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ABSTRACT

A major concern of this report was to compare the effect of three verbal reinforcement combinations (VRCs) on the rate at which children learn a simultaneous two-choice discrimination problem. The experiments were designed to test the following: (1) whether relative effectiveness of the VRCs was dependent upon task complexity or subject age; (2) what were the effects of the VRCs, task complexity, and overtraining on the learning of a discrimination reversal problem in children; (3) what were the relative effects of the delay of the VRCs; and (4) whether the VRCs would differentially affect the retention of a simultaneous discrimination problem. Findings indicate that regardless of sex or age or problem complexity, the VRCs involving the use of the term "wrong" led to rates of learning superior to those produced by use of the "right-nothing" combination. Similar effects were produced for a discrimination reversal problem. Delay of the VRCs seriously interfered with the learning of a simultaneous discrimination problem in children. Further stimulus research is suggested. (Author/CJ)

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TABLE OF CONTENTS

Acknowledgements 1

Summary. 2

Introduction 6

Experiment I 22

Experiment II. 28

Experiment III 32

Experiment IV 35

Experiment V (Supplementary Comparison). 40

Experiment VI 42

Conclusions and Recommendations. 46

References 48

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SUMMARY

This report contains a description of six sets of data concerned with the relative efficacy of various combinations of verbal positive reinforcement and punishment on discrimination learning and retention in children. In the experiments, the children were asked to choose between a black and a white block on each of several trials. For one-half of the subjects (Ss) in each experiment, the black block was designated as correct and the white block as incorrect; while for the remaining Ss, the white block was correct and the black block was incorrect. A major concern was to compare the effectiveness of three verbal reinforcement combinations (VRCs) on the rate at which children learn a simultaneous two-choice discrimination problem. The three VRCs were Right-nothing (Rn), Wrong-nothing (Wn), and Right-Wrong (RW). Under the Rn combination, the experimenter (E) said "Very good" following S's choice of the alternative designated as being correct and remained silent following his choice of the incorrect alternative. Under the Wn combination, the E said "That's wrong" following S's choice of the incorrect alternative and remained silent following his choice of the correct alternative. Under the RW combination, the E said "Very good" following each correct response and "That's wrong" following each incorrect response. In all experiments, the Ss were run to a criterion and then compared in terms of their efficiency in learning the discrimination.

Experiment I was designed to determine whether the relative effectiveness of the VRCs was dependent upon task complexity or the age of the Ss. The Ss were 144 second and sixth grade children. The experiment was a 3 x 2 x 2 x 2 factorial design with three VRCs, two levels of task complexity (1 vs. 2 irrelevant dimensions), two age levels (second vs. sixth grade), and sex. An analysis of variance was performed on the total number of trials to criterion. The significant main effects were VRC ($p<.01$) and task complexity ($p<.01$). There were no significant interactions. Post-hoc tests indicated that the RW and Wn groups were equivalent and that both groups were superior to the Rn group. The simple task was learned more rapidly than was the complex task. Contrary to expectations, there was no evidence of a VRC by complexity or a VRC by age interaction. Regardless

of age or sex of the Ss or the complexity of the task, the Rn combination produced slower learning than did either the nearly equivalent Wn or RW combinations.

Since the results of an earlier study and Exp. I were contradictory the second study was conducted to reexamine the effect of task complexity on the relative efficacy of the VRCs in discrimination learning with children. Ninety-six third- and fourth-grade children served as Ss. The investigation employed a 3 x 2 factorial design with the three VRCs and two levels of task complexity (1 vs. 3 irrelevant dimensions). The analysis of variance on trials to criterion indicated that the only significant main effect was for the VRCs ($p<.01$). Post-hoc tests showed that the Rn group was significantly inferior to either Wn or RW groups. The difference between the Wn and RW combinations was not significant. The VRC by complexity interaction was not significant. The results of this experiment agree with those of Exp. I in that the VRCs had the same relative effects (Rn<Wn=RW) regardless of the complexity of the discrimination problem.

Exp. III was designed to assess the effects of the VRCs, task complexity, and overtraining on the learning of a discrimination reversal problem in children. The Ss in this study were the 96 children of Exp. II who were presented a reversal problem immediately following either criterion training or overtraining. The design for the reversal problem was a 3 x 2 x 2 factorial with three VRCs, two levels of task complexity (1 vs. 3 irrelevant dimensions), and two levels of training (criterion training vs. overtraining). The analysis of variance performed on the number of trials to reversal criterion for the Ss showed that the only significant effect was the main effect for the VRCs ($p<.01$). Subsequent comparison tests indicated the RW and Wn combinations resulted in faster learning of the reversal problem than did the Rn combinations. The Wn and RW combinations were not significantly different. These data showed that the VRCs have similar effects on both original acquisition and the subsequent reversal problem.

The concerns of Exp. IV were to determine the relative effects of the delay of the VRCs and to ascertain if a VRC by age interaction could be obtained when relatively young (kindergarten) children were included as Ss. The Ss were

144 kindergarten- and fourth-grade children. The design was a 3 x 2 x 2 x 2 factorial with the three VRCs, two levels of delay (0 vs. 10 sec.), two levels of age (kindergarten vs. fourth-grade), and sex (boys vs. girls). The analysis of variance yielded significant main effects for the VRCs ($p<.001$) and for delay ($p<.005$). Post-hoc tests indicated that the RW and Wn combinations were equivalent and that Ss in both combinations learned the discrimination more rapidly than did the Ss in the Rn combination. Performance of Ss in the no delay condition was superior to that of Ss in the ten second delay condition, regardless of the VRC group to which they were assigned. As in Exp. I, no evidence was obtained that the VRCs were differentially influenced by the age of the Ss.

This supplementary comparison (Exp. V) was designed to examine the relative efficacy of the VRCs over an extended age range (i.e., kindergarten through sixth grade). The trials to criterion data included in this statistical analysis was that collected for the 36 second and 36 sixth grade children run on the simple task in Exp. I and the 36 kindergarten and 36 fourth grade children included in no delay condition in Exp. IV. This study was a 3 x 4 x 2 factorial design with the three VRCs, four age levels (kindergarten, second, fourth, and sixth grades), and sex. The main effect for VRC was again significant ($p<.001$). The subsequent comparison tests indicated that the combinations involving "wrong" produced equivalent levels of performance and that this level was superior to that produced by the Rn combination. None of the other main effects or interaction effects approached statistical significance. The obtained relative order of VRC effectiveness (Rn<Wn=Rw) was the same as that found in all three previous experiments. The absence of age or sex main effects and a VRC by age interaction was also indicated in Exp. I and IV.

Exp. VI was designed to determine whether the VRCs would differentially effect the retention of a simultaneous discrimination problem. It was also of interest to ascertain if overtraining would facilitate the retention of a discrimination problem. The Ss were 96 kindergarten children. The design of this study was a 3 x 2 x 2 factorial with the three VRCs, two levels of training (criterion training vs. overtraining), and two durations of retention intervals (1 day vs. 7 days). The results of a one way analysis of variance on the acquisition data indicated that the VRC effect was significant ($p<.001$). As was the case in all five previous experiments the follow up tests showed that the Rn combination was inferior to both the nearly equivalent Wn and RW combinations. The multiple factor analysis of variance performed on the retention data indicated no significant main or interaction effects. No evidence was obtained in this experiment to indicate that the retention of a simultaneous discrimination problem varies as a function of VRCs, overtraining, or length of the retention interval.

The following empirical findings were obtained in the present series of experiments. Regardless of the sex or age of the children or of the complexity (i.e., number of irrelevant dimensions) of the simultaneous discrimination problem, the two VRCs involving "Wrong" (i.e., Wn or RW) led to equivalent learning rates and these rates of learning were superior to those produced by the Rn combination (Exp. I, II, IV, V, VI). Another interesting finding was that the VRCs had similar effects on the learning of a discrimination reversal problem (Exp. III). That is, the reversal problem was learned more rapidly under the Wn and RW combinations than under the Rn combination and there was no difference in the rate of learning of the Wn and RW combinations. Another important finding (Exp. IV) was that delay of the VRCs (i.e., delay of R in the Rn combination, delay of W in the Wn combination, and delay of both R and W in the RW combination) seriously interfered with the learning of a simultaneous discrimination problem in children. In view of the consistency of the VRC effects on the learning of simultaneous and reversal discrimination problems, the failure to find VRC effects for the retention of a discrimination was also interesting. Further systematic research is needed to determine whether similar VRC effects can be obtained with different kinds of stimulus materials and with variations in the manner in which the stimulus materials are presented.

INTRODUCTION

The typical verbal reinforcement combination (VRC) paradigm has involved selecting a correct response on some task (e.g., marble dropping, discrimination learning, rote learning) and then applying a stimulus event to each response that a given S makes. If the S is assigned to the Right-nothing (Rn) combination, E makes a positive comment such as "right" or "very good" immediately following a correct response, but does nothing following an incorrect response. If the S is assigned to the Wrong-nothing (Wn) combination, E makes a negative comment such as "no" or "that's wrong" immediately following every incorrect response. However, he does nothing following a correct response. If the S is assigned to the Right-Wrong (RW) combination, E makes a positive comment following a correct response, and makes a negative comment following an incorrect response.

Effects of VRCs on Children's Behavior

Although studies involving adults had been conducted somewhat earlier (e.g., Buss, Weiner, and Buss, 1954), the first studies of the effects of VRCs on children's behavior were conducted in 1960. Sullivan (1964) investigated the effects of VRCs in a two-choice concept elicitation task. The 5-, 7-, 9-, and 11-year-old Ss were given four 25-trial blocks during which they were required to choose the one of two drawings that they "liked best." During Block I, E gave no reinforcement. During Blocks II-IV, Ss were assigned to one of the three conventional VRC groups or to a control group to which E made no response. The dependent variable was the number of correct responses on each block minus the number of correct responses on Block I. The relationship between VRC groups was RW>Wn>Rn; that is, RW was superior to Wn which was in turn superior to Rn.

