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ABSTRACT

Response latency data from two studies of 30 5-to 7-year-old and 50 3 to- 4-year-old children were analyzed to assess the interrelations of response latencies with previously reported orienting response data and standard learning data. Ss in the first study were tested on an oddity task in three distraction conditions (mirror, sound, and control), and Ss in the second study were assigned to noise, sound, and control conditions. Statistical analyses indicated significant relationships between response latencies and both trials to criterion and total number of correct scores. Multiple correlations in both studies indicated that the combination of response latency and glancing measures was a more adequate and efficient predictor of learning than either measure by itself. (Author/LH)

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INTERRELATIONS OF ORIENTING RESPONSES, RESPONSE LATENCY AND STIMULUS CHOICE IN CHILDREN'S LEARNING

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The University of Minnesota Research, Development and Demonstration Center in Education of Handicapped Children has been established to concentrate on intervention strategies and materials which develop and improve language and communication skills in young handicapped children.

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Abstract

Response latency data from two studies were analyzed to assess the interrelations of response latencies with previously reported orienting response data and standard learning data. Subjects in the first study were 5 1/2, 6 1/2, and 7 1/2 year olds who were tested on an oddity task in three distraction conditions -- Mirror, Sound, and Control. Several analyses indicated a relationship between response latencies and learning, and these were supported by correlational analyses which showed significant relationships between response latencies and both trials to criterion and total number correct scores. Multiple correlations indicated that the inclusion of both response latency and glancing measures in the analyses accounted for as much or more of the variance in learning as could be obtained by computing the best simple correlation among predictors. The use of the same statistical procedures in the analysis of data from a second study with nursery school children confirmed the interpretation that the combination of response latency and glancing was a more adequate and efficient predictor of learning than either measure by itself. The potential contribution of multiple-response methodology to the resolution of traditional problems in children's learning is discussed.

Interrelations of Orienting Responses, Response Latency and Stimulus Choice in Children's Learning[1]

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A good part of the vast literature on attention and associated topics is related to the description and discussion of various states or degrees of attention (cf. Vernon, 1970, ch. 6). Under the rubric of "attention," individuals may be said to be distracted, inattentive, attentive, vigilant, or to exhibit a special and intense form of attention called "concentration" at some time or another. The reliability of judgments on the occurrence of these states of attention has seldom if ever been assessed, and few if any investigations of their validating characteristics have been conducted.

In the past, various investigators have suggested different indices of attention such as "sensory clearness" (Dallenbach, 1913; Titchener, 1908) and readiness to respond, e.g., reaction time (James, 1890), although in many cases one specified index can take contradictory forms, i.e., attention shortens reaction times (cf. James, 1890, pp. 427-434) vs. attention provides for more deliberate (slower) responding (cf. Kagan, Moss & Sigel, 1963). Generally agreed upon as the primary requisite for visual attending has been ocular orientation toward a specified stimulus. That is, a person must at least be looking at an object to be attending to it. However, appropriate orientation is not sufficient as a unitary criterion of attention, since such orientation simply assures retinal stimulation and not central (cortical) excitation (Gibson, 1966, p. 51; Hernandez-Peon, Scherrer, & Jouvet, 1956; Woodworth & Schlosberg, 1954, p. 72; general introspection). Because ocular orientation serves only a necessary role in attending, it has often been discounted as a focus of fundamental research activity and theoretical analysis (Trabasso & Bower, 1968). Nevertheless, ocular orientation appears to be one of the few overt behaviors that can stand as a direct index of attention, and were this to be demonstrated, orienting could be employed as a validating measure for other indices of attention.

Recent research (Turnure, 1966, 1970a, b, c) has demonstrated that the incidence and duration of orienting responses can be measured reliably, and that the measures obtained correlate significantly with standard indices of learning, such as trials to criterion and number of correct responses on a discrimination learning task. Significant inverse correlations were obtained between the measure of non-task orienting (i.e., glancing away from the task) and the number of correct responses made by subjects, with the strength of the relationship varying somewhat as a function of the amount of controlled distraction incorporated into the various conditions of the studies. The findings that duration and frequency of orienting behavior correlate significantly with measures of learning strongly support the notion that the orienting response may bc used as a valid indicator of attentive functioning.

The latency of a response has long been used in studies of attention to make inferences about the attentive process and variables which affect it. Early studies focused on variability in simple reaction times (cf. James, 1890; Pillsbury, 1908) as indicative of degrees of attentive involvement in the task, a tradition of research that continues today (LaBerge, 1971). Recently, emphasis has been placed on the study of response latencies, which usually involve much longer temporal intervals than reaction times, and which are measured in more complex learning situations (Levin & Maurer, 1969; Turrisi & Shepp, 1969; White, 1965). Probably because of the long tradition of research on the relationship of reaction time to attention many experimenters have been inclined to interpret reaction time or response latency as a direct index of attention. There are only a few studies available concerned with cross-validating response latency with any other index of attention. Elliott (1964, 1966) has investigated the interrelations of various physiological reactions with reaction time, and this research is unique in having studied children as young as five years of age. No studies validating reaction time or response latency with any other behavioral index of attention (e.g., orienting responses) were found in the literature. The present study reports such (potential) validating data.

In the present study, response latency data which were available on subjects' response records, but were not analyzed previously, are reported (Turnure, 1970a, 1971). The analyses to be presented here include assessments of the interrelations of the response latency data and the previously reported orienting response and learning data. The response latencies of young children in three conditions of distraction were analyzed in such a way that the results would be comparable to results of the previously analyzed orienting responses of the subjects (Turnure, 1970a), both independently and in relation to the subject earning scores. Data from a second, comparable study (Turnure, 1971), which were analyzed similarly, are then reported as a check on the reliability and generality of the initial findings (cf. McCall, 1970, p. 1374).

