Effectiveness of different verbal reinforcement combinations on a discrimination-reversal problem in children*

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Sixty 4- and 6-year-old Ss were given a discrimination reversal task employing a right-blank (Rb), wrong-blank (Wb), or right-wrong (RW) verbal reinforcement condition. The discrimination problem performance in the Wb and RW conditions was similar and superior to performance in the Rb condition. The reversal problem indicated that in the Wb condition older Ss reversed faster than did younger Ss and that younger Ss reversed faster in the RW condition than in the Wb condition. These results, in conjunction with percentage analyses of the acquisition and reversal data, were discussed with reference to Spence's information hypothesis.

Several experiments involving adult Ss (e.g., Buss, Braden, Orgel, & Buss, 1956; Buchwald, 1959a, b, 1962; Spence, 1964, 1966a; Spence & Lair, 1965; Spence, Lair, & Goodstein, 1963) have compared the effects of different verbal reinforcement combinations (VRC) on performance in a variety of conceptual and discrimination problems. Three response-contingent conditions have been employed in procedures using verbal reinforcement combinations. These conditions consist of E's informing S of (1) correct responses (right-blank, or Rb), (2) incorrect responses (wrong-blank, or Wb), or (3) both correct and incorrect responses (right-wrong, or RW). The results of these studies have demonstrated that, when Ss are not given prior explanation of the reinforcement procedure, the Rb condition produces performance inferior to that in either the Wb or RW condition, with Ss in the latter two conditions being similar in performance. While early hypotheses (e.g., Buss & Buss, 1956; Buchwald, 1959a) have stressed motivational interpretations, an information hypothesis has been suggested more recently to account for the performance differences in the VRC conditions (e.g., Spence, 1964, 1966a).

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Spence (1964) proposed that an informational discrepancy existed between the Wb and Rb conditions, with Ss extracting more information from blank in the Wb condition than from blank in the Rb condition. In addition, the performance equivalence of the Wb and RW conditions is attributed to the tendency of Ss to use blank in the Wb condition as effectively as an overt reinforcer (i.e., right), once the information value of blank has been obtained. Subsequent investigations (Spence, 1966a, b; Spence & Segner, 1967) have indicated more specifically that Ss have a tendency to regard blank as meaning right. This tendency can explain the performance equivalence exhibited in the Wb and RW conditions. Similarly, initial conflict between the tendency to regard blank as meaning right and the requirement in the Rb condition to regard blank as meaning wrong can account for the inferior performance of Ss in the Rb condition. In accordance with these assumptions, Spence (e.g., 1964, 1966a) has demonstrated that blank in the Wb condition is equally as effective in producing a correct response on the subsequent trial as is right in the Rb and RW conditions, and that blank in the Rb condition produces more incorrect responses on the subsequent trial than does wrong in either the Wb or RW condition. Furthermore, these performance differences are minimized when Ss are informed of the reinforcement contingencies.

The general finding of significantly inferior performance of the Ss in the Rb condition and equivalent performance of Ss in the Wb and RW conditions has been obtained with children in a card-sorting task (Curry, 1960), in an object discrimination task with more than one irrelevant dimension (Meyer & Offenbach, 1962), and in a verbal discrimination task

(Spence, 1966b). Consistent with the information hypothesis, it has been shown that, when instructions include statements about the information value of the overt reinforcers and blank, normal elementary school Ss' performance in a two-alternative verbal discrimination task is equivalent, regardless of the VRC condition (Spence, 1966b; Spence & Segner, 1967). However, Sugimura (1966), in a two-alternative figure discrimination problem, found that preschool Ss in the Rb condition performed significantly better than did Ss in either the Wb or RW condition, with no significant difference in the latter two conditions.

Other studies have been concerned primarily with the relative effectiveness of VRC conditions at different age levels. Meyer & Seidman (1960) reported that in an object discrimination task preschool Ss (4-5 years old) showed superior performance in the RW condition, while elementary school Ss (8-9 years old) performed best in the Wb condition. These results are based only on inspection of the performance curves, since the multiple comparison tests did not yield significant differences among the VRC conditions. This interaction was not obtained in a replication study. Using only the Wb and RW conditions, Ss at both age levels showed equivalent performance (Meyer & Seidman, 1961, Experiment I). In contrast, Matsuda & Matsuda (1966) found that in a figure discrimination problem kindergarten Ss performed best in the Wb condition, whereas third-grade Ss were superior in the Rb condition.

The present investigation was concerned with the effectiveness of VRC on performance in a discrimination reversal task. The purpose was to examine the information hypothesis of Spence (e.g., 1966b) by testing 4- and 6-year-old children on a discrimination reversal task where brightness was the only relevant cue and position was the only irrelevant cue present. The reversal problem was given to assess the relative strengths of the VRC conditions in discrimination learning in terms of the number of trials required to reach the reversal criterion. It was predicted that in the acquisition and reversal problems, at both age levels, performance in the Rb condition would be inferior to that in the Wb and RW conditions, with performance in the latter two conditions being similar. On the basis of the information hypothesis (e.g., Spence, 1966b), it was also predicted that, where a correct response on Trial 2 was preceded by a correct response on Trial 1, no differences in performance would be observed among the VRC conditions. However, where a correct response on

Trial 2 was preceded by an incorrect response on Trial 1, performance of Ss in the Wb and RW conditions would be similar to that of each other and superior to that of Ss in the Rb condition. Since the Rb condition is assumed not to convey as much information as the Wb and RW conditions, this differential performance in the VRC conditions would be exhibited in the Trial 2 data for the reversal problem.