Curry (1960) required fifth- and sixth-grade children to sort 50 cards on the basis of color, and 100 cards on the basis of the number of figures printed on each card. Analysis of the number of errors made by Ss in each VRC group indicated that, regardless of the task, (RW=Wn)>Rn; that is, RW and Wn were equivalent and superior to Rn. On the color sorting task only, boys made significantly fewer errors than did girls.

Meyer and Seidman (1960) employed four- and five- and eight- and nine- year-old Ss to investigate VRC effects on acquisition and extinction of a two-choice simultaneous concept learning problem. The acquisition problem involved pairs of two-inch high blocks differing in shape and basal surface area. The relevant dimension was basal area. The Ss were given 30 trials unless they first reached a criterion of 9/10 successive correct responses.

The extinction stimuli were 1 inch, .5 inch, and .25 inch in height, but retained the same 2:1 basal-surface area relationship employed on the acquisition series. Five trials were given with stimuli of each of the three heights.

The dependent variable for both acquisition and extinction was the number of correct responses. At the end of 20 trials, all Ss were performing equivalently regardless of the VRC they received. A further analysis carried out only on Trials 1-20 produced a significant effect for trial blocks and a significant Age X VRC and Trial Blocks X Age X VRC interaction. The interaction effects indicated that for the 4- and 5- year-olds the RW combination resulted in better performance than did the Wn or Rn combinations, while for the 8- and 9- year-olds, the Wn combination resulted in better performance than did the RW or Rn conditions.

Significant effects in the extinction data were those for VRC, stimulus size, and their interaction. T-tests on the number of correct responses made over all sets of stimuli indicated that Wn>Rn, while no other comparisons were significant. The significant effects involving stimulus size were interpreted as meaning that the slopes of the generalization curves were not parallel.

Meyer and Seidman (1961) performed two other experiments in an attempt to further investigate the age-related findings of their previous study (Meyer and Seidman, 1960). In Experiment I, the Ss, apparatus, and procedure were similar to those used in the 1960 study, except that only RW and Wn VRCs were employed. Analysis of the number of correct responses in the acquisition series indicated that the two VRCs were equally effective regardless of the developmental level (age) of the Ss. However, analysis of the extinction data indicated that the Wn VRC produced more correct responses during extinction than did the RW VRC. In addition, an interaction of stimulus size and VRC indicated that the slopes of the extinction curves were different. Inspection of the curves indicated that the Wn group tended to improve somewhat in performance while Ss in the RW group declined somewhat in performance.

In Experiment II, the Wn and buzzer-nothing combinations were compared, the study being otherwise a replication of Experiment I. Analysis of the performance during acquisition indicated that the Wn group was superior to the buzzer-nothing group. However, the age effect and its interaction were non-significant. The Wn group also exhibited superior performance during the extinction series. A significant Stimulus Size X VRC interaction was do to the fact that the buzzer-blank Ss declined sharply in performance following the discontinuance of reinforcement.

Meyer and Offenbach (1962) investigated the relationship between VRC and task complexity in determining the performance of third- and fourth-grade children on a two-choice simultaneous discrimination problem. The task involved either one irrelevant dimension, two irrelevant dimensions, or three irrelevant dimensions. The relevant dimension was always position. All Ss learned the problem to a criterion of ten successive correct responses.

The number of trials to criterion did not differ significantly for the two- and three- irrelevant dimension tasks, so data for these two tasks was combined. The analysis of the combined data indicated that the performance of the combined RW-Wn group was superior to that of the Rn group. Disregarding VRC, performance was superior on the task involving one irrelevant dimension as compared to the performance on tasks involving two and three irrelevant dimensions. Further, the interaction between VRC and complexity was also significant. On the simple task, all VRCs were equally effective; however, on the more complex tasks, (RW=Wn)>Rn.

Matsuda and Matsuda (1966) compared the performance of kindergarten, third grade, and retarded Ss on a two-choice simultaneous discrimination task involving pairs of figures. Kindergarten Ss learned best when given the Wn combination while third grade Ss learned best when given the Rn combination.

Sugimura (1966) employed preschool children in a two-alternative rote learning task. The Ss learned two lists, each comprised of four repetitions of four pairs of animal figures. The Ss were instructed to choose the correct animal on each presentation. Eight trials, consisting of four presentations each, were given each S. The VRC effect, the trial blocks effect, and their interaction were all significant for both the number of correct responses and the number of perfect trials. The VRC effect was due to the fact that RW>(Wn=Rn).

Doctor (1969) investigated the role of awareness and the effects of VRCs on verbal conditioning of fifth and sixth grade Ss. The Ss were required to make up a sentence including the verb and one of six pronouns appearing on each of 120 cards. The verbs and the order of the pronouns varied, but the same six pronouns occurred on every card. The first and last 30 trials were, respectively, operant level and extinction periods and no reinforcements were given. The appropriate VRC was delivered following each response on Trials 31-90. The correct response consisted of employing the pronouns "I" and/or "we" in the sentence. Following completion of the task, each S answered six questions designed to determine his awareness of the meaning of the VRCs.

Analysis of the number of correct responses per block of ten trials indicated no differences in operant level between groups. Analysis of the acquisition data indicated that Ss in all groups increased their emission of the correct response. However, VRC, grade, and sex of the S did not affect performance in any detectable manner. When the extinction data was analyzed, no significant effects were found for any of the variables. The Ss continued to use the reinforced pronouns after the reinforcments were no longer delivered.

Further tests were made to compare the performance of Ss who were at least partially aware of the information value of the reinforcement combinations with that of Ss who were not aware of the information value of the combinations. A modified trend analysis of the acquisition data indicated a significant linear increase in correct responses for all Ss over trials; however, the performance curves of aware and unaware Ss departed significantly from one another over trials. The Ss in the aware groups showed an increase in the frequency of reinforced responses while the performance of unaware Ss remained unchanged over trials.

A second trend analysis, on the extinction data, indicated that neither aware nor unaware Ss changed their performance during extinction from that level which had been established by the end of acquisition. Chi-square tests indicated that development of awareness was not associated with any of the independent variables under investigation.

Ahammer and Goulet (1969) investigated the role of intrapair conceptual similarity and VRCs in the discrimination learning and retention of first and second, third and fourth, and fifth and sixth grade children. The task was a two-alternative simultaneous discrimination consisting of twelve pairs of line drawings of familiar objects. Half of the pairs consisted of objects having a high degree of conceptual similarity (e.g., apple-banana) while the remaining pairs were unrelated (e.g., house-rabbit). The Ss were given 20 trials (i.e., 240 presentations) unless they first reached a criterion of two successive perfect trials. Following acquisition, Ss were given eight retention trials after being informed that E would give no further information and that they were to try to remember the correct responses.

Analysis of the number of correct responses during acquisition indicated that RW>Wn>Rn. In addition, dissimilar pairs were learned more rapidly than similar pairs.

Since not all Ss had reached asymptotic performance during acquisition, the retention score was obtained by dividing the number of items S recalled on each trial by the S's mean number of correct responses on the last two acquisition trials. The only significant effect in this data was the effect for similarity of pairs. Retention of similar pairs was inferior to that of dissimilar pairs.

Two studies (Spence & Segner, 1967; Spence & Dunton, 1967) have been conducted which allow for a comparison of the efficacy of verbal vs. nonverbal reinforcement combinations. Spence and Segner (1967) compared the effectiveness of verbal and nonverbal reinforcement combinations (NRCs) in producing learning of a two alternative simultaneous discrimination task. Middle and lower class children in the first through fourth grades were required to learn to choose one of each of eight pairs of line drawings of familiar but unrelated objects. The Ss were given 15 trials on the set of eight pictures (i.e., 120 presentations) unless they first made two successive perfect trials. In addition to the three VRC groups, three VRC groups were employed. The nonverbal reward and punishment were, respectively, presentation of candy and sounding of a 77 db (re, SPL) buzzer for one second. All Ss were informed fully as to the information value of the reinforcement combination in effect for their group, including the meaning of nonreinforcement.

The VRCs produced better performance, as measured by the total number of correct responses, than did the NRCs. In addition, lower-class Ss did not perform as well on the task as did middle-class Ss. A RC X Type of RC interaction was due to the fact that all three VRCs were equally effective, but that the reward-nothing VRC was inferior to the equally effective reward-punishment and punishment-nothing VRCs.

Spence and Dunton (1967) replicated the above study employing nursery school and kindergarten Ss. In addition to the significant main effects for social class and RC, analysis of the total number of correct responses revealed significant Class X RC and Class X Type of RC interactions. Lower-class Ss manifested inferior performance in the reward-nothing condition regardless of whether the combination was verbal or nonverbal. For lower-class Ss reward punishment>punishment-nothing>reward-nothing. For middle-class Ss, (RP=Pn)>Rn, disregarding type of RC. In addition, middle-class Ss performed better when they received VRC than when they received the parallel NRC.

Another variable of interest is the kind of instructions given Ss as to the meaning of the VRCs. Instructions have been manipulated in three studies with children and one with adults.

Spence (1966a) investigated verbal discrimination performance as a function of instructions and VRC in normal and retarded children. The Ss were normal second and third graders and educable retarded children, the latter having a mean CA of 14 years and 3 months, a mean IQ of 62.5, and a mean grade level of 3.0. The verbal discrimination list consisted of eight pairs of familiar words presented on individual cards. The Ss in the informed condition were told the meaning of overt reinforcement as well as of nonreinforcement. The Ss in the uninformed condition were told only that they would learn which was the correct word in each pair as they went along. Sixteen trials (i.e., 128 presentations) were administered unless S first met a criterion of two successive perfect trials.