Method

Subjects. Ss of ages 5 1/2, 6 1/2, and 7 1/2 years performed in one of three conditions--Mirror Distraction, Sound Distraction, or Control. Each age group in each condition consisted of 5 boys and 5 girls matched on CA and all IQ's were in the normal range of 90 to 120. All Ss were white, and modal SES was estimated as lower-middle class (see Turnure, 1970a). The data were treated in a general two-between (Age X Condition) and one within (Trials: Pre vs. Postcriterion) design.

Apparatus. A light-proof portable booth housed the projector which presented the learning problem stimuli and the recording equipment, and provided a place where observers (Os) could be stationed unobtrusively. The front or subject side of the booth consisted of a 32 x 45 in. one-way vision mirror rested upon a base part which had an aperture 7 1/2 x 11 in. cut in it, in which was affixed the stimulus presentation, response, and reward panel. This panel consisted of three translucent plastic windows, each 3 1/2 x 4 in., and three red reward lights, one mounted above each of the windows.

The subject was instructed to press the window of his choice when the stimuli appeared. The projector allowed for automatic projection of stimuli according to a fixed schedule established by *E*. A remote control device allowed *E* to project training stimuli from outside the booth. The six stimuli--circle, square, triangle, cross, octagon, and >------< appeared as black figures in the illuminated windows.

A twenty-pen Esterline-Angus event recorder was wired to the equipment described above in such a way that there was continuous and simultaneous recording of the correct stimulus window, the *S*'s response, the latency of that response, and the *O*'s judgment regarding the *S*'s incidence and duration of glance behavior (recorded during both trial and intertrial periods). A glance was recorded each time *S*'s eyes left the stimulus panel.

Procedure and Experimental Conditions. Each *S* was taken individually from his classroom by *E*, who informed the child that they were going to play a game. Subjects were tested on the stage of their school's auditorium.

In the Mirror Distraction condition, a one-way vision screen affixed to the front of the apparatus was removed, exposing the mirror. In the Sound Distraction Condition, the screen remained over the mirror, but an LP phonograph record played children's songs and stories continuously during *S*'s presence in the test situation (the phonograph was on when the child entered the experimental setting). The source of this auditory distraction was to the right and rear of the *S* and was hidden from view by being placed beneath a chair.

The volume control was set to provide a sound level of 60 decibels, ± 5 dB. In the Control condition, the screen remained over the mirror and no auditory distractor was present.

The task presented the children was an oddity problem as modified by Moon and Harlow (1955). The S had to select the odd stimulus in order to be reinforced. The odd figure appeared in either the right or left stimulus-response window but never in the center, a procedure designed to facilitate learning (cf. Moon & Harlow, 1955; Ellis, Hawkins, Pryer & Jones, 1963). The stimuli were selected randomly for presentation in a Gellerman series.

Upon completion of the instructions and training trials, E rose and entered the rear of the booth. E operated the slide projector and, with the presentation of the first slide, O began recording S's glances. A stimulus presentation lasted 4 seconds, regardless of S's response latency or the correctness of the response, and the intertrial interval was 1 second. Each S was given all 60 trials.

Results

An Age X Condition analysis of variance of the subjects' average response latencies over the 60 trials of the discrimination problem produced no significant differences. However, as in a previous study (Levin & Maurer, 1969), the response latencies were further analyzed to show their relation to the actual acquisition of a correct response. To carry out these analyses, subjects were classified as either criterion or non-criterion, depending on whether they had reached the learning criterion of six consecutive correct responses, and the scores of the criterion subjects were further separated into pre-criterion and post-criterion components (cf. Turnure, 1970a, 1971). The means and standard deviations of the criterion subjects' pre- and post-criterion latencies and the pre-criterion latencies of non-criterion subjects averaged over 60 trials are presented in Table 1.

Insert Table 1 about here

A 3 x 3 x 2 (Condition X Age X Trials) analysis of variance, with repeated measures on the Trials factor (cf. Winer, 1971, p. 559) was performed on the response latency data of the criterion subjects (for unequal sample sizes; cf. Winer, 1971, p. 210). For the between-subjects factors, both the Distraction Condition [$F(2,42) = 4.74$, $p < .025$] and the Distraction Condition X Age interaction [$F(4,42) = 2.74$, $p < .05$] were significant. A Newman-Keuls test for differences among means revealed that across all ages, the children in the mirror and sound conditions took significantly longer to respond than children in the control condition (both $ps <$ .01). Within age levels, this significant difference was found only for the 5 1/2 year old subjects.

For the within-subjects factors, the Trials factor [$F(1,42) = 47.47$, $p < .001$] and the Distraction Condition X Trials [$F(2,42) = 4.00$, $p < .05$] and Age X Trials [$F(2,42) = 39.09$, $p < .001$] interaction factors were significant. Overall, the pre-criterion response latencies of criterion subjects ($\bar{X} = 2.41$) were significantly longer than the post-criterion response latencies ($\bar{X} = 1.64$). In all conditions, criterion subjects responded significantly slower prior to solution of the discrimination task than after solution, and the separation of pre- and post-criterion scores was deemed justifiable. Backward latency curves were plotted to determine if the criterion subjects' longer latencies were uniform throughout the pre-solution period and to illustrate the form of the reduction in latencies after criterion had been reached. As can be seen in Figure 1, latencies varied prior to criterion but, after a warm-up period, showed a steady increase to the point of solution. The dramatic reduction in the variability in responding after solution, which was noted by Levin and Maurer (1969), is quite obvious in the present data.