SUBJECTS

Sixty preschool children, 26 enrolled in the University of South Dakota Nursery School and 34 attending kindergarten classes at Austin Elementary School in Vermillion, South Dakota, were employed in this study.

APPARATUS

The stimuli consisted of two identical pairs of wooden blocks, 4 x 4 x 1½ in. One block in each pair was painted black, the other white. These stimuli were presented in pairs on an 18 x 22 in. gray turntable. A 13 x 22 in. vertical panel placed in the center of the turntable prevented Ss from observing E preparing the second pair of blocks for the next trial. As measured from their center, the stimuli were separated by 11 in. on the turntable.

DESIGN

Twenty Ss were assigned to each of the three VRC groups (RW, Wb, and Rb). The Ss in each VRC group were divided equally into 4- and 6-year-old subgroups. The 4-year-old Ss ranged in age from 50 to 68 months, with a mean CA of 54 months. The age range for the 6-year-old Ss was from 69 to 82 months, with a mean CA of 76 months. Each VRC-age subgroup consisted of five boys and five girls.

Brightness of the correct stimulus was counterbalanced in each VRC-age subgroup. The spatial position of the correct stimulus was determined randomly using the Gellerman (1933) series.

PROCEDURE

Each S was tested individually in the University of South Dakota mobile Child Development Laboratory. A S was seated before the apparatus and was instructed to choose one of the two blocks that were in front of him by placing his hand on it each time E revolved the turntable. The instructions did not include statements concerning the subsequent verbal reinforcement procedure.

For Ss in the RW condition, E said, "Very good" following a correct response and "No" following an incorrect response. The Ss in the Wb condition were given the negative verbal statement for an incorrect response and no verbal reinforcement for a correct response. The Ss in the Rb condition were given the positive verbal statement for a correct response and no verbal reinforcement for an incorrect

response. All statements were given immediately after S responded and were expressed in a matter-of-fact, neutral tone.

The criterion for both the discrimination acquisition and the subsequent reversal problem was six consecutive correct responses within the 30 trials allotted for each problem. Upon reaching the acquisition criterion, the relevant dimension (i.e., brightness) was reversed without interruption of the trials. The Ss failing to meet the acquisition criterion were not administered the reversal trials and were assigned the maximum score of 30 for the problem.

The intertrial interval was approximately 5 sec. Each S was always praised for his performance before he left the testing room.

RESULTS

An analysis of variance (Winer, 1962) of the total number of trials to acquisition criterion for each S yielded a significant VRC effect ($F = 21.39$, $df = 2/54$, $p < .001$). A Tukey a comparison test (Winer, 1962, p. 87) indicated that the performance of Ss in the Rb condition was significantly inferior to that of Ss in either the Wb or the RW conditions ($p < .05$). The performance of Ss in the Wb and RW conditions did not differ significantly ($p > .05$). The main effect for age and the VRC by Age interaction were not significant ($p > .05$).

A similar analysis of variance was performed on the reversal data, but only for Ss in the Wb and RW conditions, since 14 of the 20 Ss in the Rb condition did not reach the acquisition criterion. Only 2 Ss in the Wb condition failed to meet the acquisition criterion and were included in this analysis. All 20 Ss in the RW condition met the acquisition criterion. A VRC by Age interaction was the only significant effect obtained ($F = 11.08$, $df = 1/36$, $p < .001$). An analysis of variance excluding the two Ss in the Wb condition who did not reach acquisition criterion yielded identical results. A Tukey a comparison test indicated that: (1) for the Wb condition, 6-year-old Ss reversed significantly faster than did 4-year-old Ss ($p < .05$); (2) for 4-year-old Ss, the RW condition produced significantly faster reversal than did the Wb condition ($p < .05$); (3) for the RW condition, 4- and 6-year-old Ss did not differ significantly in their reversal performance ($p > .05$), and (4) for 6-year-old Ss, the Wb and RW conditions did not result in significantly different reversal performance ($p > .05$).

In a further analysis of the data, the percentage of Ss who made correct responses on the first two trials or on only the second trial was determined for each

VRC-age subgroup. A 3 by 2 by 2 analysis of variance (Winer, 1962) with VRC, age, and measures (i.e., correct following correct, correct following incorrect) as between-Ss effects was performed on these percentages for the acquisition data. Significant effects included VRC ($F = 3.28$, $df = 2/108$, $p < .05$), measures ($F = 14.94$, $df = 1/108$, $p < .01$), VRC by Measures ($F = 5.11$, $df = 2/108$, $p < .05$), and the third-order interaction ($F = 4.80$, $df = 2/108$, $p < .05$). Since the third-order interaction was influenced largely by the VRC and measures components, a Tukey a comparison test was applied to the significant VRC by Measures interaction. The results indicated that: (1) for previously correct trials, the VRC conditions did not differ significantly ($p > .05$), and (2) for previously incorrect trials, the Rb condition was significantly inferior to the Wb and RW conditions ($p < .05$), with differences in the Wb and RW conditions being not significant ($p > .05$).