Data for normal and retarded Ss was analyzed separately. Since no significant differences emerged between the RW and Wn VRCs in the analysis for normal Ss, the data for these groups was combined. An initial analysis of the total number of correct responses indicated that, over both instructional conditions; RW=Wn=Rn. Performance of instructed Ss was superior to that of uninstructed Ss. The above analysis was repeated using only the data from Trials 11-15. The VRC and instructions main effects and their interaction were all significant. Separate analyses of the data from Trials 11-15 for the two instruction groups, with VRC and sex as factors, indicated that the VRCs were equivalently effective for informed Ss, but that (RW=Wn)>Rn for uninformed Ss. The sex effect and the interactions were not significant.

Further analyses were conducted on the percent of correct responses on one trial which continued to be correct on the next trial, and the percent of incorrect responses which continued to be incorrect on the next trial. Inspection of the data indicated that for uninformed Ss, the "blanks" in the Rn combination were less effective than wrong in the RW and Wn groups in producing a switch from incorrect to correct responses. However, the blank in the Wn groups was equally as effective as right in producing repetition of correct responses. For informed Ss, a blank was as effective as the appropriate overt reinforcer regardless of the VRC in which it occurred. The inferior performance of uninformed Rn Ss appears to be due to the large number of Ss in this group who repeated incorrect responses on one trial and on the succeeding trial.

Retarded Ss performed somewhat differently than did normal Ss. Analyses of the number of correct responses indicated no significant effects for VRC, information, or sex, either over all trials or on Trials 11-15 only.

Hamilton (1969a) investigated the role of experimenter nonreaction in determining the effectiveness of Rn and Wn VRCs.

Nursery school Ss were given four three-minute sessions on a two-hole marble dropping task, one session under each of four reinforcement conditions. It appears that in two of the conditions, one involving an Rn combination and one involving a Wn combination, Ss were given 100% reinforcement of correct or incorrect responses, respectively. No information was given as to the meaning of the response outcomes. In the remaining two conditions, one involving a reward-nonresponse combination and the other involving a punishment-nonresponse combination, Ss were reinforced only 50% of the time for correct or incorrect responses, respectively. The Ss in the latter two groups were instructed as to the meaning of the response outcomes, including the fact that nonresponse on the part of the E had no meaning.

The dependent variable was the number of marbles dropped in the correct hole during each session, minus the number of marbles dropped in the incorrect hole during the same session. The only significant effect was the interaction between VRC and information. This interaction was due to the fact that Ss in the Wn-informed group performed at a level superior to that of Wn-uninformed Ss. The Ss in the wrong-nonreaction group who were informed as to the meaning of the response outcomes were the only ones whose performance failed to improve to a level above that expected by chance.

Hamilton (1969b) used the same task in a follow-up study and it appears that the following procedures were employed. Nursery school Ss were assigned to the same four VRC conditions employed in Hamilton (1969a). However for Rn and reward-nonresponse Ss, all correct responses were rewarded. For Wn and punishment-nonresponse Ss, all incorrect responses were punished. The Ss in the informed conditions were told the meaning of "right" or "wrong" and were told that it was a secret whether the other (nonreinforced) hole was right or wrong. The sessions lasted four minutes.

A significant interaction occurred in the analysis of the performance score, due to the fact that performance of Ss in the wrong-nonreaction group was superior to that of Ss in the right-nonreaction group when Ss were informed. The performance of Ss in the Rn and Wn groups was equal when they were informed. When an analysis was performed on the total number of marbles dropped during the four minute period, no significant effects emerged.

In summary, several studies have been conducted which were concerned with the effects of reinforcement combinations on the performance of children in a variety of discrimination learning tasks. Several variables which have been shown to influence the relative efficacy of the reinforcement combinations are task complexity, age, type of reinforcement combination, and instructions. In studies which have used verbal reinforcement combinations in conjunction with incomplete instructions (i.e., no information regarding the meaning of "right", "wrong", and "nothing"), the most common finding is that children learn the discrimination slower under an Rn combination than under either a Wn or an RW combination (Ahammer & Goulet, 1969; Curry, 1960; Spence, 1966a; Sullivan, 1964). However, these findings are not universal. Doctor (1969) found no difference in the effectiveness of the VRCs and Sugimura, (1966) found that the Rn combination was as effective as the Wn combination. There is also evidence that under these conditions, the relative effectiveness of the VRCs varies as a function of task complexity (Meyer & Offenbach, 1962) and age (Matsuda & Matsuda, 1966; Meyer & Seidman, 1960).

Other studies (Hamilton, 1969a,b; Spence, 1966a; Spence & Segner, 1967) indicate that the kind of instructions given is an important variable. Spence (1966a) and Spence & Segner (1967) have shown that complete instructions (i.e., Ss are told the meaning of "right", "wrong", and "nothing"), results in equivalent performance for the three VRCs. However, this finding is not unanimous. Spence (1966a) found that type of instructions did not affect the performance of retarded Ss under the three VRCs. Further, Spence (1966b) with adult Ss found that performance under the Rn combination remained inferior to performance under the Wn combination even when complete instructions were given. Two studies with children have also been concerned with the type of reinforcement combination. Spence & Segner (1967) showed that verbal RCs produced performance superior to that produced by nonverbal or material RCs. In addition, Spence & Dunton (1967) found that the effectiveness of various types of reinforcement combinations is dependent upon the socio-economic class of the children involved. That is, VRCs were superior to NRCs for middle-class children; whereas, there was no difference in performance between the VRCs and NRCs for lower-class children.

Effects of VRCs on Adults' Behavior

While studies of VRCs involving children have been primarily empirical in nature, studies of the behavior of adults when exposed to the VRCs have included a number of hypotheses as to what may be the mechanisms behind their varying effectiveness. These hypotheses will be noted below in connection with the studies through which they were developed.

In an early study of VRCs, Buss, Weiner, and Buss (1954) investigated the effect of VRCs on stimulus generalization in patients. For the acquisition task, Ss were shown a series of eight single blocks of varying colors and areas. All blocks had a height of two inches, and a correct response consisted of responding "Vec" rather than "Not Vec" on this basis. The generalization series consisted of 11 presentations each of 2 inch, 1 inch, .5 inch, and .25 inch high blocks. Responses during the generalization series were not reinforced. Analysis of the dependent variable, frequency of "Vec" responses during the extinction series, produced significant effects for VRC (RW>Wn: RW=Rn, Wn=Rn), and height of the stimulus. In addition, the slopes of the generalization gradients differed significantly depending on the VRC involved.

Neuropsychiatric patients were utilized in a study by Buss, Braden, Orgel, and Buss (1956) of the relative strength of right and wrong as reinforcers. The Ss were given 15 trials on a two-alternative task in which they were to choose one of a pair of two inch high blocks. Two irrelevant dimensions were present. The relevant dimension was height. A correct response consisted of the S's responding "Vec" rather than "Not Vec" to each block. The extinction-generalization task involved ten presentations each of 2 inch, 1 inch, .5inch, and .25 inch high blocks.

Analysis of the number of correct responses during acquisition yelded no significant VRC main effect; however, the slopes of the acquisition curves did differ significantly. Analysis of the extinction-generalization data indicated that the VRC groups differed significantly in their overall frequency of correct responses (visual inspection indicated that RW=Wn>Rn). Further, the number of responses to stimuli of the various heights differed, and the slopes of the generalization gradients were not significantly different. No significant effects emerged when the number of correct responses during extinction was computed in two blocks of five trials for the stimuli of each height.

In Experiment II, the acquisition series was extended to 60 trials. The only other differences between Experiments I and II were that the latter involved no extinction series and that the RW VRC was not included. Analysis of the number of correct responses over six blocks of ten trials each indicated that Wn>Rn and that the slopes of the curves for the two groups were significantly different.

A third experiment was performed to extend the extinction data for Ss receiving RW and Wn VRCs. The Ss were given 15 acquisition trials and 30 extinction trials, all with two inch high stimuli. Analysis of the acquisition data indicated no significant VRC or VRC by Trials effects. When the extinction data was analyzed, no significant differences emerged as a function of trials or VRC. However, the slopes of the RW and Wn curves were different.

On the basis of this data, the authors suggested that the disparate performance of Ss receiving different VRCs is due to right being a weaker positive reinforcer than wrong is a negative reinforcer. Nothing is assumed to be a non-reinforcement.

Ferguson and Buss (1959) reported an extension of the above study by Buss, Braden, Orgel, and Buss (1956). The two studies were similar except that Ferguson and Buss employed college students as Ss rather than psychiatric patients. In addition, the extinction series was expanded to 100 trials and a group was added which received 100 counter-conditioning trials.

A difference score (percent of correct responses on the last ten trials minus the percent of correct responses on the first five trials) was employed as the dependent variable for the acquisition series because there was an initial difference in response level for the three VRC groups. T-tests on the significant VRC effect indicated that (RW=Wn)>Rn. No drop in the level of responding occurred during extinction. Analysis of the counterconditioning data indicated that the Rn group did not countercondition as well as the RW and Wn groups did.

Buss and Buss (1956) employed neuropsychiatric patients on the Wisconsin Card Sorting Test, in which Ss were required to sort 64 cards on the basis of shape, color, or number of figures on each card. The Ss first learned, to a criterion of ten successive correct responses, to sort the cards on the basis of shape, then on the basis of color. A maximum of 100 trials was given if the S did not learn to criterion.

The data for the learning of the shape concept was not analyzed because of the large number of Ss who did not receive both components of their VRC. For the color concept, a chi-square test indicated that the VRC groups differed significantly in the number of Ss failing to learn the concept (RW - 2; Wn - 5; Rn - 14). Evaluation of the number of trials to criterion indicated that (RW=Wn)>Rn.