Insert Figure 1 about here

The significant within-subjects interactions in the overall analysis reflected the relatively longer pre-criterion response latencies and shorter post-criterion response latencies of the children in the mirror condition (Condition X Trials) and of the 6 1/2 year old children (Age X Trials). While no condition differences existed in post-criterion response latencies, a significant difference was found between the mirror and control conditions in pre-criterion response latencies [$\underline{t}(36) = 2.46$, $\underline{p} < .01$], with the subjects in the mirror condition having significantly longer latencies. A similar analysis of the response latencies of non-criterion subjects averaged over 60 trials did not reveal any significant differences.

The difference between the pre-criterion response latencies of the criterion and non-criterion subjects within each condition was analyzed by a simple *t* test. Differences were significant only in the two distraction conditions [mirror condition: t (28) = 4.33, $p < .001$; sound condition: t (28) = 2.63, $p < .02$]. The mean difference in response latencies between criterion and non-criterion subjects in the control condition was not significant [t (28) = 1.61].

In order to investigate the general relationship between response latencies and the learning of the discrimination problem further, correlational analyses were performed on (1) trials to criterion and response latencies, (2) number correct and latencies, and (3) number correct and a combined response latency and glancing measure.

Because of the relatively large number of subjects who did not reach criterion, the trials to criterion measure was skewed. Contingency coefficients were computed within conditions by splitting the distributions of the trials to criterion and pre-criterion response latency scores. These coefficients revealed a significant relationship between trials to criterion and pre-criterion response latencies for the mirror condition (C = .471; $\chi^2 = 8.53$, $p < .005$) and a lesser, but significant one in the sound condition ($C = .374$; $\chi^2 = 4.89$, $p < .05$). No significant relationship was found between the two scores within the control condition ($C = .196$; $\chi^2 = 1.21$, n.s.). The Yates correction was included in the computation of all *C*s.

In further analyses, the total number of correct responses was used as the measure of learning. When the relationship between pre-criterion response latency and learning was assessed by Pearson product-moment correlations, a significant relationship between latency and learning was found for all three experimental conditions. The correlations were significant at the .01 level for the mirror condition ($\underline{r}$ = .73) and at the .05 level for both the sound condition ($\underline{r}$ = .38) and the control condition ($\underline{r}$ = .46). The magnitude of these correlations appears to be in good agreement with those reported by Turnure (1970a), which measured the relationship between pre-criterion glancing scores (time spent looking away from task stimuli) and learning (total number of correct responses). In conditions identical to those used here, Turnure found the following correlations: mirror condition $\underline{r}$ = -.65; sound condition $\underline{r}$ = -.44; control condition $\underline{r}$ = -.33. Although these correlations using two different measures are quite comparable, there are some differences. The correlations reported for glancing scores are generally of slightly lower magnitude than those for response latencies. And, although the correlations in the mirror condition are higher than those for the other two conditions, the ordering of the correlations for the sound and control conditions do not agree for the two measures (glancing and latencies).

Despite these discrepancies, evidence for the similarity of the response latency measure and the glancing score measure was found in the correlations between these two measures: mirror condition $\underline{r}$ = -.49; sound condition $\underline{r}$ = -.40; control condition $\underline{r}$ = -.49

(for all *rs*, $p < .05$). It should be emphasized that these correlations are all based on independent samples of 30 subjects who were observed in three different conditions, thus making the observed consistency even more impressive. The effect of chronological age on these correlations was assessed by partial correlational techniques. These analyses had minimal effects on the previously obtained correlations (the partial *rs* were: mirror -.46; sound -.43; control -.47), indicating that CA does not enter in any significant way into the relationship between glancing and response latency across the age span of 5 1/2 to 7 1/2 years.

The correlations of glancing and response latency with the number correct within each condition were entered into a series of multiple correlations. The resultant *Rs* are as follows, first with the effects of CA included and then with CA partialed out: mirror condition *R* s = .80, .77; sound condition *R* s = .49, .50; control condition *R* s = .48, .46. The merit of combining response latency and glancing into a unitary predictor of learning was demonstrated by the increase in the amount of variance accounted for by the multiple correlations (*Rs*) over that accounted for by the larger of the correlations of response latency or glancing with learning (*rs*). In the mirror condition, the *R* of .80 accounted for 64% of the variance in the learning scores while the largest simple correlation was the response latency *r* of .73, which accounted for only 53%. Similarly, in the sound and control conditions, computing multiple correlations accounted for as much or more of the variance in learning as could be obtained by computing the best simple correlation from among the predictors (response latency and glancing). Furthermore, the procedure of using the best simple correlation would appear to require empirical assessment of which predictor was most adequate depending on the conditions. Combining response latency and glancing into a unitary predictor of learning (as measured by the number correct) therefore appeared as a more adequate and efficient predictor of learning in the present discrimination problems. Thus, investigations into the role of attention in discrimination learning would likely profit from measuring multiple presumptive indices of attention and examining their intercorrelations by psychometric methods.

Discussion

The analyses of the latency data clearly show that subjects who attain criterion on the discrimination task respond significantly slower prior to solution than after solution in all conditions tested. That the post-solution latencies were also considerably less variable for these subjects, both within and across conditions, can be seen most clearly in Figure 1. However, it was only for the two distraction conditions that response latencies prior to solution were significantly slower for the criterion than for the non-criterion subjects. Again observation of Figure 1 shows in keeping with this latter finding, that when comparing the three criterion groups it is the control condition subjects who respond the most rapidly prior to solution, and, as was shown in the results, they are performing no differently from the non-criterion subjects in that condition.

