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CHILDREN'S REACTIONS TO DISTRACTORS IN A LEARNING SITUATION--A DEVELOPMENTAL INVESTIGATION.

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THE PERFORMANCE OF CHILDREN 5 1/2, 6 1/2, AND 7 1/2 YEARS OF AGE ON AN ODDITY PROBLEM UNDER THREE CONDITIONS OF DISTRACTION WAS INVESTIGATED. SUBJECT'S GLANCES AWAY FROM THE TASK WERE RECORDED ALONG WITH THEIR LEARNING DATA. ON THE BASIS OF EARLIER FINDINGS AND AN HYPOTHESIS THAT THE ABILITY OF CHILDREN TO MOBILIZE AND DIRECT THEIR ATTENTION INCREASES WITH AGE, IT WAS PREDICTED THAT THE DISTRACTORS EMPLOYED WOULD ATTENUATE THE PERFORMANCE OF THE YOUNGER SUBJECTS BUT WOULD FACILITATE THE PERFORMANCE OF THE OLDER SUBJECTS. THE RESULTS FROM THE ODDITY PROBLEM PROVIDED PARTIAL SUPPORT FOR THE HYPOTHESIS, AS TWO OF THE CONDITIONS WERE ORDERED OVER AGE AS WAS PREDICTED. THE GLANCE DATA OFFERED FURTHER SUPPORT FOR THE ATTENTION MOBILIZING AND DIRECTING HYPOTHESIS. HERE IT WAS FOUND THAT SUBJECTS GLANCED SIGNIFICANTLY MORE AFTER REACHING A LEARNING CRITERION THAN PRIOR TO SUCH MASTERY OF THE TASK, AND CORRELATIONS BETWEEN THE LEARNING AND GLANCE DATA INDICATED THAT BETTER LEARNERS GLANCED LESS. (AUTHOR)

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Abstract

The performance of children 5 1/2, 6 1/2, and 7 1/2 years of age on an oddity problem under three conditions of distraction was investigated. Subjects' glances away from the task were recorded along with their learning data. On the basis of earlier findings and an hypothesis that the ability of children to mobilize and direct their attention increases with age, it was predicted that the distractors employed would attenuate the performance of the younger subjects but would facilitate the performance of the older subjects. The results from the oddity problem provided partial support for the hypothesis, as two of the conditions were ordered over age as was predicted. The glance data offered further support for the attention mobilizing and directing hypothesis. Here it was found that subjects glanced significantly more after reaching a learning criterion than prior to such mastery of the task, and correlations between the learning and glance data indicated that better learners glanced less.

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Children's Reactions to Distractors in a Learning Situation: A Developmental Investigation

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That the performance of young children can be easily disrupted by distracting stimuli has long been a tenet of the literature on children's attentive abilities (Hildreth, 1950; James, 1890). Recent studies (Turnure & Zigler 1964; Ellis, Hawkins, Preyer and Jones, 1963) have shown, however, that the presence of distracting stimuli in an experimental situation does not inevitably disrupt children's performance and can even result in a facilitation on certain problem solving tasks for children as young as six years of age. In the Turnure and Zigler (1964) study, six-year-olds exposed to distracting stimuli scored higher, although not significantly so, on an object assembly task than a control group which faced no distraction. Ellis, et al., (1963) used an oddity learning task with subjects 7 years of age and found the performance of their experimental (i. e., distracted) subjects to be significantly better than that of their non-distracted subjects.

The findings reported by Turnure & Zigler (1964) and by Ellis, et al., (1963) were unexpected and difficult to explain. When con-

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sidered in conjunction with the finding of a decrement in performance of children 3 to 5 years of age on a peg board task in another distraction experiment (Poyntz, 1933), a developmental trend in the ability of children to cope with distracting stimuli is suggested. Thus the hypothesis may be formulated that younger children will suffer a decrement in performance with distraction, while older children will have their performance facilitated in the same conditions, with a cross-over or no difference in performance between experimental and control groups occurring at about age 6 (after Turnure & Zigler). Since there were procedural differences between the three studies discussed above the present study was designed to provide a test for the presence of such a pattern of results under comparable conditions.