In Experiment II, the authors employed student murses as well as patients and utilized only RW and Wn VRCs. An additional difference between Experiments I and II was that the tasks for Experiment II were sorting according to number and color. Both patients and nurses in the RW and Wn groups learned the number concept at the same rate and shifted to the color concept in approximately the same number of trials. The authors noted, however, that 15 patients were discarded from the study because they failed to learn the first task. No nurses were discarded.

Buchwald (1959a) hypothesized that "nothing" or "blank" becomes a negative reinforcer during the course of acquisition under Rn trials, but becomes a positive reinforcer during the course of acquisition under Wn trials. He suggests, however, that blank acquires a greater absolute reinforcement value in the Wn combination than it does in the Rn combination, or that it acquires its value more rapidly in the former. On this basis, he predicted that extinction would occur more rapidly following acquisition under Rn than under RW or Wn. College undergraduates performed a pseudocoding task in which they were required to select one member of a pair of nonsense syllables presented jointly with a three digit number. The Ss were told that the correct response dependent on the number, but the number was actually irrelevant. The Ss were given 144 acquisition trials and 72 extinction trials.

On acquisition, the three VRC groups differed significantly in the last trial on which an incorrect response occurred, but the difference in the number of incorrect responses did not quite reach significance for both dependent variables, RW>Rn, while RW=Wn and Wn=Rn.

In a replication of this experiment, the only significant effects were the between-replications effect for the number of incorrect responses and the VRC effect for the last trial on which an incorrect response occurred. The latter finding indicated that RW>Wn>Rn.

Chi-square tests on the number of Ss who made at least one incorrect response during extinction indicated that the three VRC groups differed significantly on that measure. The Ss in the Rn group were most likely to make an incorrect response. Further Chi-square tests on groups equated for degree of acquisition of the correct response indicated that extinction differences were not due to differences in initial level of learning.

Buchwald (1959b) exposed college students to all three VRCs in a single series of trials in order to test the hypothesis that blank acquires reinforcement value over trials. If blank remains neutral in value, Ss ought to perform equivalently under multiple and single VRCs. However, if blank acquires reinforcement value, performance under Rn and Wn should be inferior in the multiple combination situation as compared with the single combination situation. In addition, performance differences under Rn as compared to Wn should be lessened in the multiple combination situation.

Except for the use of multiple combinations, the task and procedure were similar to that employed by Buchwald (1959a). An additional difference was that Ss received 216 acquisition trials and no extinction trials.

Analysis of one dependent variable, the number of incorrect responses, indicated that RW>(Wn=Rn); while analysis of a second dependent variable, the last trial on which an incorrect response occurred, indicated that RW>Rn>Wn. When the number of trials intervening between the next-to-last and last incorrect responses was evaluated, it was found that the difference was larger for the Wn condition than it was for the Rn or RW conditions.

Spence, Lair, and Goldstein (1963) employed psychiatric patients, non-psychiatric patients, and college students in two verbal discrimination tasks in which they were required to learn and call out the correct number on each of a series of coordinated pairs. Groups were a Rn group, a Wn group, and an information group which was shown the correct word after each choice. The VRC groups were fully informed as to the meaning of all reinforcement contingencies. Patient groups and students all performed best in the condition in which they were shown the correct response. There was no difference in performance between Ss in the two verbal reinforcement groups.

Spence (1964a) found that male medical patients performed a two-alternative verbal discrimination task signficantly better under Wn and Rn VRCs than they did under an Rn VRC.

Spence (1964b) investigated performance on a four-alternative task under different VRCs. The Ss were male patients at a VA hospital; they were given either 10 or 15 trials on a verbal discrimination task under either an Rn or a Wn VRC. The meaning of all VRCs, including the blanks, was explained to each S.

When the total number of correct responses for the 10- and 15- trial groups was analyzed separately, no significant differences emerged between the Rn and Wn groups. When data for the 10- and 15- trial groups was combined, performance of the Rn group was superior to that of the Wn group for Trials 1-10. A successive percentage analysis was also applied to the data. The analysis indicated that the same percent of incorrect responses was repeated following the blank in the Rn combination as was repeated following the wrong in the Wn combination. The blank in the Wn combination was less effective in producing repetition of correct responses than was the right in the Rn combination.

Spence and Lair (1965) administered a two-alternative verbal discrimination task similar to that used by Spence, Lair, and Goldstein (1963) to male schizophrenics. For the combined data for open-and closed-ward Ss, and for the data for open ward Ss only, (RW=Wn)>Rn. However, when the data for closed ward Ss was analyzed, it was found that RW>Wn>Rn. Further, a trend analysis of the number of correct responses made by Ss in the Rn group indicated that their performance did not diverge from that expected by chance. In contrast, open ward Ss in the Rn group improved over trials.

Spence (1966b) investigated the performance of male medical and surgical patients on a sentence construction task in which Ss chose one of four personal pronouns to combine with a simple past-tense verb on each of several trials. The Ss in one condition were informed as to the meaning of both overt reinforcers and the E's failure to respond. The Ss in a second condition were told only that they would learn which kind of sentence to make as the task progressed. In a third condition, "good" and "not so good" were used as reinforcers instead of "right" and "wrong" and this group was considered to be a verbal conditioning group rather than a problem-solving group. The Ss in this group were given no information as to the meaning of the response outcomes. The dependent variable was the number of correct responses on the last 20 trials. For all three instruction groups, Wn>Rn. The RW combination produced better performance than did the Wn combination in the verbal conditioning group, but produced slightly poorer performance in the two problem-solving groups, a fact reflected in a significant interaction between instructions and VRC.

On the basis of above mentioned studies (e.g., Spence, 1964a; Spence, 1966a; 1966b), Spence suggests that the difference in performance between Ss receiving the various VRCs is due to the different amounts of information that Ss are able to extract from "blank" or "nothing" in the Rn and Wn conditions. The Ss are assumed to have a tendency to regard blank as meaning "right" in both the Rn and the Wn combinations. In the Wn combination, this assumption is consonant with the demands of the situation. However, when Ss in the Rn condition assume that blank means "right," they are [illegible] to make incorrect responses. This explanation is similar to one advanced by Levine, Leitenberg, and Richter (1964), who suggest that in a nonoutcome problem (i.e., a blank trial), the S behaves as though the E were saying "right." However, Levine, et. al. limited the applicability of their theorem to the first two trials of a discrimination learning problem.

Lovelace (1966) employed college students in a study of the relative knowledge of correct and incorrect items as a function of the VRC employed during original learning. The Ss learned a 12-pair word list to a criterion of one errorless trial (i.e., 12 responses). Two new lists were then drawn up. One list was composed of new words paired with the previously correct word from each pair and the other list was composed of new words paired with the previously incorrect words from each pair. The Ss were given four trials (i.e., 48 presentations) after being informed that words retained their original status, correct or incorrect, but that they were paired with new words. No VRCs were administered during this phase.

As measured by the mean number of trials to criterion, no differences were found between VRCs during acquisition. On the transfer lists, Ss performed better on the list containing the originally incorrect words. The VRC and trials main effects were not significant. Performance on the lists diverged across trials; with performance improving slightly on the correct list and deteriorating on the incorrect list.

As was the case in studies with children, Rn is inferior to one or both of the other VRCs under many circumstances when acquisition measures are employed (Buchwald, 1959a, 1959b; Buss, Braden, Orgel, & Buss, 1956, Exp. I; Buss & Buss, 1956, Exp. I; Ferguson & Buss, 1959; Spence, 1964a; Spence & Lair, 1965). One investigator has found all three VRCs to be equivalent in effectiveness (Lovelace, 1966) and others have found Rn to be equivalent in effectiveness to Wn (Buchwald, 1959a, 1959b; Spence, Lair, & Goldstein, 1963). Only two studies (Buchwald, 1959b; Spence, 1964b) have indicated that Rn is superior to Wn.

The relationship between RW and Wn is less clear. Some have found the two to be equivalent (Buss, Braden, Orgel, & Buss, 1956, Exp. III; Buss & Buss, 1956, Exp. I, II; Ferguson & Buss, 1959; Spence, 1964a; Spence and Lair, 1965). Others have found RW to be superior to Wn (Buchwald, 1959b, Exp.I; Spence and Lair, 1965).

Some of the variables which appear to be important in determining the effectiveness of VRCs with adults are the number of trials given (Spence, 1964b), experience with more than one VRC at a time (Buchwald, 1959b), instructions (Spence, Lair, & Goldstein, 1963; Spence, 1966b) number of response alternatives (Spence, 1964b), and psychiatric status of Ss (Spence & Lair, 1965).

EXPERIMENT I

VERBAL REINFORCEMENT COMBINATIONS, TASK COMPLEXITY, AGE AND SEX IN CHILDREN'S DISCRIMINATION LEARNING

Several studies with children have been concerned with the relative effectiveness of various combinations of verbal positive reinforcement and punishment on performance in a variety of discrimination tasks. In the typical experiment, S is required to choose between two or more alternatives on each of several trials. In the Rn condition, the S receives a positive verbal reinforcer (i.e., "right") immediately following his choice of the alternative designated as being correct and receives E's silence (i.e., nothing) following his choice of the incorrect alternative. In the Wn condition, S is given a verbal punishment (i.e., "wrong") contingent upon his choice of the incorrect alternative and receives E's silence (i.e., nothing) following his choice of the correct alternative. In the RW condition, S is presented a positive verbal reinforcer (i.e., "right") for a correct response and a punishing stimulus (i.e., "wrong") for an incorrect response. In order to be consistent with previous literature, the words verbal reinforcement combinations (VRCs) will be adopted to refer to these reinforcement and punishment conditions. Typically, the Ss in all three conditions are run to some acquisition criterion and then compared in terms of their efficiency in learning and discrimination.