This latter finding seems consistent with the contingency coefficients computed in order to reveal the degree of the relationship that exists between the number of trials taken to reach criterion and mean response latency to criterion. These coefficients revealed a significant relationship for the mirror and the sound conditions. The one-way analysis of variance of the latency scores for the criterion subjects and for the non-criterion subjects indicated that it is only for the criterion subjects that any differences among conditions emerge; specifically, the mirror condition criterion subjects performed significantly slower than did control condition criterion subjects.

When the relationship between response latency and learning was assessed using the total number correct as the measure of learning, a significant relationship was found for the control as well as for the two distraction conditions. These correlations, it was noted, were in good agreement with previously reported correlations between number correct and glancing scores (Turnure, 1970a). Significant negative correlations were found between glancing and response latency measures in all conditions, and further, combining response latency and glancing into a unitary predictor of learning (as measured by the number correct) was shown to produce the most adequate prediction of learning. The significant correlations between glancing and response latency support the assumption that response latency is related to, and presumably is an index of, attentive functioning. Significant independent correlations showed that both glancing and response latency were related to learning. However, the greater magnitude of the relation of learning with both measures as observed in the multiple correlations indicates that one of the measures is contributing something beyond that of the other. Since the glancing measure appears to be a straightforward index of attending, it stands to reason that response latency reflects some further process or processes. This additional increment could emerge from the operation of some further different aspect of the attentive process itself, such as "focal attending" (Neisser, 1967; Schactel, 1959), or perhaps a judgmental process (Fellows, 1968), or a general "cognitive" style" (cf. Kagan & Kogan, 1970). Perhaps the availability of two overt responses, each significantly related to learning, but not entirely equivalent, will provide a start towards isolating the varied, sequential aspects of the complex process known as learning (Fellows, 1968; Turrisi & Shepp, 1969).

Before discussing other general methodological and theoretical implications of these findings, the results of applying similar methods of statistical analysis to data from a comparable study (Turnure, 1971) will be reported.

Method

Subjects. All subjects attended the university nursery school, and could be characterized as being from advantaged environments (i.e., middle and upper class SES), and of above average intellectual ability, based on the principal's estimate. Twenty subjects of mean CA 3-9 and twenty of mean CA 4-9, composed younger and older age groups. Pairs of boys and girls from these groups matched on CA were randomly assigned to either the noise or control conditions. Ten additional subjects (mean CA = 4-3) were assigned to the sound condition (see Turnure, 1971).

Apparatus. The apparatus employed was identical to that used in the first study described.

Procedure. The procedures also were very similar to those employed in the previous study. Each subject was taken from his classroom during the daily free-play session and told he was going to play a game. The child was then taken to a room used only for experiments. In the noise condition, a hidden tape recorder was located adjacent to a door leading to another room, and a tape of typing noise (activated prior to the child's entry) played continuously at about 70 dBs throughout testing. The control and sound condition procedures were identical to those used in the first study reported. After instructing the subject, the experimenter entered the rear of the booth, switched the projector to automatic advance and began recording glances away from the task.

In the present study a two-choice simultaneous discrimination task was employed instead of the more difficult oddity problem (Hill, 1965) used for the 5 1/2 to 7 1/2 year old children. One of the six black geometric forms was arbitrarily designated correct. This stimulus was paired with all other stimuli and the pairs were ordered over 50 trials in a Gellerman series. Each stimulus pair was shown for 4 seconds regardless of the subject's response latency or correctness in a noncorrection procedure with an intertrial interval of one second. Each subject was given 50 trials.

Results

As in the first study reported, an Age X Condition analysis of variance of the groups' response latencies over the 50 trials showed no significant differences. This overall analysis compared only the control and noise conditions at the two age levels since only one age level was tested in the sound condition. The subjects in all groups were then classified as criterion or noncriterion depending on whether they made six consecutive correct responses or not, and response latencies were further analyzed to show their relation to the acquisition of the correct response. Table 2 presents the means and standard deviations of subjects' pre- and post-criterion response latencies and the latencies of non-criterion subjects averaged over 50 trials.

Insert Table 2 about here

A 3 x 2 (Condition X Trials) analysis of variance, with repeated measures on the Trials factor, was performed on the response latency data of the older criterion subjects. The only significant factor was the Trials factor [$F(1,12) = 19.68$, $p < .001$], with the pre-criterion response latencies of criterion subjects ($\bar{X} = 2.19$) being significantly longer than the post-criterion response latencies ($\bar{X} = 1.43$).

The differences between response latencies of criterion and noncriterion subjects within conditions, also seen in Table 2, were then analyzed by simple t tests. The difference in mean response latency between these two groups of subjects was found significant for the noise condition [$t(18) = 1.89$, $p < .05$]; the difference in the control condition [$t(18) = 1.04$, $p < .20$] was not significant, and in the sound condition [$t(8) = 1.89$, $p < .10$] just approached significance.

Backward latency curves were plotted for the nursery data, and as can be seen in Figure 2, only in the sound condition did these subjects show the dramatic reduction in the variability of responding after solution that was found in all three experimental conditions with the older subjects in the first study reported. The noise and control condition subjects in the present study, while showing some slight decrease in the mean length of response latency after solution, showed relatively little variability in responding prior to solution as well as after solution.

Insert Figure 2 about here

As in the first study, the general relationship between response latencies and learning was explored by correlational methods. In order to make these analyses comparable to those in Study I, contingency coefficients were first computed within the control and noise conditions by splitting the distributions of the trials to criterion and pre-criterion response latency scores at the means (a contingency coefficient was not computed for the sound condition since the total n of 10 was so small). For the control condition subjects, no significant relationship between the two scores was found ($C = .07$, $\chi^2 = .11$, n.s.). In the noise condition, however, a significant C of .45 was found ($\chi^2 = 5.00$, $p < .05$). The Yates correction was included in the computation of the Cs.

