Effects of stimulus similarity and locus of response on simultaneous and successive discrimination learning in children

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EFFECTS OF STIMULUS SIMILARITY AND LOCUS OF RESPONSE ON SIMULTANEOUS AND SUCCESSIVE DISCRIMINATION LEARNING IN CHILDREN

By

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B.A. Western Washington State College, 1963
B.A. in Education, Western Washington State College, 1963
Presented in partial fulfillment of the requirements for the degree of Master of Arts
UNIVERSITY OF MONTANA
1967

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Acknowledgments

In particular, the author would like to express her gratitude to Dr. Charles K. Allen who gave both his time and energy in order that the completion of this research might be realized. Without his interest in the experimental problem and his willingness to be of assistance throughout all phases of the project this research could not have been successfully completed.

Thanks go especially to David Stroebel who spent many hours modifying the electrical circuit for the apparatus.

Special thanks go to the two Missoula Public Schools, Missoula, Montana, which participated in this research; Emma Dickinson and Paxson, whose principals Messrs. Donald Richardson and Leon Nelson showed great interest in facilitating an efficient procedure in the schools. The cooperation of Mrs. Laura Fricke, Mrs. Myrtle Heinle, Mrs. Janis Stoecker, Mrs. Maurine Cloke, Mrs. Donnaleen Lagerquist, Mrs. Sara Peck, and Mrs. Hyla Ulriggs, teachers in the respective schools, and the enthusiasm of their children made possible the collection of data in a pleasant and smooth manner.
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The learning process in the human child has been studied from many different points of view. The investigation of discrimination learning has centered around possible differential effects of two types of stimulus presentation, simultaneous and successive, on learning. However, the experimental design of these studies has frequently included the manipulation of other variables: type and number of stimuli presented, the temporal and spatial relationship between stimuli and between stimulus and response, stimulus similarity, opportunity for stimulus comparison, and delay of reinforcement. In addition, the age of Ss and response measure used has varied among studies. The research in this area in the last 15 years has produced some conflicting results, possibly due to interactions between manipulated variables and procedures not seen as being crucial to a particular experiment. Therefore, this study was designed to investigate simultaneous and successive discrimination, varying response locus, and stimulus similarity, two variables which seem to affect differentially S's learning simultaneous and successive discrimination problems (Lipsitt, 1961).

Theoretical Orientation

In 1936 and 1937 Spence described theoretically the discrimination process applicable to the simultaneous situation in which two or more different stimuli are presented at the same time, and S is required to choose one stimulus
irrespective of spatial arrangement. Learning occurs when a response is rewarded, with relative strengthening of that response tendency to certain components of the stimulus complex. With the resulting increase in the strength for that response tendency there is an increased inhibition of the competing response tendency. For any one trial the choice is controlled by the strengths of the various response tendencies. Behavioral evidence of learning occurs when the correct (reinforced) response tendency becomes sufficiently greater in strength than the competing response tendencies.

In 1951 Weise and Bitterman, using a complex T-maze, studied simultaneous and successive discrimination learning in rats. The successive method required that the stimuli be presented such that only one of the two or more different stimuli was presented on any one trial, and resulted in faster learning than the simultaneous method. They argued that Spence's theory either could make no prediction or would predict the opposite of their results; that is, that learning is facilitated by the simultaneous presentation of the stimuli.

In 1952 Spence answered the charges of Weise and Bitterman. When defining the successive and simultaneous discrimination problems Spence utilized a simple T-maze and black, white, left, and right discrimination conditions. The "simultaneous" problem consisted of presentation of both black and white cues for each trial, with one of the
cues (e.g., black) on the left for 50 percent of the trials and the other (e.g., white) on the right. On the other half of the trials the positions were reversed, S being consistently reinforced for one cue (e.g., black or white). Spence stated that S needed only to attend to the blackness or whiteness of the arms of the maze to learn the discrimination. In the second problem, termed the successive problem, only one of the cues is present on each trial. If the apparatus is an alley, both paths are either white or both black. The S must learn to go to the right when white cues are present and left when the alleys are black, or vice versa. Spence termed the successive problem a patterned discrimination, for attention must be given to the total complex \( W_L - W_R \) or \( B_L - B_R \), since no one stimulus compound is consistently reinforced on successive trials. For example, S is reinforced for \( W_R \) and \( B_L \), thus having to learn brightness and position discrimination. Therefore, in the successive situation no single element (B, W, L, or R) of the stimulus complex should attain greater strength than any other, but the approach to a stimulus compound (B - L and W - R) may be consistently reinforced and learning result. On the basis of his experimentation Spence predicted that learning is not as difficult under the simultaneous condition. The stimulus compounds in the successive situation are more similar and make discrimination learning more
difficult. More recently, Spiker (1963) showed how a component theory, fundamentally a modification of the Spence (1936) theory, will predict learning of the successive discrimination problem, and that the successive problem will be learned more slowly than the corresponding simultaneous problem, at least under some conditions.

Because Weise and Bitterman obtained results which did not support Spence's contention Bitterman and Wodinsky (1953) replicated their study, substituting a typical Lashley jumping situation for the complex T-maze. Following their investigation, Bitterman and Wodinsky drew the following conclusions: (a) when the animal is required to orient towards and approach the stimulus complex containing the positive stimulus cue, simultaneous stimulus presentation tends to result in better discrimination learning than successive; (b) when the animal is required to make a response to a locus removed from the stimulus source and the stimuli are placed close side by side, the successive problem tends to be either equal to or easier than the simultaneous problem. Furthermore, the relative difficulty of the simultaneous and successive problems seems to be influenced by the similarity of the stimuli to be discriminated; that is, the simultaneous configurations \((W_L - B_R \text{ and } B_L - W_R)\) are probably more similar to each other and, therefore, should be more difficult to distinguish than those presented
by the successive method \((W_L - W_R, B_L - B_R)\).

A possible theoretical interpretation of the three investigations is that in a conventional jumping apparatus the animals are required to jump directly at the stimuli, and in Spence's (1952) T-maze they are required to enter upon the stimulus runways. These may be labeled approach situations. The relative simplicity of the simultaneous problem in such situations can be explained on the assumption that they facilitate the functional isolation of the stimuli.

In the four-unit, alley-maze type apparatus of Weise and Bitterman (1951) two stimuli (lamps) were closely juxtaposed at each choice point, and the animals were required to turn away from them, to one side or the other. (Under the simultaneous condition Ss were to turn in one direction when the right lamp was on and in the opposite direction when the left lamp was on, and under the successive condition the rats were to turn in one direction when both lamps were on and in the opposite direction when both lamps were off.) This may be described as a response situation which facilitates configurational organization - the animals merely learned to make one response to the bright configuration and an opposed response to the dark - and retards the functional isolation of the components of each pair of stimuli. Therefore, the greater difficulty of the simultaneous problem is understandable, either in terms of the greater
similarity of its two configurations, or in terms of the difficulty of analyzing situations where the solution is based on the response to components.