A similar percentage analysis of variance was performed on the reversal data for all Ss in the Wb and RW conditions. The measures effect for this analysis consisted of only the event in which a correct response on Trial 2 was preceded by an incorrect response on Trial 1. None of the Ss in the Wb and RW conditions made two consecutive correct responses on the first two reversal trials. This analysis failed to yield any significant differences for VRC ($F = 1.47$, $df = 1/36$, $p > .05$), age ($F < 1$), and the interaction ($F < 1$).

DISCUSSION

The results of the present investigation with preschool Ss confirm the conclusion based on adult Ss, that discrimination performance of Ss in the Rb condition is inferior to that of Ss in either the Wb or RW condition, with the latter two conditions being similar in performance. This Rb-condition inferiority was evidenced by the observation that 14 of the 20 Ss in this condition failed to reach criterion in a simple two-alternative simultaneous brightness discrimination problem. However, except for the Curry (1960) study and the uninformed VRC group in the Spence (1966b) study, both of which employed normal elementary school Ss, results of the present study are not in agreement with the child findings previously cited. Recall that the VRC conditions in the Meyer & Seidman (1960, 1961) studies did not produce statistical evidence of differential performance in the preschool Ss. The presence of a single irrelevant dimension (i.e., color) for one group in the Meyer & Offenbach (1962) study resulted in equivalent performance in the VRC conditions. The authors

attributed this finding to the limited number of response alternatives, which resulted in equally rapid acquisition in all VRC conditions. In the present study there was only one irrelevant dimension (i.e., position); nevertheless, differential performance among the VRC conditions was obtained. The fact that Matsuda & Matsuda (1966) found performance of preschool Ss best in the Wb condition and Sugimura (1966) found it best in the RW (but not in the Wb) condition may be attributed to the presentation of several different pairs of stimuli within the two-alternative discrimination problem. Perhaps the complexity of the stimulus dimensions and the different experimental arrangements imposed within the limits of the discrimination problems, and not the VRC, were responsible for such divergent findings in the literature.

The percentage analysis of the discrimination data supports Spence's (e.g., 1966b) information hypothesis. Consistent with this position, in the present study it was shown that blank had less effect in producing a correct response for the Ss in the Rb condition than did wrong for the Ss in the Wb and RW conditions. Furthermore, blank had an equivalent effect for Ss in the Wb condition in producing a correct response, as did right for Ss in the Rb and RW conditions. Whether or not this is a result of S's tendency to regard blank as meaning right is difficult to interpret. Due to the age of the Ss, no postexperimental interviews were conducted. However, if Ss in the Rb condition were, in effect, regarding blank as meaning right, a repetition of correct responses should have occurred. If these Ss used a "repetition strategy" (Spence, 1966b), then in the present study this strategy should have been most noticeable in the performance of the 14 Ss who did not reach the acquisition criterion. Instances of three or more consecutive incorrect responses were arbitrarily defined as a "repetition." Examination of the data indicated that only seven Ss exhibited this strategy. A more direct test of whether Ss regard blank as meaning right is required before this crucial assumption of the information hypothesis can be adopted.

In terms of the number of trials to criterion in the reversal problem, the performance of the 4-year-old Ss was better when an overt (RW) rather than a covert (Wb) reinforcer was employed. In

contrast, these overt and covert forms of reinforcement did not differentially affect reversal performance in the 6-year-old Ss. These findings suggest that, while the information value of the covert reinforcer had been acquired by all Ss in the Wb condition during the discrimination problem, 6-year-old Ss were capable of more effectively utilizing the covert information than were the 4-year-old Ss for the completion of the reversal problem. This was evidenced further by the fact that there were no significant age differences in the overt (RW) condition, whereas in the covert (Wb) condition 6-year-old Ss performed significantly better than did the 4-year-old Ss. Future studies should consider the reversal problem as being possibly a more sensitive indicator of the ability of children at various age levels to utilize overt and covert forms of information in the VRC paradigm than only a discrimination problem.

The Trial 2 percentage analysis of the reversal data for the Wb and RW conditions showed no differences in performance for either 4- or 6-year-old Ss. This was not surprising since, in both the Wb and RW conditions, all Ss made an initial incorrect response which was followed by the negative overt reinforcer. The only evidence concerning the tendency of Ss to treat blank as meaning right was obtained by inspection of the data for the six Ss in the Rb condition, who were given the reversal problem. Four of six Ss in this group who made an initial incorrect response and received no overt reinforcement chose the correct stimulus on Trial 2. Again, the reversal problem seemed capable of providing some information, if only indirect, concerning the hypothesis proposed by Spence (e.g., 1966b).

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