The relationship between response latency and learning was further assessed by computing Pearson product-moment correlations for each condition using the total number of correct responses made by each subject as the measure of learning. The correlation was significant at the .01 level for the noise condition [$r(18) = .67$] but was not significant for either the control [$r(18) = .13$] or the sound conditions [$r(18) = .47$]. In the present study the correlation between number correct and chronological age was extremely high and significant for the sound condition ($r = .73$, $p < .02$). In fact, this was the only instance in which any of the factors--number correct, response latency to criterion, or pre-criterion glance scores--were found to be significantly related to chronological age, although in each case the correlation of these factors with CA was higher in the sound condition than in the noise or control conditions. Partial correlations computed to assess the effects of age on the correlation of number correct with response latency showed that the effect of CA was minimal in both the control (partial $r = .14$) and noise conditions (partial $r = .64$), but substantial in the sound condition (partial $r = .17$). In other words, when age is partialed out, the correlation between number correct and pre-criterion response latencies drops from .47 to .17 for the sound condition, but the change is very little in the other two conditions.

Correlations between glancing and response latency measures (noise $r = -.53$; sound $r = -.13$; control $r = .21$) did not show the consistency across conditions found with the older subjects in Study I. Again, with the exception of the sound condition, the effect of CA was minimal on these correlations (partial r's: noise $r = -.49$; sound $r = .10$; control $r = .20$).

The correlations of glancing and response latency with the number correct within conditions were entered into a series of multiple correlations as had been done with the data for the older subject groups. The resultant Rs were as follows, first with the effects of CA included and then with CA partialed out (noise Rs = .68, .65; sound Rs = .56, .21; control Rs = .35, .34). Once again it can be seen that age was a substantial variable in the sound condition, but these data are based on only an n of 10, and interpretation of the results must necessarily be undertaken with some care. Again it is apparent that computing multiple correlations accounted for as much or more of the variance in learning as could be obtained by computing the best simple correlation among predictors.

Discussion

The results from the second set of data show predominant similarities with the findings of the first set. Criterion subjects showed longer latencies prior to criterion than after, although the difference in the control condition was not found significant here. Similarly, criterion subjects were found to respond slower than non-criterion subjects, although not significantly slower in all conditions. A significant difference was again obtained in the noise condition, while in the sound condition a difference of equal magnitude was not statistically reliable due to the smaller _n_ involved; as in the first study, the control condition difference did not approach significance.

The mean estimates of response latency scores within conditions in each set of data were very similar for both criterion and non-criterion subjects (compare Tables 1 and 2). No significant differences were found in between-condition analyses for non-criterion subjects in either study, and a similar analysis for criterion subjects in the present study was also non-significant, although the same analysis in the first study was significant. The backward latency curves observed in the data of this study were not as clearly reflective of the "rise-and-fall" of latencies around criterion as were those of the first study and those of Levin and Maurer (1969).

The correlational analyses on the data of the second study were generally in accord with those reported for the first study, although the magnitude of the relationships obtained in the present data were slightly lower and less consistent, possibly due to the smaller _n_ contributing to this data. The lower CAs of this sample may also have contributed to these slight differences, since individual differences in maturational patterns and rates of various, unspecified, organismic systems, which are more variable at early ages, could introduce unsystematic variance into the dependent measures. The notable influence of CA on the interrelationships of the three dependent measures in the sound condition shows that it is of more influence in the present than the previous subjects' performance. The multiple correlations obtained again showed that while the two descriptive variables of orienting behavior and response latency were significantly related, they each contribute some independent information about the course and outcome of the discrimination learning process.

The congruence of the findings from the data of the two studies indicates that response latency is a very sensitive indicator of certain subject characteristics which relate very closely to the likelihood that an individual will or will not exhibit the correct response as required on several standard discrimination learning tasks. The congruence in the patterns of results obtained in the two studies from subjects of completely different ages indicates that these data are reflecting rather basic response requirements which should be of quite broad generality. The lack of many significant CA effects within either body of data supports the contention that age is not implicated in these response functions. The observation that the response functions must be of broad generality is supported by reports of patterns of findings similar in most important aspects from studies of standard oddity learning involving mentally retarded subjects (Turnure & Larsen, 1971; 1972b), and from studies of oddity learning utilizing some novel procedures with a range of nursery school children (Turnure & Larsen, 1972a).

The fact that all of the significant findings emerged from analyses using the separated pre- and post-criterion scores, while the overall latency scores produced nonsignificant results, indicates the importance of regarding learning as a complex process, involving different operations or operating principles at different points, confirming that "the patterns of behavior at different times need to be compared [Broadbent, 1971, p. 193]." These observations gain added emphasis from the fact that orienting responses (glances) similarly show changes across the criterion point (Turnure, 1970a, 1971).

In a study by Turrisi and Shepp (1969, Experiment IV), they describe another utilization of response latency as "a measure which may vary independently of choice measure [p. 396]," which could then correlate with changes in stimuli along an irrelevant dimension, even though a subject's consistent choices may be to a stimulus on the relevant dimension. Turrisi and Shepp reasoned that finding such changes would allow the inference that both relevant and irrelevant dimensions were being attended to, and the results of a reversal shift study involving subjects given novel or original irrelevant dimension stimuli showed that all subjects chose the positive training stimulus on trial one of the reversal, but that novel condition subjects produced significantly longer response latencies. Here again, then, valuable information emerges from comparing patterns of behavior at different times. However, Turrisi & Shepp (1969) point out that while implications of differential choice and latency measures on the first reversal trial are readily apparent, "the results from subsequent trials are not so clearcut [p. 399]." They note that the course of correct choices and of latencies over trials for the novel and original stimulus groups differ in some respects and not others, and also differ depending on which of the two measures is considered.