One of the difficulties inherent in comparisons of the two types of problems is that the simultaneous method allows S to compare directly the stimuli presented while the successive one does not. The importance of stimulus comparison has been stressed by Lashley and Wade (1946). They have maintained that opportunity to compare the stimuli to be discriminated facilitates learning. Grice's experiment (1949), which was designed to test this hypothesis, failed to show an advantage for the comparison group. Another method employed by Saldanha and Bitterman (1951) did, however, give a clear advantage to the comparison group under certain conditions. It was suggested that opportunity for comparison may facilitate learning only when the stimuli to be discriminated are relatively similar. The opportunity for comparison should give an advantage to the simultaneous group that would offset the fundamental simplicity of the successive problem from Bitterman's viewpoint. Relational theory holds that a comparison does occur in the successive condition, but that it is between the stimulus now present and a memory trace of the alternative stimulus, and that such comparison is harder to make than one with both stimuli physically present (Lashley & Wade, 1946).
Experimental comparisons of the two forms of discrimination learning have produced all possible results with infrahumans: simultaneous discriminations easier to learn than successive ones (North & Jeeves, 1956; Spence, 1952); no significant difference between methods (Grice, 1949); successive easier than simultaneous (Bitterman & Wodinsky, 1953; Teas & Bitterman, 1952; Weise & Bitterman, 1951).

The implications of these various outcomes for discrimination learning theory are that (a) neither the component nor the configuration theory handle all aspects of the discrimination problem, and (b) the relative effectiveness of the two types of problems must depend on the operation of such variables as stimulus similarity and locus of response.

Several experimenters have studied the effectiveness of the two discrimination problems, varying the spatial relationship between stimulus and response (locus of response). When the animal responds directly to the stimulus source, the simultaneous method tends to provide better learning than the successive (Spence, 1952). When the response is made to a locus removed from the stimulus source sometimes the simultaneous and sometimes the successive is more effective (Bitterman, Tyler, & Elam, 1955; Bitterman & Wodinsky, 1953; Weise & Bitterman, 1951; Wodinsky, Varley, & Bitterman, 1954), depending upon the degree of similarity of the stimuli. The more similar the stimuli, the more likely will simultan-
eous presentation result in faster learning whether the response is to the stimulus source, or to a locus away from the stimulus source. MacCaslin (1954), using a Lashley jumping apparatus to study the simultaneous and successive discrimination problems while varying similarity of the stimuli, obtained results supporting the hypothesis that as stimulus similarity increases, the successive problem becomes increasingly more difficult than the simultaneous problem, while the absolute difficulty of both problems is increased.

Child Research

An analysis of the experiments published in the last 15 years shows that several different methods of stimulus presentation have been used.

The standard procedure used for studying rat's discriminations in the T-maze or jumping stand is adapted to children such that two or more stimulus apertures are used and S's response is made directly to the source of the stimulus (Lipsitt, 1961, experiment 2; Murphy & Miller, 1959; Perkins, Banks, & Calvin, 1954; Price, in Spiker & Lubker, 1965; White & Spiker, 1960). This procedure can be varied so that S responds away from the stimulus source, pushing one of two or more buttons located in a spatial isomorphism with the stimuli (Erickson & Lipsitt, 1960; Etzel & Wright, 1964; Horowitz & Armentrout, 1963, 1965;
Lipsitt, 1961, experiments 1, 3; Murphy & Miller, 1959; Rieber, 1964). Both simultaneous and successive problems may be presented by means of these two procedures such that a different hue (simultaneous = Si) or the same hue (successive = Su) is presented in each aperture on any one trial, S being required either to respond directly to the stimulus source (D), or to push a button removed from the stimulus source (R).

Another method of stimulus presentation is such that only one aperture is used for presentation of the stimuli, and S is required to choose one of two or more response buttons located some distance from the source of the stimulus (Hockman & Lipsitt, 1961; Jeffrey, 1961; Perkins, Banks, & Calvin, 1954; Spiker, 1956; Spiker & Holton, 1959). Since there is presentation of only one hue per trial the correct and incorrect stimuli cannot be simultaneously exposed; therefore, only a successive problem can be presented by this method.

A further method is designed such that the simultaneous problem (two or more different stimuli presented contiguously) is presented successively on any one trial (Si–Su). On a given trial the left window lights up with a given color and stays on for 2 sec. The offset of the light in the left window activates a stimulus light in the center window which stays on for 2 sec. The termination of
the light in the center window activates a third light in
the right-hand window which remains "on" for 2 sec. A dif­
ferent colored light is displayed in each of the three
apertures on any one trial. Offset of the third light in­
dicates to $S$ that he is either to push a window (D) (modi­
fication of Rieber, 1966) or choose the button he thinks
is correct (R), depending upon the experimental condition
to which he has been assigned; and, with one of the three
colors having been arbitrarily selected as correct for him.

Experiments studying the relative difficulty of succes­
sive, as compared to simultaneous discrimination have
yielded conflicting results. Although some investigators
(Erickson § Lipsitt, 1960; Horowitz § Armentrout, 1963,
1965; Jeffrey, 1961; Lipsitt, 1961, experiments 2, 3; Per­
kins, Banks, § Calvin, 1954; Price, in Spiker § Lubker,
1965; Rieber, 1964) have reported the successive problem
to be more difficult than the simultaneous, at least under
some conditions; Lipsitt (1961, experiment 1) and Rieber
(1966) have found the opposite; not to mention those studies
finding no significant differences between the types of
problems. However, it is necessary to consider that the
studies varied in the method of simultaneous and succes­
sive stimulus presentation, and locus of response, as well
as in the manipulation of additional variables, which may
have contributed to the confusion. In order to make some
sense of these results in relation to the present experiment pertinent studies will be compared with Lipsitt's (1961) crucial research in which he systematically manipulated these variables.

Lipsitt conducted three experiments with fourth-grade children to compare the methods of simultaneous and successive stimulus presentation under different levels of stimulus similarity and two locations of response with respect to stimulus source. Experiment I (Si R, Su R) utilized both similar stimuli (red, pink, and blue lights) and dissimilar stimuli (red, green, and blue lights). The results showed that when the response locus is removed from the stimulus source successive stimulus presentation resulted in significantly better discrimination learning than simultaneous presentation. Experiment II (Si D, Su D) partially replicated Experiment I except that locus of response was contiguous with stimulus site. The stimuli in all groups were similar (red, pink, blue). It was reported that simultaneous discrimination results in better learning when the child has to respond directly to the stimulus. This was in contrast to the findings of Experiment I where the response was made to a site away from the stimulus. Experiment III (Si R, Su R) studied discrimination learning with the following variables; simultaneous and successive stimulus presentation and two levels of stimulus
similarity (highly similar—red, pink, orange and dissimilar—red, green, blue). The experimenter wished to test the limit of superiority of successive over simultaneous presentation in Experiment I by using an extremely high stimulus similarity condition. The direction of the difference was the same as Experiment I although there was not a significant superiority of successive over simultaneous at the dissimilar stimulus level. However, the expected inversion of simultaneous and successive means was obtained with an increase in stimulus similarity. The conclusion was that both the relative likeness or difference between stimuli and the locus relationship of stimulus and response affect simultaneous and successive discrimination in children. The following conclusions can be drawn upon the basis of Lipsitt's experiments: (1) simultaneous learning tends to be superior to successive when the response is directly to the stimulus (Si D, Su D); (2) however, if the response is not directed toward the stimulus (Si R, Su R), then successive learning may equal or exceed simultaneous learning; and (3) the combination of removal of the response from the stimulus source (Si R, Su R) and presentation of highly similar stimuli may produce simultaneous discrimination learning which is superior to successive.

Earlier experimenters (Loess & Duncan, 1952) used college students to study the relationship of the method of
stimulus presentation (Si R, Su R) to the difficulty of the task. Their results support Lipsitt's Experiment III if the stimulus continuum is relabelled, so that easy and difficult refer to relatively dissimilar and highly similar stimuli.