The demonstration of the age trend described, however, would do little to explicate the anomalous facilitation phenomenon, and a hypothesis was therefore developed to account for this particular effect. It was hypothesized that 6 and 7-year-old children have developed the ability to mobilize and direct their attention to arbitrarily assigned tasks despite the presence of other interesting and conspicuous stimuli. This presupposes some capability in these children for inhibiting attending to irrelevant, non-task stimuli (c.f., White, 1965). Thus in studies of distraction such as Turnure and Zigler (1964) and Ellis, et al. (1963) a gross distracting stimulus should result in the child mobilizing his attention and conscientiously

directing it to the task at hand. In the process of focusing on the task, the subject inhibits attending to the gross distractor and so inhibits attending to countless other stimuli which are normally present in any situation. Subjects in the non-distraction condition would have their performance attenuated by attending to these countless other stimuli, which though distracting, are not so conspicuous as to be labeled as distractors.

It may be emphasized here that by attending to a task it is meant to the task as opposed to something else, (e. g. the experimenter) not to the specific cues of the task itself. This latter aspect of the role of attention in discrimination learning has been emphasized recently by many investigators (c. f., Mackintosh, 1965; White 1963; Zeaman & House, 1963). The general problem under investigation in the present study has been phrased by Berlyne recently as being to "show how a child must learn to expose himself to the important stimuli in a situation, by performing the correct orienting responses, before he can learn to carry out the correct instrumental or 'executive' activities" (1960, p. 218). It should also be emphasized here that the distracting stimuli in studies encompassed by the foregoing analysis must be irrelevant and extraneous to the task assigned. A recent study by Maccoby and Hagen ('966) employed as a distracting stimulus another task which the subjects were specifically instructed to perform. The results of such a study of divided attention would not

necessarily subscribe to the analysis advanced above.

Evaluation of the attention mobilizing and directing hypothesis required some assessment of the subjects' attending behavior. To provide direct data on the effects of the distractors, subjects' visual orientation to the task and to the surroundings was monitored. In accordance with the above rationale it was expected that facilitation in performance would be a function of nonattention to all irrelevant, non-task stimuli. Thus the incidence and duration of subjects' glances away from the task would correlate negatively with learning, with an Age x Condition interaction resulting then in the glance data as well as the learning data.

Method

Experimental design. Subjects 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 IQ (where available), allowing for the investigation of the sex variable. The design was thus a 3 (age) x 3 (experimental condition) x 2 (sex) factorial design.[1]

Subjects. Approximately half of the subjects in each of the age groups came from one of two elementary schools. (A preliminary analysis revealed no experimental effects associated with schools, and therefore school effects will be ignored in the remainder of this paper). Subjects age 7 1/2 years were selected from class lists

which included only children with IQ's ranging from 90 to 120 (IQ's were available at 7 1/2 years only), and for the other ages from lists based on teachers' judgments of their average students, i.e., not dull but not extremely bright. At all age levels subjects' CA's were no more than $\pm$ 3 months from specification (e.g., age 5 1/2 = 66 months $\pm$ 3 months), thus there was no overlap in the subjects' ages in adjacent age groups.

Apparatus. A light-proof portable booth was constructed to house the projector which presented the stimuli for the learning problem, the recording equipment, and to provide a place where observers could be stationed and not be seen by the subjects. Two 3 x 5 feet plywood boards painted grey formed sides of the enclosure, which was designed to rest upon a large table. Another piece of plywood 8 x 45 inches formed the lower or base part across the front, or subject, side, and a 32 x 45 inch one-way vision mirror in a wooden frame rested upon this base and so completed the front wall of the booth. The base part upon which the mirror rested had an aperture 7 1/2 x 11 inches 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 inches, mounted in such a way that when each was pressed it tripped a microswitch which recorded this response on an event recorder and also energized further aspects of the circuitry to provide the contigencies described below. This panel also contained three red reward lights, one mounted

above each of the windows.

Stimuli were projected from the rear onto the plastic windows, with a sleeve between the projector and the panel enclosing the diffuse light from the projector. The projector was an Anscomatic II, which allowed for automatic projection of stimuli according to a fixed schedule established by E (4 seconds on, with an inter-trial interval of 1 sec.). 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 subject's response, and the observer's response describing the subject's incidence and duration of glance behavior which was recorded during both trial and inter-trial periods. A glance was recorded each time the subjects' eyes left the stimulus panel.

