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GENERALIZATION OF INSTRUCTED REHEARSAL STRATEGIES IN DEAF CHILDREN

by

ELSPETH R. MACKAY

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ABSTRACT

Research has shown that the performance of deaf children on memory tasks is usually inferior to that of hearing children. This deficiency is usually attributed to limitations in symbolic behavior in the deaf. Furthermore, it has been demonstrated that training deaf adolescents to actively rehearse increases their memory performance. The present experiment studied the effects of a repetitive naming rehearsal strategy on the memory performance of manually trained deaf children. In addition, the generalization of rehearsal behavior to new test items was assessed both immediately following training and after a ten day delay. An attempt to facilitate generalization using the method of training sufficient exemplars was included by training one-half the subjects in each rehearsal condition on four lists of pictures, while training the remaining subjects on only one list.

Sixteen younger (mean age = 7 years, 6 months) and sixteen older (mean age = 12 years, 9 months) deaf children served as subjects in a position probe recall task using lists of familiar pictures. In the first training session, subjects were randomly divided into rehearsal and no rehearsal conditions. Rehearsal subjects were told to sign the name of the picture and to continue signing until the next picture was presented. The rehearsal subjects were also prompted to rehearse in this manner during the picture probe task. In the first phase of session 2, one-half the subjects in each rehearsal condition received further training trials on List 1 (single list training) and the other subjects received the

same number of training trials on three new lists (multilist training). The second phase of session 2 consisted of an immediate generalization test; a new set of pictures was presented without rehearsal instructions or prompting. The third session, given 10 days later, provided a delayed generalization test.

With respect to recall performance, analyses revealed that the rehearsal subjects performed significantly better than the no rehearsal subjects during rehearsal training. Furthermore, on both the immediate and delayed generalization tests, rehearsal subjects continued to perform at a higher level than control subjects. Serial position analyses indicated that the rehearsal strategy was effective in enhancing recall performance at all positions. This indicates that repetitive naming rehearsal improved both short and long-term storage.

Six of the eight younger subjects and four of the eight older subjects maintained their repetitive naming behavior in both the immediate and delayed generalization tests, while the two remaining younger subjects and three additional older subjects named the pictures when they were presented but not during the interitem interval. None of the no rehearsal children repetitively named the pictures and only one younger and two older no rehearsal subjects named the items. The number of training lists had no effect on accuracy of recall or the amount of generalized rehearsal.

It is evident that sign language rehearsal training not only increases memory performance in manually trained deaf children, but that such behavior can become generalized over time, and to new test items.

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INTRODUCTION

Rehearsal is one type of mnemonic strategy that has been found to increase memory retention in children and adolescents (Belmont, Karchmer & Pilkonis, 1976; Keeney, Cannizzo & Flavell, 1967; Kingsley & Hagen, 1969; Kurtz & Hovland, 1953). Rehearsal can range from simply producing a verbal label for a stimulus item, either overtly or covertly, to cumulative rehearsal. The labelling of items is often referred to as 'naming', and this procedure can also be extended to continuous or 'repetitive naming' (Allik & Siegel, 1976). Cumulative rehearsal refers to the continuous, additive repetition of all items to be learned.

According to Weist and Crawford (1977), rehearsal appears to have two functions which are adaptive under different memory conditions. These functions have been called 'maintenance' and 'recoding'. Repetition of item names maintains them in short-term storage, while making use of relationships that exist among items organizes and recodes them in such a way as to facilitate long-term storage. When relatively few items have to be remembered for a short period of time, the maintenance function is most appropriate. Longer lists, or items that must be remembered over time, probably require the recoding function in order to retain the information.

Memory researchers have argued that the natural development of rehearsal processes facilitates the memory capabilities of children (Flavell, 1970), and many studies have been conducted to test this hypothesis. Kurtz and Hovland (1953) experimentally manipulated verbalization with hearing children, in a study designed to test the prediction that naming would improve the accuracy of retention, a finding previously noted by Barlow (1928) in a study that investigated the role of articulation in memorizing. These authors reported that accuracy of retention was increased by verbalization at the time of stimulus observation.