More recently, Erickson and Lipsitt (1960) investigated the relationship between delay of reinforcement and simultaneous and successive discrimination learning in children (Si R, Su R). They based their discrimination problem upon Spence's (1936, 1937, 1952) theory that simultaneous discrimination learning is not as difficult as successive discrimination learning. They tested this with a three stimulus complex (stimuli were red, orange, and green lights) under each presentation condition. The interaction between trials and type of discrimination was found to be reliable, indicating a greater learning rate for the simultaneous than the successive group. However, while their problem seemed to support Spence's theory, their design, with responses being made to a source removed from the stimulus source, resembled more closely that of Bitterman and his associates. In addition, the stimuli were not as dissimilar as those used by Spence (white, black) with rats. These factors serve to raise the question as to whether Erickson and Lipsitt's research actually supports Spence's as they contend.

Contrary to Erickson and Lipsitt's results, the simul-
taneous method of presentation did not result in a faster learning rate in a study conducted by Etzel and Wright (1964). The discrimination problem was similar in the two studies (Si R, Su R), but the color of the stimulus lights varied. It would appear that Spence's thesis is not supported (Etzel & Wright, 1964). In fact, the successive group showed a tendency to be learning at just a slightly better rate throughout the total experiment. One possible explanation of their opposing results is that Etzel and Wright used red, blue, and green stimulus lights, defined by Lipsitt in his experiment as dissimilar; while Erickson and Lipsitt used red, orange, and green lights, defined by Lipsitt as similar. From Lipsitt's results the prediction would be made that the mean performance of a dissimilar stimuli-successive method group would result in somewhat (but not necessarily significantly) better learning than the dissimilar stimuli-simultaneous method. This was the result of the Etzel-Wright experiment. The combination of similar stimuli-simultaneous method, according to Lipsitt, would produce significantly better learning than the similar stimuli-successive problem. Erickson and Lipsitt's findings were consistent with Lipsitt's. Lipsitt concluded that conditions which would maximize successive superiority over simultaneous would involve high stimulus dissimilarity and the response removed from the stimulus source. Both the
Erickson and Lipsitt study and the Etzel and Wright investigation had the response mechanism removed from the stimulus source but differed in the similarity of the stimuli. What would otherwise appear to be an inconsistency between the results of simultaneous and successive discrimination learning in these two studies is in effect an agreement, because different points on the similarity continuum were used. This appears to be a possibly crucial interacting factor.

The differences between simultaneous and successive presentation might be investigated in a second way. Etzel and Wright's experiment with humans and Spence's with rats differ with respect to locus of response. In Spence's design the rats respond directly to the stimulus site, while in their study the response is to a button removed from the stimulus site. This difference in design may be critical when comparing Spence's results of the superiority of the simultaneous problem with the findings of the nonsignificant differences for successive in their study. Reasoning in a post hoc fashion as a result of a casual observation of the Ss under the successive condition, Etzel and Wright felt that some developed a swaying motor response while making the response. The reason for this is not clear, but at least the addition of another reinforced response may be an important variable that might work against
the superiority of the simultaneous problem - at least with humans and within the conditions of their experiment.

Horowitz and Armentrout (1965) investigated discrimination learning (Si R, Su R), manifest anxiety, and effect of reinforcement. They reported two experiments, the results showing either no significant differences in rate of learning between the simultaneous and successive discriminations or performance on the simultaneous problem yielding a significantly higher mean number of correct responses than performance on the successive problem. They noted that their results support Erickson and Lipsitt's (1960) study. However, Horowitz and Armentrout used dissimilar stimuli (red, green, blue) while Erickson and Lipsitt used more similar stimuli (red, orange, green). Furthermore, Lipsitt (1961) concluded from his experimentation that (a) when the response is to a locus removed from the stimulus source, as in these two experiments, successive stimulus presentation may result in performance equal to or better than simultaneous, a finding which Horowitz and Armentrout were unable to replicate; and (b) when the response is to a locus removed from the stimulus source simultaneous may produce better learning than successive if the stimuli are similar, a finding which Erickson and Lipsitt (1960) did obtain. At this point no attempt will be made to explain the discrepancies both within this investigation and between studies,
e.g. Etzel and Wright (1964) obtained no significant differences between the simultaneous and successive discrimination problems although the same stimulus colors (red, green, blue) were used in both experiments, and the response was to a locus away from the stimulus source. It should be remembered that Etzel and Wright's results support Lipsitt's (1961), essentially the same apparatus being used by all investigators.

It is necessary to look at one further study in order to define the problem area. Using kindergarten children Rieber (1964) found that simultaneous presentation of the stimuli (red, blue lights) during discrimination training (Si R, Su R) resulted in faster learning. These findings do not support Lipsitt's. However, Ss responded relatively close to the stimulus source. In this experiment one inch separated the stimulus from the response, as opposed to a six or more inch distance in other studies. Therefore, if Rieber's design is considered similar to Si D, Su D then his results are in accordance with Lipsitt's.

A comparison of Rieber's and Etzel and Wright's results using response latency as a criterion measure reveals that although in Etzel and Wright's (1964) study response latency decreased significantly from the beginning to the end of S's learning session, this measure was not reliably influenced by the simultaneous or successive method of pre-
sentation. Rieber (1964) found that starting speed for the successive condition was reliably slower than for the simultaneous condition. If this measure of the time taken to initiate a response is assumed to be positively related to the degree of response competition, then the successive method produces a greater degree of response competition. This is in agreement with the analysis of discrimination learning presented by Spence which holds that the successive problem is solved by responses to relatively similar stimulus compounds rather than to more dissimilar stimulus elements, resulting in a greater degree of stimulus generalization.

If a comparison is made between the seemingly conflicting results of the Rieber and Etzel and Wright studies in terms of locus of response, then possibly the response latency measure for simultaneous and successive discrimination is differentially influenced by the locus of response variable. However, the difference in age of Ss in the two studies may be a critical factor, one which the present experiment did not manipulate. Nevertheless, the present study investigated the possibility of differential results due to varying the locus of response.

Statement of the Problem

It is difficult to make any general statements concerning the discrimination problem using children because
age, tasks, procedure, response measures, reinforcement and stimulus and response variables used have varied from study to study. The present experiment was designed in a manner similar to the Erickson-Lipsitt (1960), Etzel-Wright (1964), Horowitz-Armentrout (1965), Lipsitt (1961), and Rieber (1966) studies, but concentrated upon a comparison of the relative difficulty of the simultaneous and successive problems when stimulus similarity and response locus are systematically manipulated within one experimental design.

More specifically, the experiment was designed to (a) replicate partially Lipsitt's three experiments, (b) investigate any differences between Si D and Su D when the experimental groups are presented dissimilar stimuli, as this had not been tested, and (c) study the effects of opportunity for stimulus comparison in relation to the stimulus similarity continuum upon the following simultaneous and successive discrimination conditions: (Si D, Su D, Si R, Su R, Si-Su D, Si-Su R). The Si-Su groups were included in order to investigate the possible differential effect of opportunity for stimulus comparison on simultaneous and successive discrimination. They were designed to minimize the differences between the simultaneous (R, D) and successive (R, D) groups; whereas the simultaneous and successive tasks differ in terms of the number of relevant stimulus dimensions, the simultaneous and Si-Su tasks do
not. In the simultaneous problem S has to attend only to the particular stimulus independent of its spatial characteristics whereas solution of the successive problem depends upon cue-position patterning, and both the spatial and stimulus dimensions are relevant. Furthermore, the simultaneous and successive problems differ in the number of habits which must be learned in order to master them. The simultaneous task requires that a response be learned to only one of the two or more stimuli which are presented (as does the Si-Su problem). With the successive problem, different responses must be learned to each stimulus.