The relative effectiveness of the three VRCs in discrimination learning with children has been shown to vary as a function of a number of variables. Previous research (Meyer & Offenbach, 1962) has demonstrated that task complexity interacts with the VRCs. In this study, task complexity was defined in terms of the number of irrelevant dimensions and no differences in rate of learning was found among the VRCs for a simple task (1 irrelevant dimension). However, for the more complex tasks (2 and 3 irrelevant dimensions) Ss in the RW and Wn conditions learned faster than those in the Rn condition. A concern of the present investigation was to determine whether there is an interaction between task complexity and verbal reinforcement conditions.

There is also evidence that chronological age influences the relative efficiency of the VRCs. Meyer and Seidman (1960) obtained a significant age by VRCs interaction in an object discrimination task. Inspection of the data indicated that for preschool Ss (4-5 years), the RW group performed better than the Wn or Rn groups while for older Ss (8-9 years) the Wn condition resulted in better performance than did the RW or Rn conditions. In a study which involved Japanese children a figure discrimination problem, Matsuda and Matsuda (1966) found that kindergarten Ss performed better in the Wn than in the RW or Rn conditions, whereas, third-grade Ss performed better in the Rn than in the RW or Wn conditions. In contrast to the findings of these studies, Ahammer & Goulet (1969) and Meyer & Seidman (1961, Exp. I) have failed to find that the effectiveness of the VRCs is a function of the age of the children involved. Hence, another concern of this study was to investigate the influence of chronological age on the relative effectiveness of the VRCs in children's discrimination learning.

Method

Subjects

The Ss were 144 second and sixth grade children attending Jolley or Austin Schools in Vermillion, South Dakota.

Apparatus

The stimuli were 11/2-in. thick wooden blocks. Four of the stimuli were circles with a diameter of 3 inches and four other stimuli were squares whose dimensions were 25/8 x 2 5/8 inches. Thus, the surface areas of the circles and squares were nearly equivalent. Two circles and two squares were painted white and the remaining two circles and two squares were painted black. The stimuli were presented in pairs on a 18 x 22 in. gray turntable. A 13 x 22 in. vertical panel bisected the turntable and prevented S from observing E's placement of the blocks for the next trial. The turntable and panel were mounted on a lazy susan bearing so that either side could be turned to face the S. On each trial, the pair of blocks were centered on the turntable and the distance between their inner edges was five in.

Procedure

The design employed was a 3 x 2 x 2 x 2 factorial involving VRCs, complexity, age and sex. One-third of the Ss were randomly assigned to each of the three VRC groups. One-half of the Ss in each VRC group were given a simple simultaneous discrimination problem involving one irrelevant dimension while the remaining Ss learned a complex simultaneous discrimination problem with two irrelevant dimensions. One-half of the Ss in the above mentioned subgroups were second graders and one-half were sixth graders. Within each of the VRC-complexity-age subgroups, half of the Ss were male and half were female.

The Ss were individually escorted to a mobile laboratory located a few yards from their school. Each S was seated opposite E and was instructed to choose one of the two blocks in front of him, by placing his hand on it, each time E revolved the turntable. Statements concerning the VRCs were not included in the instructions.

For Ss assigned to the Rn condition, E said "Very good" following a correct choice, and said nothing following an incorrect choice. For Ss assigned to the Wn condition, E said "That's wrong" following an incorrect choice and said nothing following a correct choice. For Ss assigned to the RW condition, E said "Very good" following a correct choice and "That's wrong" following an incorrect choice. All verbal statements were administered by E in a normal conversational tone of voice immediately after S responded.

At the first level of task complexity which involved the simple problem with one irrelevant dimension, only one pair of stimuli were used across trials for each S. Shape was constant across trials with half of the Ss being required to discriminate between a black and white circle and the remaining Ss between a black and white square. Brightness was the relevant dimension. Black was the correct stimulus for half of the Ss and white was the correct stimulus for the remaining Ss. Position (left or right) was the irrelevant dimension. Position of the correct stimulus on any trial was determined by a Gellermann series (Gellermann, 1933), and was the same for all Ss. The second level of task complexity involved a more complex problem with two irrelevant dimensions. All four pairs of stimuli were used for each S.

Brightness was again the relevant dimension with black being the correct stimulus for half of the Ss. Both position and shape of the correct stimulus varied across trials and were irrelevant to the learning of the discrimination. The position of the correct stimulus on each trial was the same as those at the simple complexity level. Shape of the correct stimulus was randomly determined for each trial with the restriction that the four combinations of brightness, position and shape appeared equally often over the 100 trial sequence. This sequence was employed for all Ss in the complex task.

At the younger age level second-grade children were used. At the older age level, sixth-grade children were employed. The remaining factor in the design was sex of the S and half of the children were boys and the remain Ss were girls.

Each S was given trials on the simultaneous discrimination problem to a criterion of eight successive correct responses or for a maximum of 100 trials. The interval between trials was about five sec. The E sat behind the apparatus, positioned the blocks, administered the verbal statements, and recorded S's response on each trial. At the end of the session, each S was praised for his performance and returned to his classroom.

Results

Mean trials to criterion for the verbal reinforcement, age, and task complexity factors are presented in Table 1. A four-factor analysis which involved VRC, complexity, age and sex was conducted on the trials to criterion data. A significant main effect was obtained for reinforcement combinations ($F = 21.75$, $df = 2,120$, $p<.001$). Multiple comparisons (Newman-Keuls) indicated that both the RW and Wn combinations were significantly different from the Rn combination ($p<.05$) and that there was no difference between the RW and Wn combinations. The Ss in the RW and Wn conditions learned the discrimination faster than did those in the Rn condition. Further, there was no difference in performance for Ss in the RW and Wn conditions. The main effect for task complexity ($F = 5.58$, $df = 1, 120$, $p.<.05$) was also statistically significant. The simple task was learned more rapidly than was the complex task. The main effects for age ($F<1$) and sex ($F<1$) were not significant.

Table I

Mean Trials to Criterion for each Verbal Reinforcement Combination as a Function of Task Complexity, and Age

Complexity level	Age	Reinforcement Combinations			
		RW	Wn	Rn	Mean
Simple					22.0
	2nd grade	14.2	18.0	41.6	
	6th grade	11.4	19.5	27.3	
Complex					30.4
	2nd grade	15.5	16.7	57.1	
	6th grade	20.0	29.2	43.9	
	Mean	15.3	20.9	42.5	

None of the interactions was significant at the .05 level of confidence. The reinforcement by complexity interaction did not approach significance ($F = 1.16$, $df = 2, 120$), whereas, the reinforcement by age interaction did approach significance ($F = 2.99$, $df = 2, 120$, $p < .10$). Under the RW condition, performance was nearly equivalent for both age groups. In contrast to this pattern of results, performance of the 2nd grade Ss was superior to that of the 6th grade Ss under the Wn condition, however, the 6th grade Ss performed better under the Rn condition than did the 2nd grade Ss.

Discussion

The major findings of the present study were that children in the Rn condition learned the discrimination slower than did those in either the RW or Wn conditions and that the rate of learning did not differ between the latter two conditions. The finding that the Rn condition, as contrasted with the RW and Wn conditions, results in slower acquisition for Ss who are uninformed about the reinforcement combinations is in agreement with several other child studies (Ahammer & Goulet, 1969; Curry, 1960; Meyer & Seidman, 1960; Spence, 1966a) on this topic. The finding of no difference in rate of learning for Ss in the RW and Wn conditions has also been obtained previously (Curry, 1960; Meyer & Seidman, 1961, Exp. I; Spence, 1966a). However, other investigators (Ahammer & Goulet, 1969; Sigimura, 1966) have obtained results which indicate that the RW condition results in faster acquisition than does the Wn condition.

Another finding of interest was that the simple task was learned more rapidly than the complex task, regardless of the age or sex of the children or the VRC to which they were assigned. There was no evidence of a VRC by task complexity interaction in the present study. This finding is in disagreement with the results of an earlier study (Meyer & Offenbach, 1962). The present study and the previous investigation (Meyer & Offenbach, 1962) are comparable except that their complex task consisted of discrimination problems which involved two or three irrelevant dimensions.

The rate of discrimination learning did not vary as a function of age, nor was there an interaction between VRC and age. The failure to find the age main effect is consistent with the results of previous studies (Ahammer & Goulet, 1969; Meyer & Seidman, 1960; 1961, Exp. I). The failure to find the age by VRC interaction was somewhat unexpected since evidence suggesting an interaction had been obtained in previous studies (Matsuda & Matsuda, 1966; Meyer & Seidman, 1960). One possibility is that the interaction involving age and VRC might have been obtained had the younger children been younger (i.e., 4-6 yrs.).

EXPERIMENT II

VERBAL REINFORCEMENT COMBINATIONS AND TASK COMPLEXITY IN CHILDREN'S DISCRIMINATION LEARNING

A previous study (Meyer & Offenbach, 1962) indicated that the effectiveness of the VRCs with children varied as a function of the complexity of the discrimination task. Specifically, these investigators found that there was no difference in rate of learning among the VRCs for a simple discrimination problem involving one irrelevant dimension. However, for more complex problems involving two or three irrelevant dimensions Ss in both the Wn and Rn conditions learned faster than did those in the Rn condition. In contrast, results of Exp. I showed no evidence of a VRC by task complexity interaction. The Ss in the Rn condition exhibited inferior performance to those in the Wn and RW conditions regardless of whether they were assigned a simple or complex problem. Since the results of these two experiments are contradictory, the present study was conducted to reexamine the effect of task complexity on the relative efficacy of the VRCs in discrimination learning with children.

Method

Subjects

The Ss were 96 third and fourth grade children attending Austin or Jolley Schools in Vermillion, South Dakota.

