary training (Stage 1), the first training block of oddity learning in which 24 oddity problems were given to the subjects over a four-day period (Stage 2), and then a conventional, two-stimulus simultaneous discrimination problem (Stage 3). After reaching a learning criterion in this original learning, they were trained differentially. Two experimental groups (Groups PSI and NSI) were given an IRT block which were composed of either 30 PSI or 30 NSI reversals of the original discrimination. And, the third group of monkeys (Group OT) was provided with the overtraining of the original learning the length of which were matched to the trials that Groups PSI and NSI needed to complete their respective 30 reversals (Stage 4). The three groups of monkeys were next exposed to the second block of oddity learning which was similar to the first oddity learning block comprised of 24 problems and which lasted three days (Stage 5). Following this stage, they were given another training block of either 20 PSI reversals, 20 NSI reversals or OT trials of comparable number (Stage

6). At the completion of these different types of training, all the monkeys engaged in the same two three-day blocks of oddity learning (Stages 7 and 8).

Procedure

Preliminary training. According to the schedule described by Murofushi (1966-67), progressive stages of training were imposed on the subjects. According to the rate of progress in this training, the six monkeys of the first pool were assigned, in a counter-balanced order, to either Group

PSI or Group NSI to produce two equated groups of three monkeys. The six subjects of the second pool were also divided in the same way but the assignment was not even: Four monkeys were allocated to Group OT, one to Group PSI, and the remaining one to Group NSI. Eventually three groups of four monkeys each were formed.

General training procedure. A trial started when the opaque screen was raised. A few seconds later, when the subject looked forward, the experimenter raised the transparent screen to about 10 cm above the floor. As soon as the subject was rewarded for a correct response or displaced the incorrect stimulus, the screen was lowered. Then the opaque screen was lowered and the trial was terminated. The subjects were ordinarily trained on 48 trials a day. Intertrial interval was kept within a range from 25 to 30 s except specially mentioned.

Oddity learning. Subjects were exposed to four 24-problem blocks of oddity learning. Ordinarily eight oddity problems were given on a day, and all the oddity learning blocks excepting the first block lasted three days. Since daily problems were restricted to four on the initial two days of the first block of oddity learning (Stage 2), the first oddity block lasted four days. In the subsequent analysis, the performance on these two days was pooled and the two-day period was treated as a single session.

The oddity problems were of the type which Moon and Harlow (1955) devised; two-position six-trial oddity problem. Odd stimulus was permitted to appear on the right and left positions but not on the center position. To each problem a set of four stimulus objects (double pairs) was assigned. On every trial of the problem, three stimuli were presented on the tray. Two stimuli were identical pairs and the third was one member of the other pair, and the odd stimulus served as the positive stimulus on the trial. The position and the quality of the odd stimulus were varied

STAGES

Fig. 1. Diagrammatic representation of the successive stages of training given to Groups PSI, NSI and OT.

according to the predetermined sequences. Intertrial interval was kept from 30 to 60 s.

Moon and Harlow (1955) derived 32 three-trial sequences from all combination of changes in the position and quality of the odd object over the three trials. Out of the 32 sequences, four different sets of 24 sequences were selected, ordered randomly, and applied to the four oddity learning blocks.

Original discrimination. One of the four heterogeneous stimulus pairs was assigned to one subject of each group as discriminanda, and the nonpreferred member of the pair was the correct stimulus. The discriminanda were presented over the two side food wells, and the site was altered between left and right according to the predetermined random sequences. Twenty-four sequences were selected from the table by Fellows (1967) and combined to form six series of 48 trials. These series were repeatedly applied by being rotated every six days. The subjects were trained until the learning criterion of 10 consecutive correct responses was achieved.

Successive informed-reversals. On the day following the original discrimination, the first block of successive informed-reversal training was initiated (Stage 4). The negative stimulus of the original discrimination was now changed to the positive stimulus and the prior positive object to the negative stimulus. The reversal of the cue values of the fixed stimulus pair was introduced at each new reversal and repeated 30 times in the first block, and 20 times in the second block, of the training.