In conclusion, the following experiment was concerned with discrimination learning in children with three methods of presenting the discrimination problem (Si, Su, Si-Su), with two levels of stimulus similarity (dissimilar, similar), and with two loci of response (D, R).

The following were the hypotheses.
1. Increasing improvement in performance (i.e., learning) will occur under all conditions as a function of trials.
2. When dissimilar stimuli are presented learning differences are less likely between the simultaneous and successive discrimination problems.
3. Using similar stimuli the following relationships will hold when comparing experimental groups: Si D > Si-Su D > Su D; Si R > Si-Su R > Su R; where > represents significantly
faster learning, and = represents no significant differences in learning.

4. Using dissimilar stimuli the following relationships will hold: Su R > Si R > Si-Su R; Si D > Si-Su D > Su D.

5. Performance for experimental conditions when locus of response is at the stimulus source will be superior to the performance of those groups responding to a source removed from the stimulus.

6. In particular, response latency should result in no differences in response latency for Si R, Su R, but Su D will be slower than Si D.

Method

Subjects

One hundred-eighty fourth graders, representing seven classrooms from two Missoula public schools, were used. The schools were chosen because of their similarity—socioeconomically (middle class). Eighty-six Ss were males and 94 were females. Ages ranged from 9 years 3 months to 11 years 5 months, the mean age being 9.9 years.

Seven subjects were lost for the following reasons: three because of apparatus failure or because E used the wrong procedure; two because of color blindness; one because of S's refusal to participate during the learning situation; and one because S's parents were unwilling to allow participation. All rejected Ss were replaced from the subject
pool, unsystematically.

Apparatus

The basic apparatus consisted of a stimulus discrimination box, similar to one described by Erickson and Lipsitt (1960); Etzel and Wright (1964). A sketch of the discrimination apparatus is found in Appendix B. The black plywood box was 12" high x 25 3/4" long. Depth of the apparatus was 12 1/4". The front panel of the apparatus was divided horizontally into two sections. The top panel contained three stimulus windows covered with milk glass. Behind the windows were the stimuli; red, green, and blue lights (dissimilar stimuli), and red, orange, and pink (similar stimuli) (GE C-7 1/2 multiple type). In order that preselection of the color to appear in each window could be handled by E, three selector switches were located at the back of the apparatus, one for each stimulus aperture. For the Si-Su method a toggle switch activated Hunter Interval Timers controlling the duration and order of each stimulus presentation. The lower half contained three response buttons 6 1/2" below the windows. Preselection of incorrect and correct away-from-the-source buttons and to-the-source responses was made by three toggle switches on the lower half of the back panel. Three additional toggle switches were used to preselect the type of response to be made— to or away from the stimulus source; activating either the window micro-switches or
response buttons. The reward was a red jeweled reflector light above the middle response button activated when S pushed the correct response button or window. If S made an incorrect response, he was informed by a 6-volt door buzzer, put into action by S's button- or window-pushing. Correction was impossible because S's response deactivated the stimuli and response windows and buttons. Activation of the preselected lights and acknowledgment of S's chosen response (light or buzzer) were controlled by a toggle switch handled by E which controlled the entire electrical circuit. In a modification of Erickson and Lipsitt's (1960) apparatus, a delayed time vacuum tube was added (Etzel & Wright, 1964) to determine the 2 sec. duration of the reinforcement light and buzzer. A Hunter Model 120 A Klockounter, Series D, recorded response latency, to the nearest 1/100th of a second. The Klockounter was activated with the onset of the stimulus lights for each trial and deactivated when S pressed a response button or window.

Experimental Design

Each of one-hundred eighty Ss were randomly assigned to one of 12 experimental groups. Stimuli were presented simultaneously to four of the groups, successively to four of the groups, and the remaining four groups comprised the Si-Su condition.

The procedure for Su D and Su R involved presenting S
with three apertures in which colored lights were exposed. On any given trial, the same hue (red, green, or blue; red, orange, or pink) was presented in all the apertures, the locus of response differing for the R and D conditions. The color of the three lights was varied from trial to trial so that S had to learn a position response for each color. For example, S might have been required to learn to push the left window (Su D - dissimilar) when the blue lights showed, the middle window when the red lights were presented, and the right window when the green lights were "on".

Position and color were balanced for Su D and Su R at both levels of stimulus similarity (red, green, blue; red, orange, pink), such that for each condition each color was correct in each position for a certain portion of Ss; i.e., for Su D - dissimilar red was correct on the left for one-third of the Ss, in the middle for one-third, and on the right for one-third; the same holding true for green and blue.

Simultaneous problems were analogous to the successive problems in the variation of the spatial relationship between stimulus and response, and use was made of the three locations for the stimuli. However, all three colors (dissimilar or similar) were presented at once on any one trial. Under Si D, Ss were to learn to associate the
correct window with the color being reinforced, and under Si R Ss were to learn to push the button that was in the same relative position as the hue assigned as correct before S's session began.

One-third of the Ss in each of the simultaneous groups were reinforced for responding to blue, one-third for responding to red and one-third for responding to green; and the same for the similar-stimulus simultaneous conditions.

For conditions Si-Su D - dissimilar, and - similar, Si-Su R - dissimilar, and - similar the three stimuli were presented individually from left to right for 2 sec. each. On any one trial S viewed all three colors (stimuli) for the similarity condition to which he was assigned, but they were presented successively within the trial. Activation of response buttons (windows) was automatically controlled such that they were activated with the offset of the third light. S was positively reinforced for pushing the correct window, or button, associated with the color preassigned as being correct for his experimental group. The procedure for balancing color was identical to that used for the simultaneous experimental groups.

Response latency measurements were collected for Ss in all the Si and Su experimental conditions. Response latency was defined as the length of time from the onset of the stimulus lights to S's response (pushing a button or pressing
on a window). However, it was not possible to measure the response latency of Ss in the Si-Su conditions, because the response devices were not activated until the offset of the third stimulus. It was necessary that S be presented all three stimuli on every trial in order to accommodate the design of the three discrimination methods (Si, Su, Si-Su). To have recorded the time from onset of the first stimulus light to the onset of S’s response would not have been meaningful as it theoretically could include both decision time, the length of time necessary to present all three lights successively, and reaction time; whereas, the Si and Su groups’ latencies corresponded to just S’s decision time and reaction time. Since decision time (response latency) was the measure of interest it was decided to limit its measurement to the Si and Su groups.

The order of stimulus presentation was identical for all Si and Si-Su conditions, and the order was the same for all Su groups.

Where A, B, and C = the three arrangements occurring in every series of three trials and 1, 2, 3 = red, green, and blue or red, orange, and pink stimuli, then the possible stimulus arrangements for the Si and Si-Su groups were A: 1, 2, 3; B: 2, 3, 1; C: 3, 1, 2 and for the Su groups A: 1, 1, 1; B: 2, 2, 2; C: 3, 3, 3. The total possible combinations over a series of trials were ABC, BAC, BCA, CAB,
ACB, CBA. The order of arrangements was assigned randomly but no arrangement was repeated in consecutive order. The ordered series totalled eighteen trials or six groups of three trials each. Response measures were trials to criterion, response latency, and number of correct responses. The learning criterion was 18 successively correct responses. In the event that S did not reach the learning criterion within 54 trials and made a correct response on trial 54, then he was run until he either reached the criterion or responded incorrectly. The trials were ordered by repeating the previously selected 18 trials. Sample data sheets are found in Appendix C.