The dilemma faced by Turrisi & Shepp in attempting to interpret their complex results stems from the impossibility of directly relating response latencies to choice responses since a given stimulus object consists of one relevant and one irrelevant dimensional cue.

Two possible solutions to this problem of confounded stimulus dimensions appear to exist. One which follows from the procedures presented in this investigation would be to distinguish between individual subjects' pre- and post-criterion response latencies, which would allow more precise specification of response latencies to relevant and irrelevant cues, giving grounds for distinguishing between the longer latencies associated with settling on the correct choices (involving the judgmental process, perhaps?) and those associated merely with additional attending responses across dimensions. Also, the course of averaged group latency scores could be adjusted by separating responses of learners and non-learners. The other solution would utilize a recently developed technique for presenting stimuli in a non-confounded manner (Robichaud, 1971). In this procedure, subjects are presented with four stimulus objects, instead of two, and these are arranged in such a way that spatial contiguity would tend to produce cue associatedness comparable to that of the standard stimulus objects (see Figure 3). Because each cue can be responded to independently, there is no ambiguity in assigning measured response characteristics to appropriate analytic categories. Robichaud's doctoral thesis (1971) demonstrated the equivalence of this new procedure to the traditional one, when reinforcement contigencies are equated. It appears that a combination of this new procedure and the response analyses described in this report can contribute to the further elucidation of the processes of children's learning.

Insert Figure 3 about here

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Footnote

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Table 1

Means and Standard Deviations of Pre- and Post-Criterion Response Latencies

	Condition					
	Control		Mirror		Sound	
	Pre-criterion	Post-criterion	Pre-criterion	Post-criterion	Pre-criterion	Post-criterion
Criterion	$\overline{X}$ = 2.08	1.62	2.76	1.57	2.49	1.76
Subjects	SD = 0.74	0.27	0.92	0.25	0.90	0.28
	n = 21		n = 17		n = 13	
Noncriterion	$\overline{X}$ = 1.66*		1.53		1.72	
Subjects	SD = 0.38		0.47		0.65	
	n = 9		n = 13		n = 17	

*Pre-criterion latencies for non-criterion Ss are averaged over 60 trials.

Table 2

Means and Standard Deviations of Pre- and Post-Criterion Response Latencies

	Condition					
	Control		Noise		Sound	
	Pre-criterion	Post-criterion	Pre-criterion	Post-criterion	Pre-criterion	Post-criterion
Criterion	$\overline{X}$ = 1.77	1.62	2.25	1.44	2.50	1.30
Subjects	SD = 0.32	.34	0.85	.32	1.00	.31
	n = 7		n = 10		n = 5	
Noncriterion	$\overline{X}$ = 1.49*		1.50		1.62	
Subjects	SD = 0.66		0.42		0.29	
	n = 13		n = 10		n = 5	

*Pre-criterion latencies for non-criterion Ss are averaged over 50 trials.

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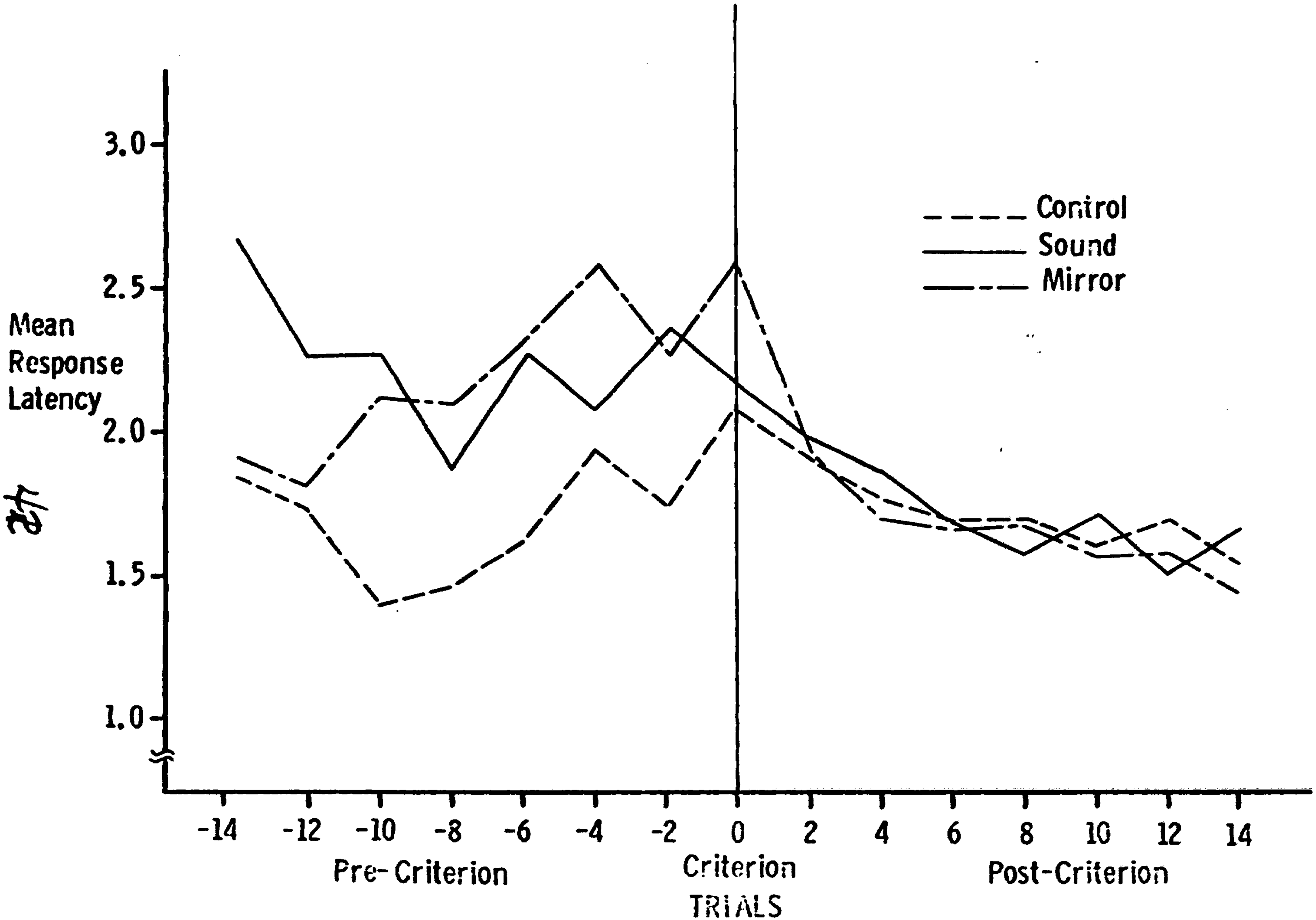
Figures