Procedure. Each subject was taken individually from his classroom by E, who informed the child that they were going to play a game. The elementary school subjects were taken to the stage of their school's auditorium and led across the stage to their seat before the apparatus at the far end of the stage. The stage curtains were closed and were to the side of the subject. Aside from the distracting stimuli of the experimental conditions an attempt was made to arrange

conditions as one usually finds the situation when subjects are run in an extra room of a school. That is, these rooms are not generally stripped bare, but contain extra chairs, cabinets, pictures, etc. To this end three chairs were placed along the length of both sides of the stage, with some papers on one, a coat on another, a briefcase on another, on one a book, and the last two bare. The two flags found on the stages were both placed behind the subjects. It should be noted that this general setting involving extraneous stimuli was theoretically necessary in the context of this experiment since expectations concerning the behavior of the control subjects were contingent upon their having the "usual" amount of stimuli about to catch their attention (Turnure, 1966). Inquiry revealed that all subjects had been on stage at least once, with older subjects having more frequent exposure. The stage had never been experienced by any of the subjects as it was set up for this study.

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 the subject'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 subject and was hidden from view by being placed beneath a chair. The volume control was set to provide a sound level of 60 decibels, $\pm$ 5 dB. In the Control condition the screen remained over the mirror and no auditory distractor was present.

Once the subject was seated before the apparatus E took a seat to the subject's right and a moment or two was spent in recording his name, age, grade, and class. Instructions and training trials were then given. During this initial period in the distraction conditions E took care never to look in the mirror nor toward the sound source.

The task presented the children was an oddity problem as modified by Moon & Harlow (1955). The subject 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, et al., 1963). The stimuli were selected randomly for presentation in a Gellerman series.

The instructions were as follows for all conditions: "The name of this game is, 'Pick-the-Right-Picture-and-Light-the-Light', and you play it this way: here in these windows you will see some pictures. They will look a lot like these" (practice stimulus slide shown, employing figures other than those used in the experiment proper, i.e.,

crescents and parallelograms). "See? There is one figure in each window" (E pointed to each in turn). "When you press the window with the right figure in it the light over that window will go on and that's good. But if you push a wrong window nothing lights up. If you play well you can light the lights lots of times, and that's what we want to do. O. K.? Let's go over just what to do, because I'm going to let you play by yourself since I have to go back here and run the machine that shows all the pictures. So remember, when each slide goes on, if you think the figure in this window is right and will light this light you press this window" (E poin ted); "If you think this window is right press it" (E pointed). "O. K.? But you should only press one window for each set of pictures, so you must push the correct window to light the light. Now let's do one for practice" (E projected the second practice slide). "Here it is, and I know which one is right so I can tell you to press this window and you can see how the light goes on. Go ahead and press this one" (E indicated which window and the subject pressed it). "Any questions?" (E cleared up any remaining confusion at this point). "All right, I'm going to go back and run the machine and as soon as the next slide comes on you push the window that you think will light a light, and do that for every slide from then on, and try to light a light each time."

Upon the 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, the observer began recording the subject's glances. A stimulus presentation lasted 4 seconds, regardless of the subject's response or the correctness of the response, and the inter-trial interval was 1 sec. Each subject was given 60 trials. Thus each subject was observed for a total of 305 secs. (In order to present 60 slides continuously two slide trays had to be joined. As a result a 5 sec. period of white light appeared in all three windows between trials 30 and 31). Upon completion of the 60 trials the task was terminated and E returned to the child's side, praised him for his performance, made a few inquiries concerning the game, and returned the child to his classroom.

Results

Learning data. Learning data on the oddity problem are presented in Table 1 and Fig. 1.

Insert Table 1 and Figure 1 about here

Examination of these data suggests that the Sound condition consistently depressed subjects' performance compared to that of controls, contrary to expectation. The Mirror condition does appear to have produced the predicted facilitative effects. That is, the cross-over at age 6 1/2 between the Mirror and Control conditions is in

keeping with the prediction that the Mirror condition would attenuate performance at an early age but would facilitate it at a later one, with this latter result serving as a replication of the Ellis, et al., (1963) finding. An Age x Condition x Sex x Trials factorial analysis of variance was conducted over the six blocks of ten trials for all subjects initially. This analysis produced a highly significant Trials effects ($F_{5, 360} = 33.58$, $p < .001$), which reflects the generally superior performance over successive blocks of trials shown by all groups. No other main effect nor any interaction was significant in this omnibus analysis. Following the recommendations of Winer (1962) for testing a priori hypotheses in the analysis of variance, trend analyses were conducted on the data.