Every reversal of the informed training was composed of two phases; the presentation of three information trials and the usual reversal training. The information trials were different in the PSI and the NSI groups. Subsequent to the criterion attainment in the original or a reversal, the PSI group subjects were informed of the positive stimulus of the next reversal. The stimulus (the negative stimulus of the

prior discrimination) was presented singly over the food well on either the left or the right side on the stimulus tray, and the response to it was rewarded. This information trial was given three times in succession. The NSI group subjects were informed of the new negative stimulus. The prior positive stimulus was singly presented over either of the extreme food wells, and the response to it was not rewarded. This information trial was also given three times successively. The negative stimulus trial was finished at the time limit of 30 s. When a subject did not displace the unbaited stimulus within the limit, the transparent screen was lowered, and the response latency of 30 s was recorded. In the previous experiments (Komaki, 1977, 1984) the stimulus was placed on the center position on the tray so as to cover the center food well. The procedure was modified in the present study in order to prevent the danger that central placement of the stimulus would enhance the error of center-position response (Moon & Harlow, 1955) which was known to be frequent in the early stage of oddity learning.

Reversal training following the information trials was conducted in the usual way. The two stimulus objects were presented on the peripheral positions, and a reward was placed underneath the new positive stimulus. The subjects were trained in this stage of the experiment on 45 to 51 trials a day. When the reversal criterion (10 consecutive correct responses) was attained within the last three trials of daily 48 trials, no information trial was given on the day. Those trials were administered in advance of the daily session on the following day. The location of the paired stimuli and that of single stimulus on the information trials was determined according to the same random sequences utilized in the original discrimination training. Intertrial interval was kept within the same range as in the original training.

Overtraining. The four monkeys of Group

OT, following the original discrimination, engaged in two blocks of overtraining. The first was 960 training-trial block which lasted 20 days. Subsequent to this block, the subjects were tested in the second block of oddity learning (Stage 5). The second block of overtraining was made of 384 trials and distributed over eight days (Stage 6). Following the second overtraining block, the OT group monkeys were shifted to the third and the fourth oddity learning block.

Results

Original Discrimination

One subject assigned to Group PSI from the second subject pool was very slow in the informed-reversal learning and failed to go through the entire course of the experiment within the planned period. As a result, the data of Group PSI were based on the three monkeys drawn from the first subject pool.

Mean number of trials to criterion in the original discrimination of Groups PSI, NSI and OT, including the criterion runs, were 38.7 ($SD=8.4$), 38.3 ($SD=14.3$) and 40.5 ($SD=11.7$), respectively. One way analysis of variance (ANOVA) was applied to them and the obtained F score was far from the level of significance. Means of number of errors by the three groups during the original discrimination were 12.7 ($SD=2.9$), 10.0 ($SD=6.4$) and 12.0 ($SD=6.6$), in the above order. One way ANOVA performed on the errors revealed no significant group differences.

Successive Informed-Reversal Training

Trials to criterion. The PSI group subjects achieved the first and the second IRT blocks in 973.0 and in 372.3 trials, respectively. For Group NSI, it required 910.0 trials to complete the first IRT block and 451.0 trials to do the second IRT block. These mean-trials scores were used as the basis for determining the length of overtraining for Group OT.

Groups PSI and NSI learned the first five reversals of the first IRT block with the means of 53.0 and 62.1 trials, respectively, including the criterion trials. They completed the last five reversals of the second block (10th subblock of five reversals) in 17.7 and 19.1 trials, in the above order. A 2 (Groups) $\times$ 10 (subblocks of 5 reversals) ANOVA conducted on this measure revealed that the reduction of the trials as a function of subblocks of reversals was significant ($F=14.29$; $df=9, 45$; $p<.01$). But, the main effects of Groups and their interactions with subblocks of five reversals (hereafter, simply subblocks) were not significant.

Errors. Means of number of errors in the first subblocks were 19.1 (Group PSI) and 24.7 (Group NSI). The same errors in the last subblocks were 3.0 and 2.8, in the above order. A 2×10 ANOVA applied to the mean errors revealed the main effects of Subblocks to be significant ($F=15.56$; $df=9, 45$; $p<.01$), but neither the main effects of Groups nor their interactions with Subblocks were significant.