Figure 1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Sound
Mirror
Mean Response Latency
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2.5
2.0
1.5
1.0
-14
-12
-10
-8
-6
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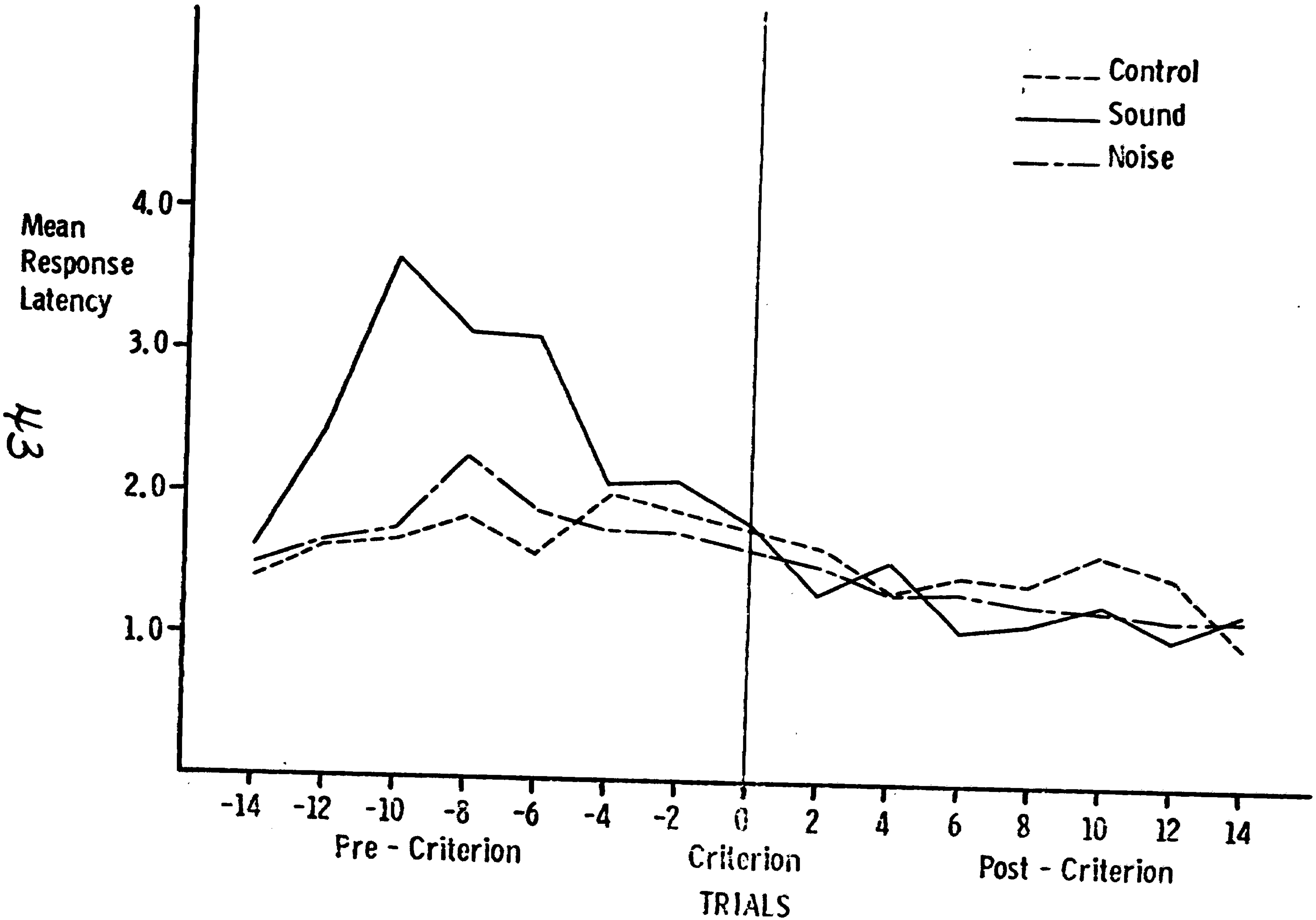
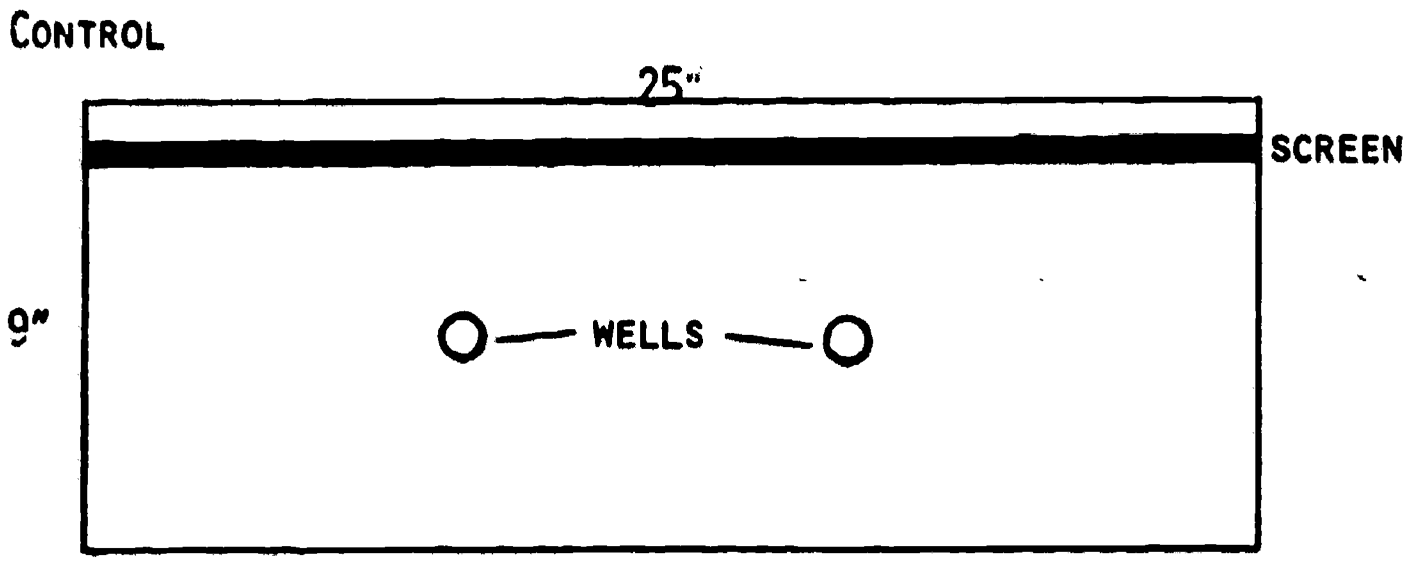
-2
0
2
4
6
8
10
12
14
Pre-Criterion
Criterion
Post-Criterion
TRIALS