The predicted Age x Condition interaction essentially states that, over age, the linear trend (slope) of the developmental curves for the three conditions will differ in prescribed ways. Accordingly, that component of the interaction attributable to differences between linear trends for the simple effects of the three conditions at the three different age levels was obtained, and found to be significant ($F_{1, 72} = 27.41$, $p < .001$). As can be seen in Fig. 1 it is only the relation of the Mirror condition to Control that is in keeping with the prediction. The linear trends of the Mirror and Control groups within the Age x Condition interaction were then investigated. It was

found in this analysis that the interaction of the Mirror and Control conditions with Age was highly significant ($F_{1,72} = 15.63$, $p < .001$). The performance of the 5 1/2 year Mirror group was found to be significantly inferior to the 5 1/2 year Control group ($t_{18} = 2.74$, $p < .01$). This effect was reversed at age 7 1/2, where the superior performance of the Mirror group compared to the Control group reached significance ($t_{18} = 2.85$, $p < .01$). The difference at age 6 1/2 was not significant ($t_{18} = 1.37$).

Glance data reliability. One observer served to record all of the data to enter into subsequent analyses. The reliability of the monitoring performance of this observer was obtained for 44 subjects by the use of a second observer intermittently from the first day of subject runs to very near the last day. A correlation of .89 was obtained between the two observers for number of glances recorded. Another correlation of .94 was obtained from the same data for the time spent glancing.

Time glancing analyses. The duration of subjects' glances appeared to be the most valid index of non-attention to the task and so only analyses of these time glance scores are presented. Only pre-criterion glance data were analyzed since learners in the study showed a marked increase in glancing after reaching the learning criterion (direct difference $t_{50} = 6.03$, p .001). A subjects' average rate of pre-criterion time glance score, then, consisted of

the amount of time he spent glancing prior to criterion (six consecutive correct choices), divided by the number of trials to criterion. Total time glancing divided by the 60 trials composed scores for non-learners. Scores were multiplied by 100 to facilitate computation. The means of groups average rate of pre-criterion time glance scores are presented in Table 1. An analysis of variance of these data produced highly significant Age ($F_{2,72} = 8.43$, $p < .001$) and Condition ($F_{2,72} = 7.52$, $p < .01$ effects. Observation of the mean glance data discloses that the Age effect is due to the marked reduction in time spent glancing at ages 6 1/2 and 7 1/2 compared to age 5 1/2. The Condition effect is attributable to Mirror condition subjects spending twice as much time glancing than Sound and Control subjects. Although this difference is strongest at ages 5 1/2 and 6 1/2, the predicted Age x Condition interaction was not significant ($F_{4,72} = 1.10$, n.s.).[2]

Correlational analyses indicated a significant inverse relation between pre-criterion glancing and learning as expected. An overall correlation run between the learning and glancing scores for all subjects produced a highly significant correlation ($r_{88} = -.41$, $p < .001$). Correlations run within conditions indicate that the relation of these two variables differs markedly as a function of the situation. The correlation was lower than the overall r in the

Control condition ($r_{28} = -.33$, $p < .05$); and similar to the overall r in the Sound condition ($r_{28} = -.44$, $p < .01$). In the Mirror condition quite a large correlation was observed ($r_{28} = -.65$, $p < .001$). The differences in these correlations suggest that while glancing is indicative of non-attention (and so non-learning) in all conditions, it becomes an increasingly reliable indicator as the amount of interesting stimuli available as alternatives to the task increases.

Discussion

The finding of most interest in the analysis of the learning data was the significant Age x Condition interaction disclosed by the trend analysis. The results from the Mirror and Control conditions supported the prediction that younger children would have their performances impaired by the presence of the distracting stimulus in the experimental situation, while older children's performance would be facilitated. That is, the performance of the 5 1/2 year Mirrer group was significantly inferior to that age Control group's performance, while the deleterious effects of the Mirror had disappeared at the 6 1/2 year level and had been reversed at age 7 1/2. These results support the developmental hypothesis advanced in this study.