Initial consecutive errors. Mean numbers of initial consecutive errors (successive errors made by a subject until the appearance of the first correct response in reversal) in the first subblock of five reversals were 2.0 (Group PSI) and 2.4 (Group NSI), respectively. Although those errors by the groups in the final subblock were nearly equal (.7 and .2, in the above order), the PSI group made more consecutive errors than the NSI group in the intermediate stages of the training. The results of a 2×10 ANOVA for this measure revealed the significant main effects of Groups ($F=8.84$; $df=1, 5$; $p<.05$). As in the previous study (Komaki, 1977), the NSI trials proved to be more influential than the PSI trials in reducing errors on early trials of each reversal. The main effects of Subblocks were also significant ($F=7.2$; $df=9, 45$; $p<.01$), the reduction in the errors from the first to the second subblock being significant ($p<.01$). There

was, however, no further significant reduction in the subsequent subblocks.

Errorless reversals. Guidance caused by the information trials was sometimes great enough to yield errorless reversal. Frequencies of the errorless reversals were pooled for each group and group totals were 2 for Group PSI and 13 for Group NSI.

Performance on information trials. The PSI group monkeys steadily reacted to the exposed stimulus. Their response-time was within the range of .3 to .6 s throughout the IRT. The NSI group subjects were presented with the unbaited negative stimulus of next reversal and were not rewarded even when they reacted to it. However, the monkeys of the present NSI group did not show any impressive reduction in response-time. Their reduction rates in response speed at the terminal stage of IRT were less than 29%.

Overtraining

The OT group subjects rarely made errors during overtraining. After meeting the criterion of 10 consecutive correct responses in the original discrimination, two monkeys of the group achieved errorless performance over the 1344 OT trials. Another subject made one error on the 335th OT trial. Performance by the last monkey of the group was rather elusive: It erred on the 3rd, 8th, 36th and 46th OT trials.

Oddity Learning

Trial 1 correct responses. The number of oddity problems in which the correct response was made on the first trial was the primary measure of oddity learning. Except for the initial two days of the first block of oddity learning, eight problems were given to the subjects on each day. Presented in Table 1 are the numbers of correct Trial 1 responses in eight problems. Performance on the first two days of the first oddity block was pooled which forms the first session of Block 1 of Table

1. Group means of percent correct Trial 1 responses were calculated from Table 1 and plotted in Fig. 2. As seen in the figure, oddity performance by Groups PSI, NSI and OT were comparable in the first oddity block. Differences in oddity performance grew larger gradually as the differential training progressed and the superiority of Group NSI to the two other groups was most apparent in the final oddity block.

Statistical analysis substantiated this observation. Percent correct responses were transformed into arcsins and an ANOVA with unweighted-means solution (Winer, 1971, p. 599) of Groups, Oddity blocks, and Days in block, with the last two factors being repeated-measures, was administered. The main effects of Groups ($F=10.18$; $df=2, 8$; $p<.01$), Oddity blocks ($F=12.31$; $df=3, 24$; $p<.005$), Days in block ($F=8.55$; $df=2, 16$; $p<.005$) and the interactions of Groups $\times$ Oddity blocks ($F=3.63$; $df=6, 24$; $p<.05$) were significant. Pairwise comparisons among the three groups revealed that the NSI group was superior to both the PSI and the OT group ($ps<.01$) whereas the latter two groups were not different. As the significant Groups $\times$ Oddity blocks interactions suggest, however, the differences among the groups were not uniform. An analysis of the simple main effects of Groups at each level of Oddity blocks revealed that there were no reliable group differences at the first, second and third oddity block. The superiority of the NSI group to the PSI and the OT groups reached the significant level at the fourth oddity block. Tests of the simple main effects of Oddity blocks at each level of Groups also detected the growth of the difference among the groups. At the PSI and OT groups the simple main effects of Oddity blocks were not significant. These two groups did not make any detectable progress as far as the Trial 1 correct response measures were concerned. Only the NSI group improved in oddity learning. The simple

Table 1
Trial 1 correct responses by individual subjects of the three groups
in each session of the four oddity learning blocks