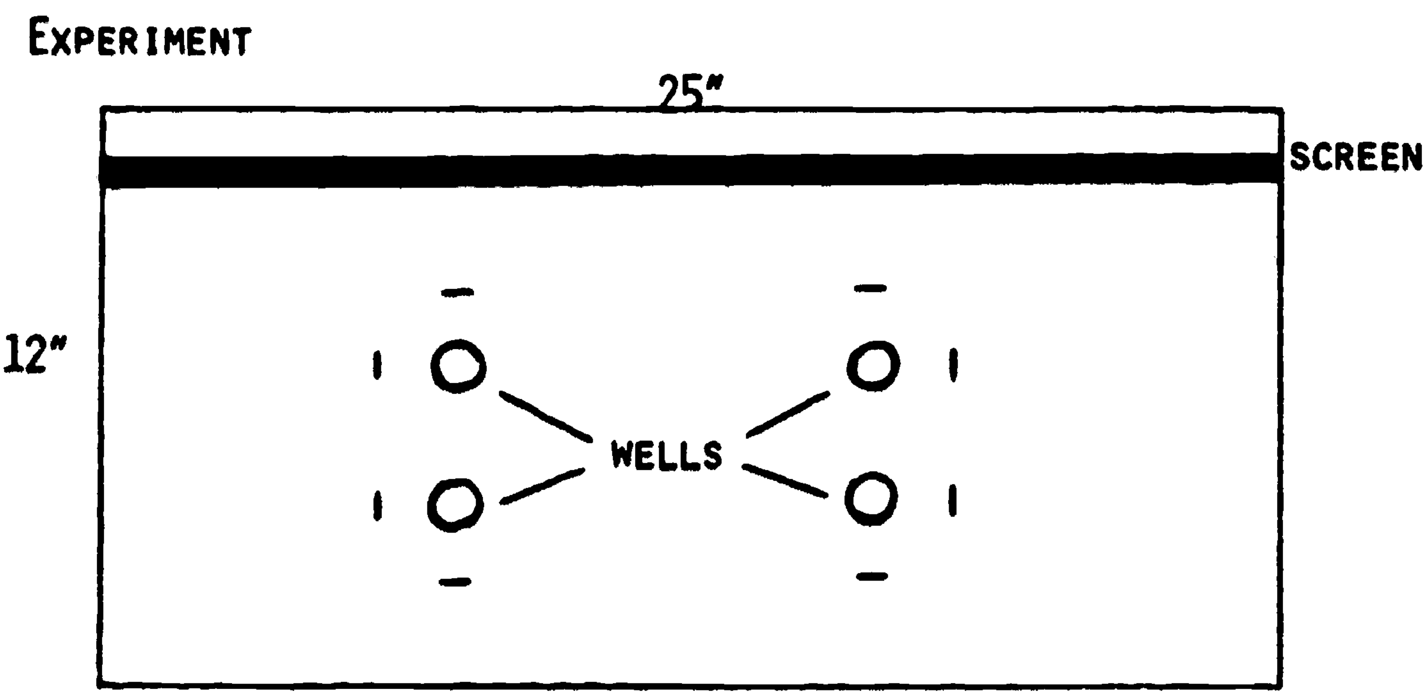
Figure 2



Control
Sound
Noise
Mean
Response
Latency
4.0
3.0
2.0
1.0
-14
-12
-10
-8
-6
-4
-2
0
2
4
6
8
10
12
14
Pre - Criterion
Criterion
Post - Criterion
TRIALS

Figure 3





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