Other studies that have looked into the role played by various rehearsal strategies (Flavell, Beach & Chinsky, 1966; Keeney, Cannizzo & Flavell, 1967; Kingsley & Hagen, 1969) have demonstrated that very young children (nursery school and kindergarten), and mentally retarded children of all ages (Belmont & Butterfield, 1971; Brown, Campione & Murphy, 1974; Kellas, Ashcraft & Johnson, 1973), do not make use of rehearsal strategies. These children can, however, be taught to verbally label stimuli in serial tasks, and thus improve their performance. These studies also show that verbal rehearsal can be an effective strategy to employ when lists of familiar or namable items are to be held in memory for short periods of time. It has been found that in serial tasks performance on the last serial position is facilitated by naming the items while performance on middle and early serial positions is facilitated by cumulative rehearsal during stimulus presentation (Kingsley & Hagen, 1969). This more complex form of rehearsal is not usually found in young children (Flavell, Beach & Chinsky, 1966; Keeney, Cannizzo & Flavell, 1967).

It has been shown that serial recall exhibits a developmental increase in accuracy, possibly caused by a lack of appropriate rehearsal strategies in very young children (Reese, 1976). It appears that in young children it is the quantity of rehearsal that is linked to retention (Weist & Crawford, 1977) but for older children this may not be the case. The superiority of older children (sixth grade) in contrast to younger ones (third grade) was studied by Naus, Ornstein and Aivano (1977). These authors discovered that this superior performance resulted from the older child's enhanced recall of the beginning (primacy) and middle items, as there were minimal age differences in the recall of items from the last (recency) positions.

Past studies have tended to agree that the performance of the deaf on memory tasks is inferior to that of the hearing (Belmont, Karchmer & Pilkonis, 1976; Pintner & Paterson, 1917; Wallace & Corballis, 1973). Furth (1964) in his review of research with the deaf, concluded that the deaf are intellectually handicapped because they lack the free use of language, and Pintner and Paterson (1917) suggested that the deaf's inability to verbalize might account for their poor performance, as they are prevented from acquiring acoustic imagery. Hiskey (1956) explained the inferiority of the deaf child on memory tasks as a limitation in symbolic behavior. He observed that the hearing children who were studied often verbalized while performing the memory task and concluded that such verbalization enhanced hearing children's performance relative to that of deaf children.

Studies focusing on how the deaf encode visual material into memory have concluded that such individuals make extensive use of a dactylic-kinesthetic code based on sign language and fingerspelling (Locke & Locke, 1971; Wallace & Corballis, 1973). Hoemann, Andrews and DeRosa

(1974) found that the deaf code information relating to the formational parameters of signs in the same way that the hearing make use of phonological cues. Bellugi, Klima and Siple (1974/75) compared deaf and hearing college students and found that, overall, short-term memory mechanisms in the deaf seemed to parallel those found in the hearing. The deaf were shown signs of American Sign Language on a videotape while hearing subjects listened to an audiotape of the same words. The results were consistent with the theory that the signs of American Sign Language are coded by the deaf in terms of their formational parameters.

If sign language can be considered to be a modality comparable to speech, then the manually trained deaf child has access to an articulatory (motor, dactylic or kinesthetic-sensory) modality that might be effective in improving memory. Training the deaf child to sign stimulus items in the same way that hearing children are taught to verbally label may provide equivalent forms of rehearsal. Such training is necessary, as it has been noted that the deaf rarely rehearse spontaneously, and when they do make use of some sort of rehearsal strategy, it is seldom task appropriate. Belmont, Karchmer and Pilkonis (1976) noted that when the deaf adolescents selected their own strategies their memory performance was poor, but when instructed to actively rehearse the stimuli using a cumulative rehearsal technique their performance greatly improved. This specific instructed rehearsal technique also resulted in immediate gains for the hearing group, lending support to the position that sign language is a modality comparable to speech.