Apparatus

The stimuli were wooden blocks, 1 1/2 in. thick, differing in form (circle vs. square), brightness (black vs. white), and size. Two pairs of the four pairs of rectangular blocks were 4 x 4 in. and the other two pairs were 2 1/2 x 2 1/2 in., one block of each pair differed in brightness. Two pairs of the four pairs of circles were 4 1/2 in. in diameter and the other two pairs were 3 in. in diameter, one circle of each pair differed in brightness. These stimuli were presented in pairs on a 18 x 22 in. turntable painted gray. A 13 x 22 in. vertical gray 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 centers, the stimuli were separated by 11 in. on the turntable.

Procedure

The experiment was a 3 x 2 x 2 factorial design with three VRCs (Rn vs. Wn vs. Rw), levels of training (criterion training vs. overtraining), and two levels of task complexity (1 vs. 3 irrelevant dimensions). Thirty-two Ss were randomly assigned to each of three VRC groups. Within each of the VRC groups, one-half of the Ss were administered a simple task (1 irrelevant dimension) and the remaining Ss were given a complex task (3 irrelevant dimensions). Within each of the VRC-complexity subgroups, one-half of the Ss were trained to a criterion while the remaining one-half of the Ss were trained to the same criterion and given 30 additional training trials. Sex of the S was counterbalanced for each VRC-complexity-level of training subgroup.

Each S was individually escorted to a mobile laboratory located a short distance from their school. Each S was seated opposite E and was instructed to choose one of the two blocks in front of him, by placing his hand on it, each time E revolved the turntable. Statements concerning the verbal reinforcement combinations were not included in the instructions.

For Ss in the Rn condition, E said, "Very good" following a correct response and remained silent following an incorrect response. For Ss in the Wn condition, E said, "That's wrong" following an incorrect response and said nothing following a correct response. The Ss in the RW condition were given the positive verbal statement, "Very good" following a correct response and the negative verbal statement, "That's wrong", following an incorrect response.

At the first level of task difficulty which involved the simple problem with one irrelevant dimension, only one pair of stimuli were used across trials for each S. Shape and size were constant over trials. One-half of the Ss were required to discriminate between a black and white circle and the remaining Ss between a black and white square. Brightness was the relevant dimension and white was the correct stimulus for half of the Ss while black was correct for the remaining Ss. Position of the correct stimulus (right or left) was the irrelevant dimension and was determined by a Gellermann series (Gellermann, 1933). This series was common to all Ss. The second level of task difficulty involved a problem with three irrelevant dimensions. All eight pairs of stimuli were used over trials for each S. Shape, size, and position varied across trials and were irrelevant to learning the discrimination. Brightness was the relevant dimension. Black was the correct stimulus for half of the Ss and white was correct for the remaining Ss. The position of the correct stimulus on each trial was the same as in the simple problem. The pairs of stimuli presented across trials was randomly determined with the restriction that all possible combinations of shape and size appeared equally often in the 72 alloted trials. This same sequence of stimuli was employed for all Ss assigned the difficult problem.

The criterion for the discrimination acquisition problem was eight consecutive correct responses within 72 trials. The data of the Ss failing to meet the acquisition criterion were discarded and replacement Ss were run to fill the groups. Thus, all Ss were initially trained to a criterion of eight successive correct responses. The Ss in the overtraining groups were then given an additional 30 training trials.

Upon completion of the training phase, the relevant stimulus dimension (i.e., brightness) was reversed for all Ss without interruption of the trials. All Ss were continued on the reversal problem until they reached a criterion of eight consecutive correct responses or for a total of 72 trials. The intertrial interval was approximately 5 sec. on both the original and the reversal problem. Each S was praised for his performance before he left the mobile laboratory.

Results

The dependent variable on the original problem was trials to a criterion of eight successive correct responses. A 3 x 2 factorial analysis of variance was performed on the number of trials to criterion for each S. The factors in this analysis were VRC and task complexity. The main effect for VRC was statistically significant ($F = 6.17$, $df = 2, 90$,

$p<.01$). The VRC effect was further evaluated by means of the Newman-Keuls method (Winer, 1962). This procedure indicated that the RW and Wn groups did not differ in performance ($p>.05$) and that both of these groups were superior to the Rn group ($p<.05$). Mean trials to criterion for the RW, Wn, and Rn groups were, respectively, 15.69, 17.50, and 26.00. The main effect for task complexity was not significant. The VRC by task complexity interaction was also not significant ($F<1$).

Discussion

The VRC findings in this experiment were identical to those obtained in Exp. I. Regardless of the complexity of the task, the Rn Ss learned the discrimination less rapidly than did either the Wn or RW Ss. The rate of learning did not differ between the Wn and RW combinations.

A task complexity main effect was not obtained in the present study. Thus, the children in this experiment learned the complex problem as rapidly as they did the simple problem. This finding is in conflict with the results of Exp. I. However, the results of Exp. II are in agreement with those of Exp. I with regard to a failure to find a VRC by task complexity interaction. Both experiments indicate that the relative effectiveness of the VRCs are the same regardless of whether the children are learning a simple or a complex task.

EXPERIMENT III

VERBAL REINFORCEMENT COMBINATIONS, OVERTRAINING, AND TASK COMPLEXITY ON REVERSAL DISCRIMINATION LEARNING IN CHILDREN

Several investigators (e.g., Eimas, 1966; Gollin, 1964) in the area of discrimination learning in children have employed reward-only in studying reversal learning. In the typical simultaneous discrimination reversal problem, the _S_ is initially rewarded for approaching one of two alternative cues until he reaches a criterion. Following criterion training on the original problem, the reversal phase is initiated and the _S_ is now rewarded only if he makes an approach response to the previously nonrewarded cue. A major finding in the area of reversal learning with children is that overtraining (i.e., additional training trials beyond a criterion) facilitates reversal learning on nonspatial discrimination problems (e.g., Eimas, 1966; Furth & Youniss, 1964; Youniss & Furth, 1964a, b). In addition, studies on the overlearning reversal effect (ORE) with children (Furth & Youniss, 1964; Furth & Youniss, 1964a,b) and with rats (e.g., Mackintosh, 1965; Paul, 1965) indicate that problem complexity is an important variable in obtaining the ORE. Eimas (1966) found that increasing the number of irrelevant dimensions enhanced the ORE with non-spatial problems although not significantly. Thus, it appears that the probability of obtaining an ORE is increased with increases in the number of irrelevant dimensions.

The primary issue in this experiment was to determine the effects of the VRCs (i.e., Rn, Wn, and RW) on reversal learning. Previous research on reversal learning has been concerned solely with the effects of reward-only (Rn) and it is not known how a punishment-only (Wn) combination or a reward and punishment (RW) combination will effect reversal learning. Another issue in this experiment was to determine whether overtraining would have similar effects for the three VRC conditions. Since previous research on the ORE with reward-only suggest that the likelihood of finding an ORE increases with increases in the complexity of the task, task complexity (i.e., number of irrelevant dimensions) was also included as a variable in the present study.

Results

The reversal trials to criterion data in the subsequent analyses were collected from the Ss run in Exp. II. Refer to Exp. II for a description of the subjects, apparatus, and procedure employed. A 3 x 2 x 2 analysis of variance was performed on the total number of trials required by each S to reach a reversal criterion of eight consecutive correct responses. The factors in this analysis were VRCs (Rn vs. Wn vs. RW), task complexity (1 vs. 3 irrelevant dimensions), and level of training on the original problem (criterion training vs. overtraining). The main effect for VRC was significant ($F = 7.64$, $df = 2, 84$, $p<.01$). A Newman-Keuls comparison test indicated that the performance of Ss in the Rn condition was significantly inferior to that of Ss in either the Wn or RW conditions ($p<.05$). The performance of S in the Wn and RW conditions did not differ significantly ($p>.05$). The main effects for complexity of the reversal problem and level of training were both non-significant. In addition, none of the interactions were significant.

Discussion

The obtained VRC effects for the reversal problem were the same as those found in Exp. I and II for the original learning of a simultaneous discrimination problem. That is, the RW and Wn Ss learned the reversal equally rapidly and both of these groups learned faster than did the Rn Ss. The VRC effects for the discrimination reversal problem are consistent with Spence's information hypothesis (e.g., Spence, 1964a; Spence, 1966a; 1966b). Spence suggests that the difference in performance between Ss receiving the various VRCs is due to the different amounts of information that Ss are able to extract from "blank" or "nothing" in the Rn and Wn conditions. The Ss are assumed to have a tendency to regard "nothing" as meaning "right" in both the Rn and Wn combinations. In the Wn combination, Ss assume that "blank" means right and that is consonant with the demands of the situation. When Ss in the Rn condition assume that "blank" means "right", this constiutes misinformation about the meaning of "blank" and results in Ss making incorrect responses.

Previous research has shown that in order to maximize the possibility of obtaining an ORE, a relatively complex nonspatial discrimination problem should be employed. The present investigation included a relatively complex task (i.e. three irrelevant dimensions) and a nonspatial brightness discrimination. Even under these conditions, this investigation provided no evidence that overtraining influenced performance on the reversal problem for either the Rn, Wn, or RW combinations.

EXPERIMENT IV

DISCRIMINATION LEARNING IN CHILDREN AS A FUNCTION OF DELAY OF VERBAL REINFORCEMENT COMBINATIONS AND AGE

The relative effectiveness of various combinations of verbal reward and punishment in producing discrimination learning in children has been investigated in a number of studies. The typical verbal reinforcement combination (VRC) paradigm has involved selecting a correct response on some task (e.g., marble dropping, discrimination learning, rote learning) and then applying one of three VRCs to each response that a given S makes. If the S is assigned to the Right-nothing (Rn) combination, E makes a positive comment such as "right" or "very good" immediately following a correct response. The E does nothing following an incorrect response. If the S is assigned to the Wrong-nothing (Wn) combination, E makes a negative comment such as "that's wrong" or "no" immediately following every incorrect response and does nothing following a correct response. If the S is assigned to the Right-Wrong (RW) combination, E makes a positive comment following a correct response, and makes a negative comment following an incorrect response. The Ss in the three combinations are typically run to an acquisition criterion and then compared with regard to their efficacy in learning the discrimination.