For all groups under the experimental conditions each response button (or window) was correct once in every series of three trials and no button (or window) was correct on successive trials. The response sequence was identical for all groups eliminating provision for response sequence learning cues for one group and not for the other.

Procedure

S was seated before the apparatus and E explained that he was interested in how well children learned who are S's age. E described the discrimination box as a game in which S was to guess for the first few turns which button (or window) was correct, but that attention to the colored lights would result in "figuring out" how to play the game. The
red reflector light and buzzer were labelled as indicating correct and incorrect responses respectively. The instructions to the Ss for the Si, Su, and Si-Su stimulus presentation situations for each locus of response are found in Appendix A.

Following the learning session copies of Ishihara's Series of plates designed as tests for color blindness (Moore, 1964) were used for all Ss for detection of color blindness. The test was administered after S had "played the game" so that he could not establish a relationship between the significance of the test and the stimuli presented in the experimental situation.

Results

Number of Correct Responses

A simple analysis of variance was performed for each method of stimulus presentation for each level of stimulus similarity, each with three subconditions (color treatment groups) to determine if any color preference existed. No significant differences were found for Si - dissimilar stimuli, F(2, 27) = .09; Si - similar stimuli, F(2, 27) = 1.40; Si-Su - dissimilar stimuli, F(2, 27) = 2.60; Si-Su - similar stimuli, F(2, 27) = 2.61; Su - dissimilar stimuli, F(2, 27) = .54; Su - similar stimuli F(2, 27) = 2.17. Therefore, color for the three methods of stimulus presentation was collapsed for subsequent analyses.
The criterion for learning was 18 consecutively correct trials. If S achieved the criterion, correct responses were extended to 54 trials, if S did not meet the criterion or did so starting with trial 54 only the first 54 trials were included in the analysis. A trial is defined as the onset of the stimuli followed by one response. The response measure was the number of correct responses in nine blocks of six trials each. Results were analyzed in a four-factor analysis of variance (Lindquist, 1953) where M = three methods of stimulus presentation; S = two levels of stimulus similarity; L = two loci of response; and T = nine blocks of trials. The critical level of significance selected for use in these analyses was 5%.

Table 1 gives the summary of the analysis of variance

---

Insert Table 1 about here

---

for all experimental groups. The method of presentation x locus of response interaction was significant, $F(2, 168) = 6.87, p < .005$.

Figure 1 describes the method x locus interaction across

---

Insert Figure 1 about here

---

trials. It can be seen that the performance of Si D and
Su D are at widely separated levels, Su D being inferior to Si D. Analyses of variance were run for method of presentation at each locus of response, collapsed for trial blocks and stimulus similarity. Tables 2 and 3 show the summary of these analyses. With locus of response removed differences between methods were nonsignificant $F(2, 87) = 1.61$. However, with locus of response at the stimulus source significant differences between methods were found, $F(2, 87) = 14.38$, $p < .001$. Duncan's New Multiple Range Test (Edwards, 1964) was used to test for differences between the methods of stimulus presentation for which the response was direct. No significant differences were obtained between methods. However, inspection of Figure 2 reveals that the Si groups tended to perform better than the Si-Su and Su groups, and that the Si-Su groups tended to perform better than the Su method of presentation with locus direct. With locus removed Su reverses its position relative to Si-Su, and the between group variances are less than with locus direct. No other interaction effects were
The main effect of trials was significant, $F(8, 1344) = 60.77$, $p < .001$. These results indicate that performance improved significantly across trial blocks. It is important to note that the trials effect did not interact with any factor, indicating that learning did occur under all experimental conditions. The main effect of method of stimulus presentation was found to be significant, $F(2, 168) = 7.93$, $p < .001$. Figure 3 shows the learning curves across trial blocks for the Si, Su, and Si-Su groups collapsed for stimulus similarity and locus of response. The Si curve is consistently above the Su and Si-Su curves. The difference between the two loci of response groups tended to approach significance, $F(1, 168) = 3.27$, $.10 > p > .05$.

In general, although the similarity factor resulted in nonsignificant differences, the hypotheses that $Si > Si-Su > Su$ were upheld with direct locus of response. Trials to Criterion

A score was assigned to each S such that the score equals the trial upon which the criterion run started, if this event occurred on or before trial 54, or equals $n + 1$ where $n = \text{the first incorrect response occurring after trial}$
Table 4 shows the summary of the overall analysis of variance, where $M =$ method of stimulus presentation; $S =$ stimulus similarity; and $L =$ locus of response. The only significant interaction was method of presentation $x$ locus of response, $F(2, 168) = 5.50, p < .01$. An analysis of variance of the three methods at each locus point showed nonsignificant differences between methods at the removed locus, $F(2, 87) = 2.37$, but significant differences with the locus direct, $F(2, 87) = 14.30, p < .001$. Testing the simple effects using Duncan's New Multiple Range Test showed there was a significant difference beyond the .01 level between the $S_i$ and $S_u$ groups, and between the $S_i$-$S_u$ and $S_u$ groups with the locus direct, but with the locus removed method of stimulus presentation is not important. A tendency for a reversal between the $S_u$ and $S_i$-$S_u$ groups can be seen by inspecting Figure 4 which shows the three methods plotted at each locus of response ($R$, $D$). This may possibly be due to the tendency for $S_u$ - dissimilar to produce better
performance than the Si-Su - and Si - dissimilar groups. Means and standard deviations for the 12 experimental groups are presented in Table 7. Inspection of them further

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Insert Table 7 about here

---

indicates the differences between methods and shows a tendency for Su R to produce better performance than Su D.

The main effect of method of stimulus presentation was significant, $F(2, 168) = 10.03$, $p < .001$. The main effect of locus of response was significant, $F(1, 168) = 3.91$, $p < .05$. In conclusion, the trials to criterion data supports the number of correct responses data, that locus of response differentially affects performance under different discrimination methods.

Response Latency

During the learning session the response latencies of Ss in the Si and Su groups were recorded. Response latency is defined as the time from the onset of the stimulus lights till the onset of S's response. This measurement was not indicated to S through instructions, and the timer was not visible.

Since the response latencies were positively skewed, the data used in the response latency analysis were reciprocal transformations ($\text{reciprocal} = 1/\text{latency} \times 1,000$), and as
such were labelled response speed measurements. Inspection of the resulting frequency distribution revealed an essentially normal distribution.

Results were analyzed in an overall analysis of variance for the eight experimental groups, similar to the one conducted for the correct responses data. However, since different Ss learned at different rates, the trials effect was analyzed into three blocks of six trials each (the first six, middle six, and last six trials). Table 8 provides an analysis summary.

Only the method of presentation x stimulus similarity x locus of response interaction was significant, $F(1, 112) = 6.99$, $p < .001$. Figure 5 describes this triple interaction, which is uninterpretable. The contributing factor seems to be that $S_1$ - similar and $S_u$ - dissimilar reverse their positions relative to one another when locus of response is manipulated. The main effect of trials was significant, $F(2, 224) = 233.38$, $p < .001$.

In conclusion, it would seem that the effect of the
variables: method of stimulus presentation, stimulus similarity, and locus of response are not meaningfully related to the response latency measure. No further analyses were considered appropriate.