Of considerable practical importance is the question of how longlasting the effects of rehearsal training are, and also whether rehearsal strategies will generalize from the training task to other similar tasks. According to Stokes and Baer (1977) generalization may be defined as "The occurrence of relevant behavior under different non-training conditions (i.e., across subjects, settings, people, behaviors and/or time) without the scheduling of the same events in those conditions as had been scheduled in the training conditions" (p. 350). In their survey of the current literature these authors emphasized the need to actively program generalization and outlined nine methods designed to accomplish this goal. Included in their review was a technique known as training sufficient exemplars. In this method generalization to new stimuli is accomplished by training the response to a number of exemplars of the class of stimuli rather than training in only one stimulus situation.

In one of the few studies that looked into the maintenance of rehearsal strategies, Keeney, Cannizzo and Flavell (1967) divided children into spontaneous rehearsers and nonrehearsers and investigated generalization of instructed rehearsal by including trials in which the subjects were told that they could repetitively name the items if they wanted to, but that they did not have to. The results indicated that when given the option to rehearse, nonrehearsers tended to abandon the strategy. Similarly, Hagen, Hargrave and Ross (1973) conducted a study with younger (prekindergarten and kindergarten) and older (first and second grade) children that employed a prompted cumulative rehearsal technique. They discovered that, although recall improved when rehearsal was prompted by the experimenter, this improvement was no longer evident when a delayed test with no prompting was given one week later.

Kellas, Ashcraft and Johnson (1973) gave mildly retarded adolescents a serial recall task, and divided the subjects into an instructed cumulative rehearsal group and a free strategy group. The instructed group showed significantly higher recall scores, and when both groups were retested two weeks later with only free recall instructions, the original cumulative rehearsal group had maintained the strategy, and still showed significantly higher performance. Brown, Campione and Murphy (1974) also reported that active rehearsal improved overall performance of moderately retarded adolescents. Their subjects were divided into instructed rehearsal and control groups and given a serial recall task. The instructed group had significantly higher recall scores than the control group, and when retested on the same task six months later, eight out of ten of the rehearsal subjects had maintained the strategy even in the absence of instructions to do so. The main difference between the studies with normals and those involving retardates seems to be one of age rather than one of rehearsal strategy, since naming or cumulative rehearsal were the instructed techniques in both. The maintenance of induced rehearsal behavior was not achieved by normal children up to seven years of age, but was evident in moderately retarded adolescents with mean mental ages of eight to ten years.

No research has been concerned with the method of training sufficient exemplars in memory tasks. It appears that such programming could be applied in memory tasks by training rehearsal strategies with several examples of the task, and looking for generalization of the rehearsal strategy to other similar tasks.

The present experiment was designed to study the effects of instructed rehearsal on retention in manually trained deaf children, and to investigate the generalization of rehearsal behavior to new lists in the absence of instructions to rehearse. Two age groups were used in this study so that developmental differences in accuracy of recall and rehearsal performance could be assessed in deaf children. Rehearsal was experimentally manipulated in a picture probe memory task. Each age group was divided into rehearsal and no rehearsal conditions, with sign language being the rehearsal modality. Children in the rehearsal group were trained to use a repetitive naming strategy which involved signing each pictorial stimulus as it appeared, and at least once during the interitem interval. In the first session, all children were trained on a six picture position probe task, with the rehearsal group being actively instructed to repetitively name the pictures. In the second session, half the children in both the rehearsal and no rehearsal conditions were trained on the original picture list, and half on three new picture lists. A generalization test with a new list of pictures was given immediately following training in the second session, and a delayed generalization test was given ten days later. Rehearsal activity was measured by observing the amount of repetitive naming and amount of naming in the generalization tests.

It was hypothesized that in both age groups: (a) the rehearsal groups would have higher recall scores than the no rehearsal groups on all lists; (b) the repetitive naming behavior would occur on immediate and delayed generalization tests in the rehearsal but not in the no rehearsal subjects; and (c) those rehearsal subjects who received training on one list would not be as apt to generalize their repetitive naming as compared to rehearsal subjects trained on four lists.