When the VRCs are delivered immediately and the Ss are uninformed about their meaning, the most common findings are that children in the Rn combination learn the discrimination slower than do those in either the Wn or RW combinations and that learning rate does not differ between the latter two combinations (Curry, 1960; Spence, 1966a; Exp. I and II of the present report). No studies to date have been published on the effects of the delayed presentation of the VRCs. Delayed presentation of the VRCs consist of the delay of R in the Rn condition, the delay of W in the Wn condition, and the delay of both R and W in the RW condition. A considerable amount of research (c.f., Terrell, 1965) on the delay of positive reinforcement suggest that delay adversely affects discrimination learning in children. In contrast, relatively little is known about the effects of delay of punishment in discrimination tasks. In addition, no evidence is available concerning the combined effects of the delay of both positive reinforcement and punishment on discrimination learning in children. One purpose of the present investigation was to determine the relative effects of the delay of the VRCs on the performance of children on a simultaneous discrimination task.

There are two studies on discrimination learning with children in which an interaction was found between VRC and age (Matusda & Matsuda, 1966; Meyer & Seidman, 1960) and three studies in which no interaction was found (Ahammer & Goulet, 1969; Meyer & Seidman, 1961, Exp. I; Exp. I of the present report). In the studies which found a VRC by age interaction, the younger children were four to six years of age; whereas in two of the three experiments (Ahammer & Goulet, 1969; Exp. I of the present report) which failed to find the interaction, the younger children were in the six to eight year age range. These data suggest that the occurrence of the VRC by age interaction may be dependent upon the age of the younger children included in the studies. The second purpose of the study was to determine whether a VRC by age interaction could be obtained when kindergarten children served as _S_s at the younger age level.

Method

Subjects

The _S_s were 144 kindergarten and fourth grade children attending Austin or Jolley Schools in Vermillion, South Dakota.

Apparatus

The apparatus consisted of a medium grey wooden turntable on which stimuli were presented, and four sets of wooden blocks. The turntable was a 18 x 22 in. horizontal surface bisected by a 13 x 22 in. vertical panel. The panel prevented _S_ from observing the placement of the blocks on any given trial. The turntable and panel were mounted on a lazy susan bearing so that either side could be turned to fact the _S_. The stimuli were two wooden circles, 3 in. in diameter and 1 1/2 in. in thickness and two wooden squares, 2 5/8 x 2 5/8 x 1 1/2 in. The surface areas of the circles and squares were approximately equivalent. One square and one circle were painted black while the remaining circle and square were painted white.

A foot pedal enabled E to activate a Hunter Decade Interval Timer as soon as a S in the ten second delay condition had made his choice. After ten seconds, the timer activated a 7 1/2-watt light bulb which had been placed so that it was visible to the E but not to the S.

Procedure

A 3 x 2 x 2 factorial design was employed involving VRC, delay of VRC, and age. One-third of the Ss were assigned to each VRC combination. One-half of the Ss in each VRC group were assigned to a no delay of VRC condition while the remaining Ss in each VRC group were assigned to a ten second delay of VRC group. One-half of the Ss in each VRC-delay subgroup were kindergarten children and one-half were fourth graders. One-half of the Ss in each VRC-delay-age subgroup learned to discriminate between a black circle and a white circle. The remaining Ss learned to discriminate between a black square and a white square. For one-half of the Ss each of these subgroups, the white stimulus was correct; for the remaining one-half of the Ss, the black stimulus was correct. Within each VRC-delay-age-shape subgroup, one-half of the Ss were male and one-half were female. The position of the two stimuli was determined for each trial according to a Gellerman (1933) series. The same sequence was used for all Ss.

Each S was escorted to the experimental room and seated in front of the apparatus. The E sat behind the apparatus and read the following instructions. "We are going to play a game with the blocks you see in front of you. I want you to pick one of them by putting your hand on the block (E demonstrates). I want you to pick a block each time I turn the table around (E revolves turntable, lets S choose a block). Remember, pick a block by putting your hand on it each time I turn the table."

Reinforcement or punishment on each trial was administered according to the VRC and delay conditions to which the S had been assigned. For Ss assigned to the Rn condition, E said "Very good" following a correct choice, and said nothing following an incorrect choice. For Ss assigned to the Wn condition, E said "That's wrong" following an incorrect choice and said nothing following a correct choice. For Ss assigned to the RW condition, E said "Very good" following a correct choice and "That's wrong" following an incorrect choice. If the S had been assigned to the no delay condition the relevant verbal statement was delivered immediately after S touched the chosen block. If the S was assigned to the ten second delay condition, the relevant verbal statement was delivered ten seconds after S had made his choice. Intertrial interval was about five seconds. The E recorded whether the response on each trial was correct or incorrect. The Ss were run to a criterion of eight successive correct responses or for a maximum of 100 trials.

Results

A 3 x 2 x 2 analysis of variance was performed on the data, trials to criterion. Factors in the analysis were VRC (Rn, Wn, RW), grade (kindergarten, fourth), sex, and delay (no delay, 10 second delay). The only significant effects in this analysis were VRC ($F = 29.64$, $df = 2, 120$, $p < .001$) and delay ($F = 8.25$, $df = 1, 120$, $p < .005$). Post-hoc tests according to the Scheffe' method (Winer, 1962) indicated that Ss receiving either of the combinations involving "Wrong" were equivalent in performance and superior to Ss receiving the Rn combination. Mean trials to criterion for Rn, Wn, and RW Ss were 62.19, 26.49, and 17.46, respectively. Performance of Ss in the no delay condition was superior to that of Ss in the ten second delay condition, the mean trials to criterion being 27.86 and 41.63, respectively.

Discussion

The VRC results of the present study are in agreement with those of both Exp. I and Exp. II. That is, Ss in the RW and Wn combinations learned the required discrimination equally rapidly and both groups learned it faster than did the Ss in the Rn combination. As mentioned previously, similar findings have been obtained for children presented other kinds of discrimination tasks (Curry, 1960; Spence, 1966a).

The finding of a significant main effect for delay in the present experiment indicates that delay of R in Rn combination, the delay of W in the Wn combination, and the delay of both R and W in the RW combination seriously interferes with the learning of a simultaneous discrimination as compared to conditions when these events are not delayed. The length of the delay in this study was 10 sec. and might be considered to be rather short when contrasted with the length of delays which occur in the "normal" classroom. It would be of interest to conduct a parametric study employing several lengths of delay of the VRCs to see how long of a delay could be tolerated before performance is seriously interfered with. The lack of an interaction between VRC and delay in the present study indicates that the delay of both R and W in the RW combination was no more detrimental to learning the discrimination than was the delay of R in the Rn combination or the delay of W in the Wn combination.

The absence of a sex main effect shows that boys are performing as well on the discrimination problem as are the girls. The failure to find an age main effect points out that the kindergarten children are learning the task as rapidly as are the fourth-grade children. Finally, the absence of a VRC x age interaction indicates that the VRCs are producing the same relative effects (Rn<Wn=RW) on this type of discrimination problem for both kindergarten and fourth grade Ss. In contrast to what was suggested in the introduction of this study, it does not appear that the occurrence of a VRC x age interaction is dependent upon the inclusion of a group of relatively young Ss in a study.

SUPPLEMENTARY COMPARISON - EXPERIMENT V

THE EFFECTS OF VERBAL REINFORCEMENT COMBINATIONS, AGE, AND SEX ON DISCRIMINATION LEARNING IN CHILDREN

The purpose of this supplementary comparison was to examine the relative effectiveness of the VRCs over an extended age range (i.e., kindergarten through sixth grade). The trials to criterion data included in this statistical analysis was that collected for the 36 second and 36 sixth grade children run on the simple task in Exp. I and the 36 kindergarten and 36 fourth grade children included in the no delay condition in Exp. IV. The Ss in the previously mentioned conditions of these experiments were presented the same simple simultaneous discrimination problem involving one irrelevant dimension. The apparatus and stimuli were identical for these Ss in both studies. In addition, all Ss were treated in a like manner by the same E and the data were collected in the same room of the mobile laboratory. For a complete description of the apparatus, stimuli, and procedure; refer to the appropriate sections in Exp. I and/or Exp. IV. The treatment of these Ss differed only with regard to calender time. That is, the data were collected on the second and sixth grade children in Exp. I approximately one month earlier than that for the kindergarten and fourth grade Ss in Exp. IV.

Results

A 3 x 4 x 2 factorial analysis of variance was performed on the trials to criterion data. The factors were VRC (Rn, Wn, and RW), age (kindergarten, second, fourth, and sixth grades), and sex (boys and girls). The main effect for VRC ($F = 20.78$, $df = 2, 120$, $p<.001$) was significant. Post-hoc tests conducted according to Scheffe's method (Winer, 1962) indicated that the combinations involving "wrong" produced equivalent levels of performance and that this level was superior to that produced by the Rn combination. The mean trials to criterion for Rn, Wn, and RW were, respectively, 42.23, 18.33, and 14.23. None of the other main effects approached statistical significance. None of the interactions was significant and the value of the F statistic for the VRC x age interaction was less than one.

Discussion

The findings and lack of findings in this analysis are in agreement with the results of earlier studies conducted in this series. The obtained relative order of VRC effectiveness ($Rn < Wn = RW$) was the same as that found in all three previous experiments. Similar VRC effects have also been obtained by other investigators (e.g., Curry, 1960) for different types of discrimination tasks. There was no evidence in the analysis that either age or sex of the Ss influenced performance on the discrimination problem. The failure to find an age main effect is consistent with the results of both Exp. I and Exp. IV. The absence of a sex effect was also indicated in Exp. I and IV. In addition, a VRC x age interaction was not found in the trials to criterion data. Although other investigators (Matsuda & Matsuda, 1966; Meyer & Seidman, 1960) have found an interaction, the present investigator has failed to find a VRC by age interaction in three sets of data.