Discussion

The correct responses and trials to criterion measures indicate that locus of response is the crucial variable in determining differences in learning when different stimulus presentation methods are employed. Although previous research seemed to emphasize possible effects of the stimulus similarity dimension upon the method and response locus used, the results of this study indicate that, regardless of the degree of stimulus similarity, when the response is made directly to the stimulus source differential learning rates occur between methods. However, when the locus of response is removed from the stimulus source the stimulus presentation method is not important. Therefore, further examination of the methods differences with direct locus of response and the effect of response locus in relation to the position of the stimuli, is necessary.

Spiker and Lubker (1965) found that changing degrees of brightness between stimuli did not differentially affect Si and Su discrimination learning with direct locus of response. Their results, combined with those of the present study, provide an indication that the crucial variable
affecting human discrimination learning is the spatial contiguity of the stimulus and response.

That Si produces better performance than Su stimulus presentation can be handled by applying reinforcement theory to the experimental situation. In the Si condition S is presented all stimulus possibilities on each trial. He may respond to color, position, color-position, position in relation to position of an E-defined irrelevant color. For example, if red is correct for S, and he responds correctly on trial n (trial n = green on the left, blue in the middle, red on the right), pressing red (color), pressing the right window (position), pressing red-right (color-position), or pressing the right window when blue is in the middle, or when green is on the left (position in relation to position of an E-defined irrelevant color), may be reinforced. Reinforcement of pressing red and pressing right in relation to the position of a stimulus light in the left or middle window increases the habit strength of the correct response tendency. On trial n + 1 (red, green, blue from left to right), if S makes an incorrect response (pressing the window with a green or blue light in it), this trial serves as an extinction trial for that color response, position response, and color-position response. Therefore, the tendency to press blue (green), press right, press blue (green)-right is lessened. For the Si method this extinction trial
serves to eliminate responses irrelevant to the correct solution of the problem, i.e., pressing red.

The Su condition can be evaluated in the following manner: it consists of three subproblems (subproblem one = three red stimuli, middle window being correct; subproblem two = three green stimuli, left window being correct; subproblem three = three blue stimuli, right window being correct). There are several sources of support for viewing the Su problem as three subproblems: 1) Ss verbally reported that they systematically eliminated the colors that would not produce reinforcement of a particular response, or learned each color and its correct position response separately; 2) inspection of Figure 3 shows that the Su group at 54 trials has reached the same level of correct responding as the Si group at 18 trials. In addition, Spence's theory of patterned discrimination could be considered compatible with the present interpretation.

In the Su condition, if subproblem one is presented on trial n, subproblem two may be presented on trial n + 1. On trial n S responds correctly (presses the middle red window), and is reinforced for making a position response, a color response, and a color-position response. However, only the color-position response tendency is relevant to solving the problem; reinforcement of color does not increase habit strength of the correct response, as color
(within a trial) is not a discriminative stimulus. On trial \( n + 1 \) \( S \) makes an incorrect response to subproblem two. Nonreinforcement and presentation of the buzzer for an incorrect response to subproblem two does not affect the strength of any response tendencies to subproblem one, nor does it increase the response tendency for responding correctly to subproblem two, presented on trial \( n + 1 \). Therefore, responses are learned independently to each of the subproblems; no information is gained if \( S \) is responding to color or position alone; and if the response is to color-position, no information relevant to the solution of the total discrimination problem is given. The amount of relevant information reinforced on succeeding trials under the \( S_1 \) condition is greater than under the \( S_u \) condition.

With locus of response removed, \( S_1 \) \( S_s \)s are reinforced for a position response, but the color of the stimuli is less likely to be reinforced as stimulus and response are no longer contiguous; the distance between reinforcement and stimulus is greater than between reinforcement and response. Pressing color is impossible (stimulus and response source are separated, the stimulus not being present at the response source when a response is made), and only a representation of color, the discriminative stimulus, can be reinforced. Furthermore, for the \( S_1 \) condition, the reinforced response, position, is an irrelevant cue.
For Su Ss, position responses are also reinforced, but since position is a relevant cue to the solution of an individual subproblem S gains information on each trial. Therefore, with locus removed the difference between the Si and Su discrimination problems is less, the Si problem being more difficult in the removed condition because fewer pieces of relevant information are available when S makes a response on each trial.

The Si-Su group has the same information available that the Si group does, but Si-Su Ss must respond to stimulus traces rather than directly to the presented stimuli. Therefore, because of the stimulus and response asynchrony, Si-Su performance tends to be poorer than Si but better than the Su group. Since the Si-Su group is basically a Si group it should be affected similarly by manipulation of the locus variable, but performance did not decrease with the locus removed. No significant change in Si-Su performance, due to a change in response locus, may have been because Ss were observed to place a hand over the chosen button at the time the discriminative stimulus was presented, thus increasing the probability of making a correct response.

To summarize the results in terms of the hypotheses stated, learning did occur across trial blocks for all experimental groups. Although differences between the levels of stimulus similarity were predicted no significant differ-
ences resulted. The following factors may be operating: the similarity levels used in this study apparently did not vary sufficiently in degree of similarity to produce significant differences; the similarity dimension is an important one, only under certain specific conditions; or similarity has not been empirically defined. Locus of response is a crucial variable, the physical relationship between stimulus and response affecting performance. This study supports earlier primate and human experimentation (Stollnitz, 1965), where spatial contiguity of the stimulus and response produces superior performance.

In conclusion, the simultaneous method of stimulus presentation results in better performance than the successive method when the response is made directly to the stimulus source. Under the Si condition more relevant information is received than under the Su condition, and thus Si is more likely to find a quicker solution to the discrimination problem presented. Whether the stimuli are actually present at the time S makes a response will determine how much better Si performance will be than Su performance.
Summary

The effects of varying locus of response and stimulus similarity on number of correct responses, trials to criterion, and response latency were studied under simultaneous (Si), successive (Su), and simultaneous-successive (Si-Su) discrimination learning in fourth graders. The discrimination problems consisted of three stimuli each (red, pink, and orange; and red, green, and blue colored lights). The loci of response were either that S responded by pushing a button (locus removed from the stimulus source - R) or by pressing on a window behind which a stimulus light shone (locus directly at the stimulus source - D). Results showed that a direct locus of response results in differential performance under the different methods of discrimination, but that with the locus removed no significant differences between methods are produced when the measure is trials to criterion or number of correct responses. A method x similarity x locus interaction was obtained using the response latency measure, and did not produce a meaningful relationship between variables. The conclusion was drawn that latency is more likely to be meaningfully affected by variations in reinforcement or a time variable rather than variables affecting the stimulus properties and relationship between stimulus and response. The following conclusions were drawn with regard to the method x locus
interaction: (a) response locus influences method of stimulus presentation only when it is direct; (b) the amount of information gained on trials n and n + 1 will influence differential learning of the discrimination problem for the Si and Su methods; (c) whether or not the stimuli are present when S makes a response will determine how great the differences are between Si D and Su D.
Table 1

Analysis of Variance Summary for All Experimental Groups Using Number of Correct Responses