METHOD

Subjects

Subjects were selected from a public school for the deaf which serves the province of Manitoba. Children at this school have hearing threshold levels for speech greater than 90 db, and use manual sign language as a method of communication. There were 16 children in each of two age groups. The mean age of the younger group was 7 years 6 months (range = 6-6 to 8-9, *SD* = 8.7 months) and the mean age of the older group was 12 years 9 months (range = 12-0 to 13-9, *SD* = 7.9 months). In the younger group there were 6 girls and 10 boys, whereas, the older group had 5 girls and 11 boys. Teachers' ratings of below average intelligence were used as the basis for excluding 8 younger children (from a pool of 24), and 6 older children (from a pool of 32). This was done prior to sending letters of permission to parents.

Test Materials and Apparatus

The materials used in this experiment were seven sets of picture cards, each containing six items (see Table 6, Appendix A). The picture cards were coloured line drawings of familiar objects traced onto

9.4 cm X 7.5 cm index cards. No two objects having similar hand configurations or from a related category were included in the same list. The cards were placed in seven 10 X 8 cm slots on a 77 X 28 cm wooden stimulus board. Six of the slots were arranged in a row parallel to the base of the board and spaced 2.5 cm apart; the slot for the probe card was centered 5.6 cm above the others. A metronome was used to time the stimulus presentations. All sessions were tape recorded by the experimenter who verbalized subjects' signed and choice responses into the microphone in addition to writing this information on a data sheet.

Procedure

Each child sat at a table in a quiet room, facing the experimenter. All subjects were instructed manually as follows: "You will be shown six picture cards, one at a time. I want you to try and remember the pictures, and where they are on the board. After you have seen each picture it will be turned over on the board. When you have seen all six cards, I will show you another picture which is the same as one you have just seen. I want you to point to the card that is just like it."

Each age group was randomly divided into rehearsal and no rehearsal conditions. Those in the rehearsal condition received instructions prior to the memory task on how to make use of repetitive naming of stimulus pictures as a memory aid. They were told "To help you remember, I want you to sign the name of each picture as I place it on the board, and keep repeating the sign until you see the next picture. I want you to do this for all six pictures." No such instructions were given to those in the no rehearsal condition. All subjects were given three training trials using the practice list to ensure that they understood the procedure involved in the picture probe position task.

On each trial the appropriate set of cards was shuffled and the cards were placed on the board one at a time from the child's left to right. Each picture was exposed for 4 sec and then turned over; the interitem interval was also 4 sec. The probe card was exposed until the subject pointed to one of the six cards. The experimenter turned over the chosen card, and if it was not correct, showed the subject where the correct card was located. In each block of six trials each position was probed once; the order in which the positions were probed was randomly chosen for each trial block.

The first session consisted of 36 training trials with List 1. Those in the rehearsal condition received instructions to rehearse, and if they forgot to name the item and sign it at least once during the interitem interval the experimenter prompted them by asking for the appropriate sign. Prompting was rarely required after the first three trial blocks. The second session was given on the following day. Half the subjects in the rehearsal and no rehearsal conditions were randomly assigned to the multilist condition and the others to the single list condition. Children in the single list condition received another 18 trials with List 1, whereas children in the multilist condition were given six trials on each of three new lists (Lists 2, 3, and 4). Again, those in the rehearsal group were instructed to rehearse, and prompted if they did not. After a 1 minute break during which the subjects were allowed to get up and stretch or walk around, the generalization phase of the second session commenced. All subjects received a further 18 trials on a new list (List 5). In this phase of the study children in the rehearsal group were not instructed or prompted to rehearse the stimuli. After a delay of 10 days, the second generalization test took place. All subjects received 36 trials on List 6, again in the absence of any instructions to rehearse.

On each trial the choice response was recorded as correct or incorrect and the position chosen was noted when an error was made. In order to provide a measure of overt rehearsal during the generalization tests with Lists 5 and 6, signing behavior was observed and recorded both in writing and by verbal repetition onto the tape recorder.

After the final testing session all subjects were asked "How did you remember where the pictures were on the board?" and their responses were recorded.