EXPERIMENT VI

VERBAL REINFORCEMENT COMBINATIONS, OVERTRAINING, AND LENGTH OF RETENTION INTERVAL AS VARIABLES IN THE RETENTION OF A LEARNED DISCRIMINATION IN CHILDREN

Several experiments have compared the effects of different verbal reinforcement combinations (VRC) on the performance of children in a variety of conceptual and discriminaton problems. Three response-contingent conditions have been employed in these studies. These conditions consist of E informing S of either: (a) correct responses (Right-nothing or Rn); (b) incorrect responses (Wrong-nothing or Wn); or (c) both correct and incorrect responses (Right-Wrong or RW). Earlier comparisons in this series (Exp. I; Exp. II; Exp. IV; Exp. V) as well as data from other laboratories (e.g., Curry, 1960) indicate that the VRCs have had consistent effects on the rate of discrimination learning in children. The common finding in these studies was that the Rn condition resulted in inferior performance when compared to the Wn or RW combinations and the latter two combinations produced nearly equivalent performance.

Most of the VRC studies have been concerned with the effects of the VRCs on the learning of a discrimination. Only one study has been conducted in which an attempt was made to assess the relative effectiveness of the VRCs on the retention of a learned discrimination. The results of this study (Ahammer & Goulet, 1969) indicated that no differences as found among the VRCs for the retention data. Since it is generally assumed that the conditions which influence learning also have similar effects on retention and since the VRCs have had consistent effects on learning, it is somewhat surprising that VRC retention effects have not been found. Another study appears warrented. Hence, one reason for conducting the present study was to ascertain whether VRC retention effects could be obtained for a simultaneous discrimination problem.

Another concern in the present investigation was to determine whether overtraining would facilitate retention of the discrimination problem. It was expected that those Ss which were given overtraining trials would retain better than those Ss given only criterion training.

The most appropriate length of a retention interval was not known so it was decided that both a long and a short interval would be included in the design. It appeared reasonable that the overtraining variable might interact with the length of the retention interval variable. The form of the expected interaction was that the differences between overtraining and criterion training would be larger for the seven-day than for the one-day retention interval.

Method

Subjects

The Ss were 96 kindergarten children attending Austin or Jolley Schools in Vermillion, South Dakota.

Apparatus

The apparatus consisted of a black wooden turntable on which stimuli could be presented. The turntable was an 18 x 22 in. surface bisected by 13 x 22 in. vertical panel. The purpose of this panel was to prevent Ss from observing placement of the blocks for any given trial. The above was mounted on a lazy susan bearing so that either side could be turned to face the S. The stimuli were four wooden blocks. The stimuli for each trial consisted of two blocks 2 1/2 x 2 1/2 x 1 1/2 in., one painted white and one painted black.

Procedure

The investigation was a 3 x 2 x 2 factorial design, with three verbal reinforcement combinations, two levels of learning (criterion vs. overlearning), and two retention intervals (one vs. seven days). The Ss were randomly assigned to each of three verbal reinforcement combinations. Within each of the VRCs, one-half the Ss were assigned to criterion learning and the remaining Ss were given criterion training plus 30 overtraining trials. Within each of these VRC-level of training subgroups, one-half of the Ss were assigned to a one day retention interval and the remaining Ss were assigned to a seven-day retention interval. Each VRC-level of training-retention subgroups were counterbalanced for sex.

For the original learning task, each S was individually escorted to the experimental room by E who seated S in front of the apparatus. Each S was seated opposite E and was instructed to choose one of the two blocks in front of him, by placing his hand on it, each time E revolved the turntable. Statements concerning the verbal reinforcement combinations were not included in the instructions. On each trial Ss were presented a black square and a white square. Black was correct for one-half the Ss and white was correct for the remaining Ss. Position of the correct stimulus for each trial was determined by means of the Gellermann series (Gellermann, 1933) and the same sequence was used for all Ss on the original task.

For Ss in the Rn condition, E said, "Very good" immediately following each correct response and E remained silent following an incorrect response. For Ss in the Wn conditon, E said, "That's wrong" immediately following an incorrect response and E remained silent following a correct response. The Ss in the RW condition were given the positive verbal statement "Very good" following a correct response and the negative verbal statement "That's wrong" immediately following an incorrect response.

The criterion for both the original acquisition and the subsequent retention test was eight consecutive correct responses within the 72 trials allotted for each problem. The Ss in the overtraining condition were given criterion training plus an additional 30 training trials. The Ss not meeting acquisition criterion in 72 trials were discarded and replacement Ss were run to fill the groups.

Each S returned to the experimental room for the retention test either one or seven-days after the original task. Again S was seated in front of the turntable and asked to choose one of the two blocks in front of him, by placing his hand on it, each time E revolved the turntable. The task was identical to that originally learned by the S including the VRC administered by the E. Black was the correct stimulus for those Ss who had been trained on black in the original problem and white was the correct stimulus for those Ss who had been trained on white in the original problem. Position of the correct stimulus (i.e. left or right) was determined by means of a Gellermann series (Gellermann, 1933). The same sequence of stimuli was used for all Ss on the retention problem.

Results and Discussion

A single factor analysis of variance was performed on the number of trials to meet discrimination acquisition criterion. The main effect for VRC was significant ($F = 16.44$, $df = 2,93$, $p < .001$). A Scheffe's comparison test indicated that the performance of Ss in the Rn condition was significantly inferior to that of Ss in either the Wn or RW conditions ($p < .05$). The performance of Ss in the Wn and RW conditions did not differ significantly ($p > .05$). A 3 x 2 x 2 analysis of variance was performed on the total number of trials to meet criterion on the retention problem for each S. There were no significant main effects or interaction effects in this analysis. However, the main effect for VRC approached significance ($F = 2.80$, $df = 2,84$, $p < .10$) The means for the Rn, Wn, and RW conditions were 10.53, 10.25, and 8,34, respectively.

The results of the original discrimination acquisition data were in accord with earlier findings with children (Curry, 1960; Spence, 1966a; Exp. I, II, IV, V of this report). That is, Rn was significantly inferior to Wn and RW with no significant difference between Wn and RW conditions. There were no main effects or interaction effects on the retention data which were significant, although the main effect for VRC approached significance. One possible explanation for the nonsignificant retention results is that the retention problem was too simple. That is, the only thing required of the Ss on the retention problem was to recall whether the white or black stimulus was correct either one or seven days earlier. However, it is of interest to note that the VRCs did not influence retention in a previous study (Ahammer & Goulet, 1969).

CONCLUSIONS AND RECOMMENDATIONS

This final report consists of a description of six sets of data collected in four experiments which were conducted to investigate the influence of a number of independent variables on the relative effectiveness of verbal reinforcement combinations (VRCs) on the learning and retention of discrimination tasks in children. The influence of age and sex of the Ss on the relative effectiveness of the VRCs was examined in Exp. I, Exp, IV, and Exp. V. The effects of task complexity and the VRCs on simultaneous discrimination learning was assessed in Exp. I and Exp. II. The influence of task complexity and the VRCs was further examined on discrimination reversal learning in Exp. III. The influence of the VRCs and overtraining on discrimination reversal learning and retention was investigated in Exp. III and VI, respectively.

The following empirical findings were obtained in the present series of experiments. Regardless of the sex or age of the children or of the complexity (i.e., number of irrelevant dimensions) of the simultaneous discrimination problem, the two VRCs involving "Wrong" (i.e., Wn and RW) led to equivalent learning rates and these rates of learning were superior to those produced by the Rn combination (Exp. I, II, IV, V, VI). Another interesting finding was that the VRCs had similar effects on the learning of a discrimination reversal problem (Exp. III). That is, the reversal problem was learned more rapidly under the Wn and RW combinations than under the Rn combination and there was no difference in the rate of learning for the Wn and RW combinations. Another important finding (Exp. IV) was that delay of the VRCs (i.e., delay of R in the Rn combination, delay of W in the Wn combination, and delay of both R and W in the RW combination) seriously interfered with the learning of a simultaneous discrimination problem in children. In view of the consistency of the VRC effects on the learning of simultaneous and reversal discrimination problems, the failure to find VRC effects for the retention of a discrimination was also interesting.

Based on the findings of the present studies, two general conclusions regarding the learning of discriminations by children appear reasonable. The first of these is that discrimination learning in children proceeds faster when they are verbally informed of their errors than when they are only verbally informed of their correct responses. It also appears that as long as they are verbally informed of their errors, additional feedback for correct responses does not further increase the rate of learning. The second conclusion is that delays in giving verbal feedback to children regarding the correctness or incorrectness of their responses seriously interferes with their learning of discriminations. These conclusions should be carefully evaluated and extreme caution is recommended in applying them to the classroom situation. Strictly speaking, the aforementioned findings regarding the relative effects of the VRCs hold only within certain specified boundary conditions. The boundary conditions of the present series of experiments include such things as the characteristics of the children involved, the kinds of discrimination problems that were presented and the manner in which the VRCs were administered. Further research is required to determine whether similar VRC findings would be obtained under conditions which differ from those holding for this series of experiments. It would be of interest to ascertain whether the relative efficacy of the VRCs remain the same for simultaneous discrimination problems when children are given complete instruction about the meaning of the VRCs and when the problem involves more than two response alternatives. Additional research should also be conducted to determine whether similar VRC effects can be obtained for other types of discrimination tasks. Specifically, the influence of the VRCs should be investigated in successive, matching-to-sample, and learning set discrimination problems as well as in concept formation tasks. However, the greatest need for future research involves the establishement of an experimental classroom in which the effects of the VRCs can be investigated while training young children to discriminate between shapes, colors, numerals, and letters of the alphabet.

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