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>179</td>
<td>17.52</td>
<td></td>
</tr>
<tr>
<td>M (method of presentation)</td>
<td>2</td>
<td>120.55</td>
<td>7.93^c</td>
</tr>
<tr>
<td>S (stimulus similarity)</td>
<td>1</td>
<td>.63</td>
<td>.04</td>
</tr>
<tr>
<td>L (locus of response)</td>
<td>1</td>
<td>49.79</td>
<td>3.27^a</td>
</tr>
<tr>
<td>MS</td>
<td>2</td>
<td>6.11</td>
<td>.40</td>
</tr>
<tr>
<td>SL</td>
<td>1</td>
<td>1.80</td>
<td>.12</td>
</tr>
<tr>
<td>ML</td>
<td>2</td>
<td>104.52</td>
<td>6.87^b</td>
</tr>
<tr>
<td>MSL</td>
<td>2</td>
<td>33.25</td>
<td>2.19</td>
</tr>
<tr>
<td>error (b)</td>
<td>168</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Subjects</td>
<td>1440</td>
<td>2.23</td>
<td>60.77^c</td>
</tr>
<tr>
<td>T (trials)</td>
<td>8</td>
<td>103.24</td>
<td>.79</td>
</tr>
<tr>
<td>TM</td>
<td>16</td>
<td>1.34</td>
<td>.76</td>
</tr>
<tr>
<td>TS</td>
<td>8</td>
<td>1.30</td>
<td>.72</td>
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<tr>
<td>TL</td>
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<td>1.22</td>
<td>.50</td>
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<tr>
<td>TMS</td>
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<td>.86</td>
<td>.52</td>
</tr>
<tr>
<td>TSL</td>
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<td>.88</td>
<td>.31</td>
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<tr>
<td>TML</td>
<td>16</td>
<td>2.22</td>
<td>.35</td>
</tr>
<tr>
<td>TMSL</td>
<td>16</td>
<td>.60</td>
<td>.35</td>
</tr>
<tr>
<td>error (w)</td>
<td>1344</td>
<td>1.70</td>
<td></td>
</tr>
</tbody>
</table>

^a 0.10 > p > 0.05

^b p < 0.005

^c p < 0.001
Table 2
Analysis of Variance Summary for Methods of Presentation with Locus of Response Removed from the Stimulus Source Using Number of Correct Responses

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups (method of presentation)</td>
<td>2</td>
<td>238.90</td>
<td>1.61</td>
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<tr>
<td>Within Groups</td>
<td>87</td>
<td>148.40</td>
<td></td>
</tr>
</tbody>
</table>
Table 3
Analysis of Variance Summary for Methods of Presentation with Locus of Response at the Stimulus Source Using Number of Correct Responses

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups (method of presentation)</td>
<td>2</td>
<td>1786.70</td>
<td>14.38*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>87</td>
<td>124.25</td>
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</tr>
</tbody>
</table>

* p < .001
### Table 4
Analysis of Variance Summary for All Experimental Groups Using Trials to Criterion

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td>179</td>
<td>466.11</td>
<td></td>
</tr>
<tr>
<td>M (method of presentation)</td>
<td>2</td>
<td>4065.04</td>
<td>10.03^c</td>
</tr>
<tr>
<td>S (stimulus similarity)</td>
<td>1</td>
<td>85.43</td>
<td>.21</td>
</tr>
<tr>
<td>L (locus of response)</td>
<td>1</td>
<td>1584.20</td>
<td>3.91^a</td>
</tr>
<tr>
<td>MS</td>
<td>2</td>
<td>236.57</td>
<td>.58</td>
</tr>
<tr>
<td>SL</td>
<td>1</td>
<td>25.69</td>
<td>.06</td>
</tr>
<tr>
<td>ML</td>
<td>2</td>
<td>2230.32</td>
<td>5.50^b</td>
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<tr>
<td>MSL</td>
<td>2</td>
<td>275.74</td>
<td>.68</td>
</tr>
<tr>
<td>error^(b)</td>
<td>168</td>
<td>405.49</td>
<td></td>
</tr>
</tbody>
</table>

^a p < .05
^b p < .01
^c p < .001
Table 5
Analysis of Variance Summary for Methods of Presentation with Locus of Response Removed from the Stimulus Source Using Trials to Criterion

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups (method of presentation)</td>
<td>2</td>
<td>1011.21</td>
<td>2.37</td>
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<tr>
<td>Within Groups</td>
<td>87</td>
<td>426.58</td>
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Table 6
Analysis of Variance Summary for Methods of Presentation with Locus of Response at the Stimulus Source Using Trials to Criterion

<table>
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<th>Source</th>
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<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups (method of presentation)</td>
<td>2</td>
<td>5284.15</td>
<td>14.30*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>87</td>
<td>369.50</td>
<td></td>
</tr>
</tbody>
</table>

* p < .001
Table 7
Means and Standard Deviations of Trials to Criterion for the Twelve Experimental Groups

<table>
<thead>
<tr>
<th>Method of Presentation</th>
<th>Locus of Response Removed</th>
<th>Dissimilar Stimuli</th>
<th>Similar Stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Simultaneous</td>
<td></td>
<td>28.07</td>
<td>22.03</td>
</tr>
<tr>
<td>Successive</td>
<td></td>
<td>27.00</td>
<td>20.15</td>
</tr>
<tr>
<td>Simultaneous-Successive</td>
<td></td>
<td>32.07</td>
<td>19.79</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method of Presentation</th>
<th>Locus of Response Direct</th>
<th>Dissimilar Stimuli</th>
<th>Similar Stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Simultaneous</td>
<td></td>
<td>20.73</td>
<td>19.50</td>
</tr>
<tr>
<td>Successive</td>
<td></td>
<td>48.93</td>
<td>13.23</td>
</tr>
<tr>
<td>Simultaneous-Successive</td>
<td></td>
<td>33.00</td>
<td>20.93</td>
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</table>
Table 8
Analysis of Variance Summary of all Experimental Groups Using Mean Reciprocals of Response Latencies

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ms</th>
<th>F</th>
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<tbody>
<tr>
<td>Between Subjects</td>
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<td>76,339</td>
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</tr>
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<td>M (method of presentation)</td>
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<td>34,260</td>
<td>.46</td>
</tr>
<tr>
<td>S (stimulus similarity)</td>
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<td>40,695</td>
<td>.55</td>
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<tr>
<td>L (locus of response)</td>
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<td>150,386</td>
<td>2.03</td>
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<td>MS</td>
<td>1</td>
<td>9,659</td>
<td>.13</td>
</tr>
<tr>
<td>SL</td>
<td>1</td>
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<tr>
<td>ML</td>
<td>1</td>
<td>7,908</td>
<td>.11*</td>
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<tr>
<td>MSL</td>
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<td>518,451</td>
<td>6.99</td>
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<tr>
<td>error (b)</td>
<td>112</td>
<td>74,219</td>
<td></td>
</tr>
<tr>
<td>Within Subjects</td>
<td>240</td>
<td>32,763</td>
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<td>233.38**</td>
</tr>
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<td>TS</td>
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<td>error (w)</td>
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* p < .01

** p < .001
Fig. 1. Mean number of correct responses for simultaneous, successive, simultaneous-successive groups for each response locus.
Fig. 2. Mean number of correct responses for simultaneous, successive, simultaneous-successive groups.
Fig. 3. Mean number of correct responses for simultaneous, successive, simultaneous-successive groups.
Fig. 4. Mean trials to criterion for simultaneous, successive, and simultaneous-successive groups.
Fig. 5. Mean response speeds for simultaneous and successive groups for each level of stimulus similarity.
References


Etzel, Barbara C., & Wright, Elizabeth S. Effects of delayed reinforcement on response latency and acquisition learning under simultaneous and successive discrimination learning of children. *J. exp. child Psychol.*, 1964, 1, 281-293.