Oddity blocks		Block 1			Block 2			Block 3			Block 4		
Sessions in blocks		1	2	3	1	2	3	1	2	3	1	2	3
PSI	S1 ^{a)}	1	4	4	4	4	4	4	4	4	4	4	4
	S2	4	3	2	3	4	5	5	5	6	4	4	3
	S3	2	4	3	2	4	5	6	3	4	0	4	6
NSI	S4	3	3	4	4	4	3	5	5	6	5	6	7
	S5	2	5	3	6	6	3	3	4	6	5	6	7
	S6	1	2	3	4	4	6	6	5	4	6	4	5
OT	Sa ^{a)}	1	5	3	4	7	5	4	5	5	7	4	8
	Sb	3	3	5	3	4	4	4	4	4	4	4	4
	Sc	2	4	4	4	5	4	4	4	4	4	4	4
	Sd	3	5	3	4	3	4	3	2	5	5	4	4
	Se	1	4	3	3	5	3	5	3	3	7	5	7

^{a)} S1 to S6 were the subjects from the first pool of subjects and Sa to Se were those from the second pool.

main effects of Oddity blocks at the NSI group were significant ($F=14.88$; $df=3, 24$; $p<.01$). As in the previous studies, the PSI and the NSI reversals differentially affected the subsequent new discriminations. The appearances of the differential transfer were by no means direct: The PSI and NSI reversals affected the rates of oddity learning in different ways.

Fig. 2. Percent correct Trial 1 responses in each session of the four oddity learning blocks. The three groups were exposed to the first oddity block before the first block of their training, to the second oddity block in the middle of, and the third and fourth oddity blocks, after the completion of their training.

As seen in Table 1, no subjects of Group PSI made more than seven correct Trial 1 responses in the oddity learning. One subject (S3) of this group made complete avoidance of an odd stimulus (or complete preference for an even stimulus) in the first session of the fourth oddity block. However, the trend was not consistent. Its choice returned to the chance level on the next day. On the other hand, three subjects of Group NSI and one subject of Group OT made more than seven correct responses in the last session of the oddity learning. (One NSI group subject achieved perfect oddity performance in it.) In an attempt to judge the absolute level of oddity behavior, a criterion of oddity learning was derived. Although the subjects were presented with three stimulus objects displayed on three different positions of the stimulus tray on every oddity trial, they rarely made responses to the center-position in the third and the fourth oddity blocks: They tended to choose only either one of the objects presented on the two side positions. In view of the trend, the chance level for deriving the criterion was set at 50%. When the 50% assump-

tion was adopted, binomial expansion (Edwards, 1973, p. 23) proved that more than seven correct responses out of possible eight Trial 1 responses were significantly different from chance ($p < .05$). As can be seen in Table 1, three subjects of the NSI and one of the OT group satisfied this criterion in the last block of oddity learning.

Trial 2 to 6 correct responses. Mean correct responses on the second to the sixth trials of oddity problems in each session of the training were transformed into arcsins and subjected to Groups $\times$ Oddity blocks $\times$ Days in block repeated-measures ANOVA of the same design as in the previous Trial 1 performance analysis. The main effects of Groups were significant ($F = 6.79$; $df = 2, 8$; $p < .05$). The main effects of Oddity blocks ($F = 46.08$; $df = 3, 24$; $p < .01$) and their interactions with Groups ($F = 2.52$; $df = 6, 24$; $p < .05$) were also significant. Other main effects and interactions did not reach the level of significance. Group NSI was superior to Group PSI ($p < .05$) and to Group OT ($p < .01$), and the latter two groups were not different. Tests of the significant interactions by means of simple main effects analysis and pairwise comparisons revealed that the differences among groups were not uniform. The superiority of the NSI group to the other two groups reached significance only in the late stages of oddity learning (the third and the fourth oddity blocks).

As a further check of the significant Groups $\times$ Oddity blocks interactions, tests of simple main effects of Oddity blocks were conducted for each group. Unlike Trial 1 correct-response analysis, the simple main effects were significant not only in Group NSI but also in Groups PSI and OT. These results are important in that they provide the evidence for the success of oddity learning by Group PSI as well as Group OT. These two groups were by no means unable to learn oddity. They were simply slower than, and inferior to, Group NSI in learning oddity.