These results are also in accord with the view of Turnure & Zigler (1964), who maintained that young children are generally outerdirected in problem solving situations and so attend to a wide variety of stimuli in seeking solutions and guides to action. According to this view, young children should be especially susceptible to the distracting effects of salient but irrelevant stimuli present in the situation. These irrelevant stimuli divert the children from the task at hand instead of providing them with the rather effective cues that young children are used to receiving from parents, older siblings, and other socializing agents. Consequently, the task is

uncompleted or inadequately performed, as was the case with the younger subjects in the Mirror condition of this study. Similar results were found for the younger subjects in the Sound condition, but the results in this condition did not remain consistent with the prediction over age and so will be discussed separately.

Turnure & Zigler further suggested that in the course of normal development there occurs a shift from outer to innerdirectedness. Slightly older children rely more on their own cognitive resources for solving problems, and the consequent reduction in the propensity to seek external cues reduces the possibility that irrelevant stimuli will divert the child from his task. Thus, as the number of inner-directed children increases over age, the differences between children performing in the Mirror and Control conditions of this study should be minimized, as was found at the 6 1/2 year level. However, this formulation, while indicating how the child becomes less susceptible to distracting stimuli, will not serve to explain the facilitation phenomenon found in the Ellis, et al., (1963) study and replicated at the 7 1/2 year level in the present study.

The attention mobilizing and directing hypothesis put forward as a possible explanation of this finding was supported to some degree by results from the glance data. This support derives from the finding that subjects who reached criterion had been glancing away from the task prior to such mastery at a rate significantly below

the rate which they produced after reaching criterion. This finding suggests that these subjects directed their attention toward the task until they had attained success, after which they turned to further exploration of the situation. This behavior of glancing about after having effectively solved a learning problem has been reported, in passing, by Shepard (1957), and similar observations have been made by Cruse (1961). The significant relationships found between the average pre-criterion time glance scores and the learning scores indicate that better learners glance less, which again is in line with the attention directing hypothesis. However, acceptance of the attention directing hypothesis based on this evidence must be made on a somewhat tentative basis, since the predicted Age x Condition interaction was not observed in these glance data.

Further, it would be erroneous to assert unqualifiedly that children over the age of seven years are capable of coping with all forms of distractors. The inability of most children in the sound condition to overcome that distractor demonstrated this point. Clearly stimuli cannot be considered homogeneous in their salience or potency as distractors. It seems probable that subjects much older than those observed could overcome the salience of the sound stimulus used in this study. That college students and adults (Ford, 1929; Morgan, 1916) have demonstrated superior performance in the face of similar and even more intense auditory distractors supports this line of reasoning.

The findings of this study indicate that children can learn to control their attending or orienting responses in the face of some distracting stimuli by the age of 6 1/2 to 7 1/2 years, reflecting a major step in the development of proficiency in dealing with external stimulation. The timing of the development of inner-directedness and the ability to mobilize and direct attention as found in this study appears noteworthy in that it converges nicely with reports of similar timing in transition periods involving the development of voluntary control of behavior, observed by such investigators as Luria (1960), Piaget (cf. especially the summary of Piaget's findings by Wallach, 1963), and White (1963, 1965). And it should be noted that despite an apparent disparity in theoretical orientation between these investigators, they are congruent in emphasizing attentional processes and abilities in cognitive development.

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Footnotes

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[1] In an attempt to extend the generality of conclusions concerning the hypothesized age trends, data gathered for this investigation included children 4 1/2 and 8 1/2 years of age. However, the learning task employed proved too difficult for the 4 1/2 year olds, with only two Control, one Mirror, and no Sound condition subjects succeeding on it. At the other extreme the task was too easy for the 8 1/2 year olds, and a ceiling effect obtained, again minimizing the possibility of other effects being demonstrated. In the interest of brevity and clarity detailed discussion of these group's performance has not been included in this report.