RESULTS

Recall Performance

The recall performance in each phase of the study was analyzed twice. In order to investigate the effects of trial blocks, the number of correct responses in each trial block was calculated for each subject and subjected to a mixed analysis of variance with age, rehearsal condition, and number of training lists as the between-subjects variables, and trial blocks as the within-subjects variable. Each trial block consisted of six trials. In order to examine the effects of serial position, the number of correct responses when each serial position was probed was determined for each subject by summing over trial blocks, and this score was entered into a mixed analysis of variance with age, rehearsal condition, and number of training lists as the between-subjects variables, and serial position as the within-subjects variable. It should be noted that the two analyses of variance produced identical results with respect to the between-subjects factors.

First session performance. Table 7, Appendix B shows the results of the analysis of variance for the number of correct responses per trial block for List 1. This analysis yielded significant main effects for age, $F(1,24) = 4.36$, $p < .05$, and condition, $F(1,24) = 42.49$, $p < .001$. Cell means revealed that the older group performed better than the younger group (4.43 vs. 4.08 mean correct), and that the rehearsal condition was superior to the no rehearsal condition (4.79 vs. 3.72 mean correct).

The summary of the analysis of variance for number of correct responses per serial position for List 1 is contained in Table 8, Appendix B. A significant main effect for serial position was noted, $F(5,120) = 30.51$, $p < .001$. Figure 1 shows the typical serial position curve with primacy and recency effects. There were no significant interactions between serial position and the other variables.

Second session performance: Training phase. During this portion of the second session, subjects in the single list condition received a fur-

Figure 1. Percentage of correct responses at each serial position on List 1 for rehearsal and no rehearsal subjects.

ther three trial blocks on List 1, whereas subjects in the multilist condition received one trial block on each of three new lists (Lists 2, 3, and 4). The analysis of variance for the number of correct responses per trial block for these subjects is contained in Table 9, Appendix B. Trial blocks and lists are confounded for the multilist group in this analysis. Significant main effects were obtained for rehearsal condition, $F(1,24) = 15.66$, $p < .001$, and number of training lists, $F(1,24) = 4.30$, $p < .05$. The three-way interaction involving number of training lists, rehearsal condition, and trial blocks was also significant, $F(2,48) = 5.39$, $p < .01$.

The cell means for the triple interaction are presented in Figure 2. Post-hoc pairwise comparisons were performed on the means involved in this interaction using the Tukey HSD statistic (Kirk, 1968). The rehearsal condition was significantly superior to the no rehearsal condition at trial blocks one and three for the single list condition and trial blocks two and three in the multilist condition. There was no difference between rehearsal and no rehearsal groups on trial block two in the single list condition and on trial block one in the multilist condition, $HSD(4,30) = 1.07$, $\alpha = .05$.

On trial block one the no rehearsal group in the multilist condition had significantly higher recall scores than the no rehearsal group in the single list condition, $HSD(4,30) = 1.07$, $\alpha = .05$. Other comparisons between single and multilist conditions with trial block and rehearsal group equated were nonsignificant.