Errors. Center-position response was frequent in the first oddity block. There were fairly great individual differences in this error, but they decreased rapidly. A two-way ANOVA was applied to the errors, and only the main effects of Groups ($F = 5.21$; $df = 2, 8$; $p < .05$) and Oddity blocks ($F = 466.55$; $df = 3, 24$; $p < .01$) were significant. Pairwise group comparisons were made, and the OT group was less than the NSI group in this error. However, the status of this difference is ambiguous because there were no reliable differences between the OT and the PSI groups and between the PSI and the NSI groups.

Moon and Harlow (1955) have developed methods to detect the various errors during oddity learning. In order to analyze error performance by the subjects fully, their methods were applied. Only the main results will be described briefly.

Position preference was one of the dominant errors in all the groups. However, parametric analyses of them revealed that release from this preference was different among the groups. Only the NSI group displayed significant error reduction with the advance of the oddity learning ($p < .01$).

Rewarded-position perseveration was different among the groups. Group NSI was significantly less in this error than Group PSI ($p < .05$) and Group OT ($p < .01$), and only Group NSI showed significant reduction in this error due to the oddity learning ($p < .01$). *Rewarded-object perseveration*, *unrewarded-object perseveration*, and *object shift errors* were detected in all the groups. These errors decreased significantly along the oddity blocks, but there were no reliable group differences.

Discussion

As in the previous experiments (Komaki, 1977, 1984), the two variations of the successive IRT had different influences on new learning. The differential transfer favoring the NSI group developed grad-

ually also in the present study. The slow growth of the difference is not surprising in view of the fact that, in the present transfer paradigm, there was no basis for the direct transfer to occur. The subjects were presented with *new* sets of discriminanda in the transfer learning which must be unable to mediate any specific learning effect from the preceding training.

The analysis of the absolute performance of oddity learning also revealed group differences. The 75% of the NSI group monkeys met the Trial 1 performance criterion of oddity learning. On the contrary, none of the PSI group monkeys satisfied it. In view of this fact, one might argue that the PSI group subjects, for some unknown reason, did not learn oddity at all and that the performance difference observed between the groups in the final block of oddity learning was simply a reflection, not of the differential transfer, but of the failure of the learning by the PSI group. In favor of this possibility, Group PSI did not manifest any appreciable improvement in terms of Trial 1 oddity performance. However, the PSI group actually learned oddity. Analysis of the Trials 2 to 6 oddity performance detected the significant improvement of oddity learning in the group. Oddity learning by the PSI group presumably proceeded in too slow a rate to be reflected in the Trial 1 measures of oddity learning.

Unlike Group PSI, Group NSI was superior to Group OT in oddity performance. Previous studies (Riccialdi & Treichler, 1970; Komaki, 1974) revealed that overtraining given to monkeys did not have any appreciable effects on the growth of subsequent learning. Therefore, if there is no other problem, we can treat Group OT as the control group to evaluate the influences of the NSI and the PSI reversals on oddity learning and conclude that the NSI reversals improved the oddity learning. However, the present OT group has a defect. As mentioned, the four mon-

keys of Group OT came from the different subject pool. Although all the subjects were equated in that they were adult and experimentally naive, there are no firm grounds to assert the equivalence of subjects among the three groups.

Fortunately, there are several sources of evidence for believing that we can treat the present OT group as a reference group. First, the OT group manifested performance comparable to the other two groups in the first block of oddity learning. Second, the learning rate of the original discrimination by the OT group was nearly equal to those of the other two groups. These results imply the homogeneity of the groups. The only difference detected between this group and the other two groups was of the marginal difference in the propensity for center-position responses. Although the status of the difference is not clear, the OT group was less than the NSI group in this error. It should be noted at this point that Group OT was suspected to be *superior* to Group NSI. If the OT group monkeys were superior to the NSI group monkeys in their learning abilities, it would have raised the OT group's rate of oddity learning and must have reduced the observable difference between the OT and the NSI group in the oddity learning. Despite the possible danger of this underestimation, the NSI group was actually superior to the OT group in the oddity learning. Therefore, even if the OT group monkeys should be more excellent in their learning abilities than the monkeys of the other groups, it is by no means the hindrance to the belief that the influences of the NSI reversals were facilitative in nature and produced the effects of accelerating the growth of oddity learning.