[2] The predicted Age x Condition interaction did occur in the Mirror and Control Condition for simple scores comprised of the number and amount of time spent glancing to criterion. That is, on the average 5 1/2 year Mirror subjects glanced more often and for a longer time than 5 1/2 year Control subjects, while 7 1/2 Mirror subjects glanced less often and for a shorter period on the average than the 7 1/2 year Control subjects. However, interpretation of these results could not be made unequivocally due to the differential amounts of time available for glancing in these groups. The rate scores were generated as a conservative corrective for this confounding.

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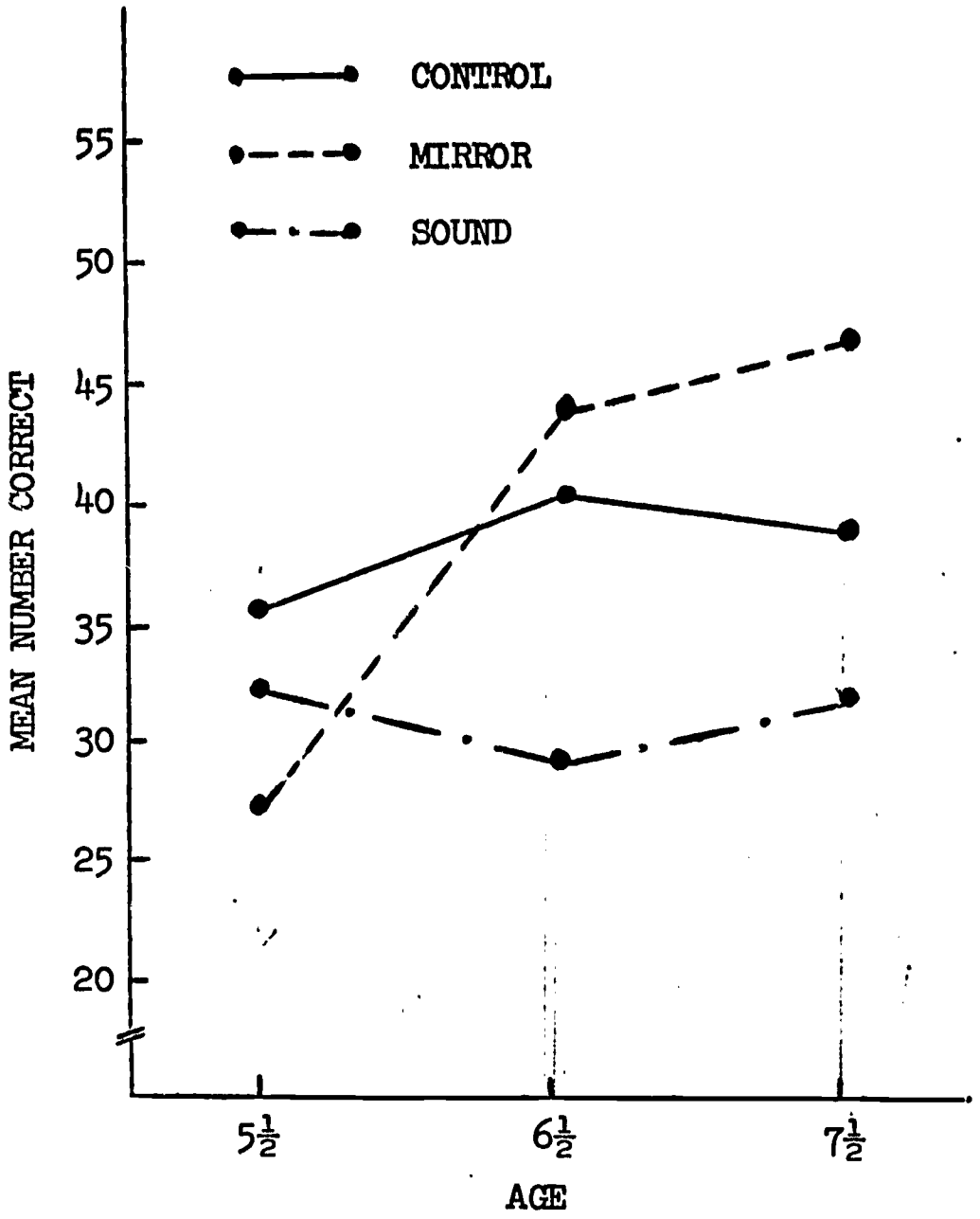
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