In the single list condition there were no significant differences

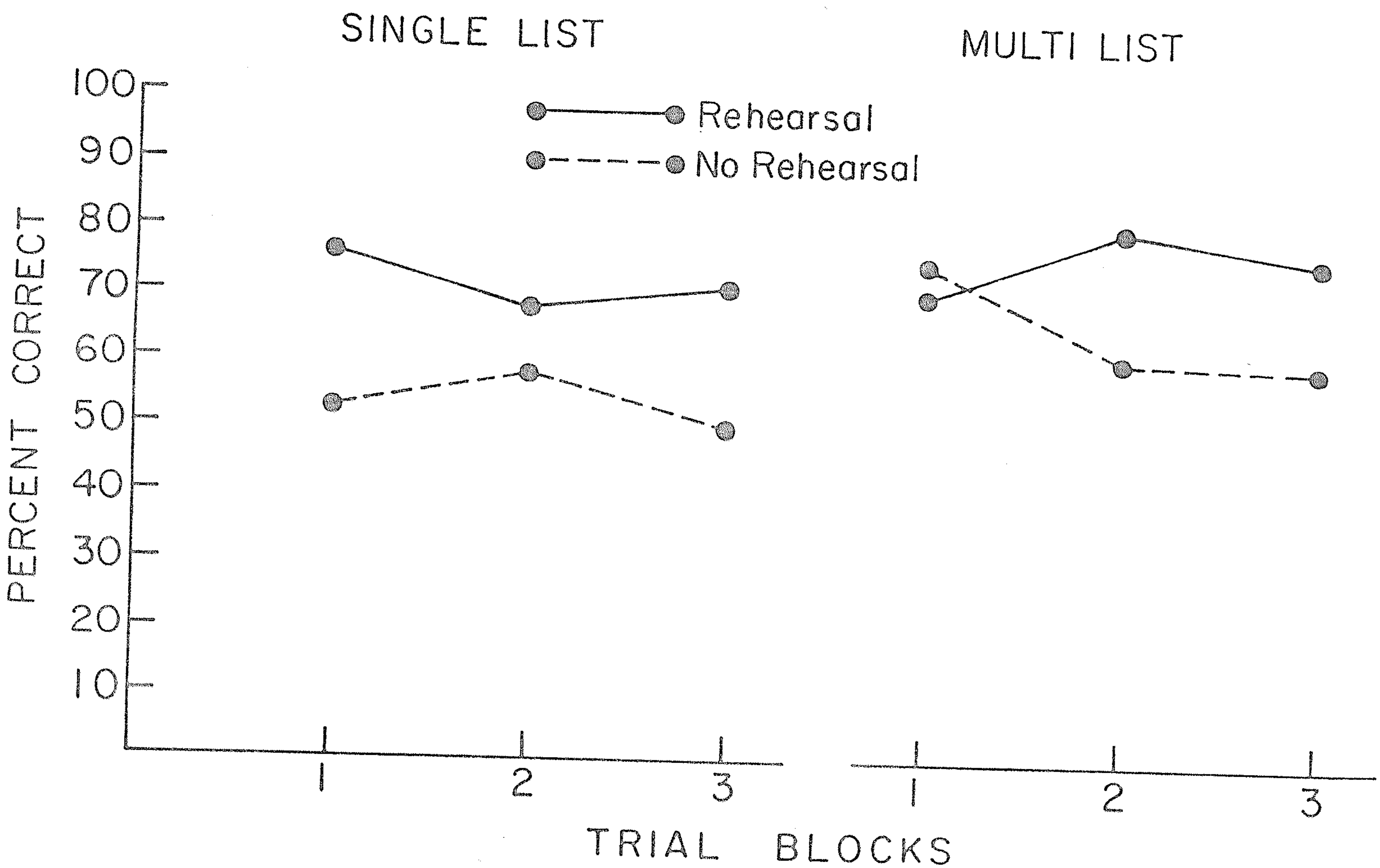

Figure 2. Percentage of correct responses on each trial block during the training phase of session 2 for single and multilist conditions.

across trial blocks for either the rehearsal or no rehearsal groups. In the multilist condition recall performance on trial block one was significantly greater than on trial block three for the no rehearsal group, HSD(4,30) = .87, α = .05; but no significant differences were noted across trial blocks for the rehearsal group.

The summary of the analysis of variance for the number of correct responses per serial position for the training phase of session two is contained in Table 10, Appendix B. The analysis yielded a significant main effect for serial position, $F(5,120) = 18.07$, $p < .001$. As can be seen in Figure 3, primacy and recency effects were obtained.

Second session performance: Generalization test phase. This part of the second session constituted the first generalization test. The summary of the analysis of variance for number of correct responses over the three blocks of trials on List 5 is contained in Table 11, Appendix B. This analysis revealed that the rehearsal condition (mean correct = 4.69) was superior to the no rehearsal condition (mean correct = 3.81), $F(1,24) = 17.76$, $p < .001$. In addition there was a significant main effect for age, $F(1,24) = 4.87$, $p < .05$; and a significant two-way interaction between trial blocks and age, $F(2,48) = 8.26$, $p < .001$. This interaction is presented in Figure 4. Post hoc comparisons of older and younger groups indicated that the older group was superior to the younger group on trial blocks one and three, but the groups did not differ on trial block two, HSD(2,30) = .58, α = .05. The older group's performance decreased between trial blocks one and two and increased between trial blocks two and three; no significant changes over trial blocks were noted for the