As noted, the NSI group was superior to the PSI group in oddity learning. This finding is free from the problem of inequality of the subject assignment, because the superiority of the NSI group was also found when only the first pool samples were compared. The data of the first sub-

ject pool were extracted and separately analysed by an ANOVA. Group NSI proved to be significantly superior to Group PSI ($F=10.04$; $df=1, 4$; $p<.05$). Thus, we are now in the position to believe that the NSI reversals facilitated oddity learning and that the two varieties of the IRT are different in their transfer effects on new learning.

As described in the introduction, the IRT and oddity learning are considered to be different from each other. The hypothesis theory of Levine (1959, 1965) has characterized LS formation as the selective learning of the "valid" hypothesis and attributed LS transfer to the generalization of the acquired hypothesis to new learning situation. That is, Levine's hypothesis theory predicts the occurrence of positive transfer (facilitation) only on the transfer condition where the same hypothesis is valid in both the training and the transfer. To put it in another way, his theory would predict a lack of positive transfer when valid hypothesis be shifted to a different one in a transfer learning. The PSI and the NSI group subjects of the present study were presented solely with the fixed *pair* of training stimuli during their training. A pair of objects contains neither "odd" nor "even" object. Thus, the PSI and the NSI group subjects, though trained to learn "object win-stay, lose-shift" hypothesis, had no opportunity to learn any hypothesis involving odd or even stimulus. Therefore, if we apply the Levine's hypothesis theory to the present transfer paradigm, and as far as the theory asserts that the hypothesis learning is the only kind of learning, it would be predicted that the PSI and the NSI groups would not be different from each other in oddity learning. As described, this was not the case.

The present author (Komaki, 1977, 1984) has presented an idea of an attention theory of the indirect transfer focusing on the function of nonrewarding during reversals. He begins with the basic as-

sumption that disconfirmation of reward expectancy occurring in every phase of successive reversals would cause the effect of making monkeys cautious and attentive. When monkeys reach a learning criterion in a reversal phase, they have learned the cue values of the discriminative stimuli and have come to expect the positive stimulus to bring about the reward. When the new reversal phase is started, the reward expectancy is disconfirmed every time they make reversal errors and suffer nonreward. If the monkeys are well-motivated to the task, the nonrewarding would not only control hasty response but also provoke various attentional responses such as multiple looking or quick comparisons of the stimuli. When these attentional responses are emitted repeatedly, they would be integrated and a behavior pattern of cautious response would develop. It generalizes to a new learning situation and, by permitting careful observation of new discriminanda, would facilitate a subsequent learning.

The NSI trials, by virtue of the nonrewarding they provide, would contribute to the attention learning in the same way as the reversal errors themselves. On some NSI trials monkeys were found to refuse to displace the unbaited stimulus and stayed without responding for 30 s. The response suppression in the presence of the object signalling nonreward might also improve the learning of careful behavior. This was the reason why the NSI groups in the previous studies (Komaki, 1977, 1984) displayed, in the two-trial strategy probes, excellent discriminative behavior comparable to the standard SRT group. The PSI trials, on the contrary, would produce the adverse effects on the attention learning. The PSI trial always provides reward for the subjects. The indiscriminate provision of reward on the trial might rather induce hasty responses, and, more seriously, would extinguish the attentional responses which have been learned on the basis of the natural errors on the

preceding reversal training trials. In essence, the PSI reversals did not provide any opportunities for the attention learning to occur. Thus, the PSI groups of the previous experiments were inferior to the SRT group as well as to the NSI groups in the two-trial strategy probes (Komaki, 1977, 1983, 1984).

One might argue that these explanations are just a *post hoc* interpretations of the results obtained. The present author admits that at present his assumptions are not supported by any direct evidence. However, the assumption that the two variations of the IRT would produce different transfer effects on the subsequent oddity learning was predicted on the basis of his idea of attention learning, and confirmed by the present study. He believes that the present results are consistent with his assumptions and are encouraging for further studies.

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