Appendix A

Instructions
Appendix A

Instructions for Ss assigned to successive or simultaneous discrimination conditions with locus of response removed from the stimulus source:

"In front of you is the game. All I'm interested in is how boys and girls your age go about learning how to play this game. First, I will show you what I can do, and then I will show you what you will be doing. I can turn on colored lights in these three windows (indicate them). When I turn on colored lights in these three windows, first look at the colored lights and then choose one of the buttons and push it (indicate buttons). If you pushed the correct button this red light will come on and tell you (indicate reinforcing light). If you pushed the wrong button you will hear a buzzer. At first you'll have to guess which button is correct each time, but if you look at the three colored lights every time and then choose a button soon you'll be able to figure out how to win points in this game. Let's try the game."

After the first correct response S was told the red light meant he pushed the correct button. After the first wrong response S was again told the buzzer indicated he pushed the incorrect button.
Appendix A

Instructions for Ss assigned to simultaneous or successive discrimination conditions with locus of response directly to the stimulus source:

"In front of you is the game. All I'm interested in is how boys and girls your age go about learning how to play this game. First, I will show you what I can do, and then I will show you what you will be doing. I can turn on colored lights in these three windows (indicate them). When I turn on colored lights in these three windows, first look at the colored lights and then choose one of the windows and press right on it (indicate windows). If you pressed on the correct window this red light will come on and tell you (indicate reinforcing light). If you pressed on the wrong window you will hear a buzzer. At first you'll have to guess which window is correct each time, but if you look at the three colored lights every time and then choose a window soon you'll be able to figure out how to win points in this game. Let's try the game."

After the first correct response S was told the red light meant he pressed on the correct window. After the first wrong response S was again told the buzzer indicated he pressed on the incorrect window.
Appendix A

Simultaneous-Successive discrimination condition instructions with locus of response removed from the stimulus source (directly to the stimulus source):

"In front of you is the game. All I'm interested in is how boys and girls your age go about learning how to play this game. First, I will show you what I can do, and then I will show you what you will be doing. I can turn on colored lights in these three windows one at a time, here, here, and here (indicate windows from S's left to right). When I turn on colored lights in these three windows one at a time, first look at all three colored lights and then, after this light (indicate right-hand window) has gone off, push one of these buttons (press on one of these windows) (indicate buttons, or windows respectively). If you pushed the correct button (pressed on the correct window) this red light will come on and tell you (indicate reinforcing light). If you pushed the wrong button (pressed on the wrong window) you will hear a buzzer. At first you'll have to guess which window is correct, but if you look here (indicate left window) when a colored light comes on, and here (indicate middle window) when a colored light comes on, and here (indicate right window) when a colored light comes on, and then after this light goes off, push one of the buttons (press on one of the windows) soon you'll be able to figure out
how to win points in this game. Let's try the game."

After the first correct response S was told the red light meant he pushed the correct button (pressed on the correct window). After the first wrong response S was again told the buzzer indicated he pushed the incorrect button (pressed on the incorrect window).
Appendix B

Picture of Apparatus
Discrimination Apparatus
Appendix C

Sample Data Sheets
Simultaneous----------- Dissimilar-correct for Green*

Simultaneous-Successive

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Date</th>
<th>School</th>
</tr>
</thead>
</table>

Response Locus: Direct | Removed

<p>| | | | | | |</p>
<table>
<thead>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
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<td>GBR (L)</td>
<td>GBR (L)</td>
<td>GBR (L)</td>
<td>GBR (L)</td>
<td>GBR (L)</td>
</tr>
<tr>
<td>RGB (M)</td>
<td>RGB (M)</td>
<td>RGB (M)</td>
<td>RGB (M)</td>
<td>RGB (M)</td>
<td>RGB (M)</td>
</tr>
<tr>
<td>BRG (R)</td>
<td>BRG (R)</td>
<td>BRG (R)</td>
<td>BRG (R)</td>
<td>BRG (R)</td>
<td>BRG (R)</td>
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<tr>
<td>RGB (M)</td>
<td>RGB (M)</td>
<td>RGB (M)</td>
<td>RGB (M)</td>
<td>RGB (M)</td>
<td>RGB (M)</td>
</tr>
<tr>
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<td>GBR (L)</td>
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<td>BRG (R)</td>
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<td>BRG (R)</td>
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<tr>
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<td>RGB (M)</td>
<td>RGB (M)</td>
<td>RGB (M)</td>
<td>RGB (M)</td>
</tr>
</tbody>
</table>

Total Number Correct in Blocks of Six Trials Each:

*This is a facsimile of the data sheet used for Ss being reinforced for green under the simultaneous or simultaneous-successive condition. Similar sheets were used for Ss reinforced for blue or red, and for the similar stimulus conditions.
Successive III (RGB)*

No.______ Name________________________ Date______ School________

Locus Response: Direct_________ Removed________

GGG (M) ______ GGG (M) ______ GGG (M) ______ GGG (M) ______
RRR (R) ______ RRR (R) ______ RRR (R) ______ RRR (R) ______
BBB (L) ______ BBB (L) ______ BBB (L) ______ BBB (L) ______
RRR (R) ______ RRR (R) ______ RRR (R) ______ RRR (R) ______
GGG (M) ______ GGG (M) ______ GGG (M) ______ GGG (M) ______
BBB (L) ______ BBB (L) ______ BBB (L) ______ BBB (L) ______
RRR (R) ______ RRR (R) ______ RRR (R) ______ RRR (R) ______
BBB (L) ______ BBB (L) ______ BBB (L) ______ BBB (L) ______
GGG (M) ______ GGG (M) ______ GGG (M) ______ GGG (M) ______
BBB (L) ______ BBB (L) ______ BBB (L) ______ BBB (L) ______
RRR (R) ______ RRR (R) ______ RRR (R) ______ RRR (R) ______
GGG (M) ______ GGG (M) ______ GGG (M) ______ GGG (M) ______
BBB (L) ______ BBB (L) ______ BBB (L) ______ BBB (L) ______
GGG (M) ______ GGG (M) ______ GGG (M) ______ GGG (M) ______
RRR (R) ______ RRR (R) ______ RRR (R) ______ RRR (R) ______
GGG (M) ______ GGG (M) ______ GGG (M) ______ GGG (M) ______
BBB (L) ______ BBB (L) ______ BBB (L) ______ BBB (L) ______

Total Number Correct in Blocks of Six Trials Each:

*This is a facsimile of the data sheet used for Ss under the successive dissimilar condition, being reinforced for the stimuli occurring in the pattern (RGB). Similar sheets were used for Ss reinforced for BRG and GBR, and for the corresponding similar stimulus conditions.
Vita

(a) Name: Elizabeth Smith Wright

(b) Place of Birth: Bellingham, Washington

(c) Date of Birth: May 14, 1941

(d) Marital Status: Married almost four years, no children

(e) Undergraduate School Attended: Western Washington State College

(f) Degrees Awarded: Bachelor of Arts with Honors and Bachelor of Arts in Education with Honors, graduated cum laude, 1963

(g) Teaching Experience: Two years as Kindergarten teacher two sessions daily in the Bellingham Public Schools, Bellingham, Washington, 1963-1965

Kindergarten teacher, Student Teacher's supervisor, and instructor of college course "The Kindergarten Teacher", Western Washington State College Bellingham, Washington, Summer 1966

(h) Assistantships and Fellowships: Undergraduate Assistantship, Department of Psychology, 1961-1962

Research Assistantship, with Dr. Barbara C. Etzel, 1963

Research Assistantship with Dr. Barbara C. Etzel, 1964

Graduate Assistantship, Western Washington State College Elementary School, Summer 1965
NDEA Fellowship, University of Montana, 1965-1967


(l) Areas of Special Interest: Behavior and development of preschool children.