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Educational ability, practice and short term memory

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EDUCATIONAL ABILITY, PRACTICE AND SHORT TERM MEMORY

BY

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PREFACE

The author takes pleasure in acknowledging the advise and supervision given to her by Dr. William Walker during the course of this investigation. The author would also like to acknowledge the assistance given by Mrs. Jean Dickinson and Dr. James Tromater.

EDUCATIONAL ABILITY, PRACTICE AND SHORT TERM MEMORY

Thirty-six fourth grade students were selected and classified into one of three groups on the basis of participation in the DISTAR Reading Program, educational ability as measured by the STEA and a reading readiness factor. Each group received two tests of short term memory (STM) involving auditory presentation and either auditory or visual recall after a retention interval of 4,8 or 12 seconds. Analysis verified previous research in this area with respect of task difficulty, retention as a function of interval length and acoustic similarity of response errors. Neither educational ability nor practice elevated the students' performance on the STM tasks.

Chapter I

INTRODUCTION

Intersensory integration has been defined as the "processing of multiple stimuli which are being transmitted through different modalities" (Chalfant & Scheffelin, 1969). It is not unusual to find that children who have been classified as learning disabled, brain damaged or retarded readers also possess disabilities in intersensory integration which manifest themselves in deficits of auditory or visual retention, recall and/or recognition (Chalfant & Scheffelin, 1969; Learner, 1971; Waugh & Bush, 1971). Many researchers and educators have recently become concerned with the relationship of intersensory integration to academic achievement and particularly its relation to success in reading.

Meuhl and Kremenak (1966) investigated the ability of six year old children to match information involving both the auditory and visual modalities. They found that these children performed best using only their visual modality to match pairs while they had the greatest difficulty working only with the auditory modality. Mixed modality tasks, that is, matching visual to auditory pairs and auditory to visual pairs resulted in intermediate difficulty. Further investigation revealed that all matching tasks except those involving only the visual modality contributed to

the prediction of reading ability. Bruininks (1969) using twelve tests of auditory and visual perception and memory determined that auditory perception measures correlated better with reading achievement than did visual perception tests. This relationship, however, decreased when the factor of verbal intelligence was controlled. In addition, a non significant relationship was found between reading achievement and perceptual integration. He, therefore, concluded that auditory and visual skills are more closely related to reading achievement than the combination and elaboration of these skill.

Hammill and Larsen (1974) reviewed 34 studies which investigated the relationship of reading ability to auditory discrimination, memory, sound blending and intersensory integration. They found that sound blending and sound discrimination, although significant factors, correlated too low to be considered stable predictors. Intersensory integration was also significant when the factor of mental ability was partialled out. They concluded that auditory skills, as measured by various means, are not sufficiently related to reading to be considered stable predictors of success. They suggest that their results are divergent from those of other studies because they controlled for intelligence rather than simply comparing the mean achievement level of the poor and good reading groups.

In an attempt of account for individual differences

in intersensory integration, Kahn and Birch (1968) employed a technique which involved the identification of visual dot patterns and their corresponding rhythmic auditory stimuli. They found that auditory-visual integrative competence was related to reading achievement in grades two through six but that this ability did not correlate with auditory rote memory skills as measured by the Digit Span subtest of the Wechsler Intelligence Scale for Children. They concluded that no one factor accounted for individual differences in auditory-visual integrative performance. It appears, however, that the most rapid improvement in this type of performance occurs between the ages of five and seven as measured by temporal and spatial patterns (Birch & Belmont, 1965). Birch and Belmont (1964) in their examination of nine and ten year olds, again using an auditory-visual equivalence task concluded that retarded readers were less adequate in their judgement than normal readers. This relationship continued to exist even when children with low normal IQ's were examined.

Much research has been devoted to the examination of the role of intersensory integration in short term memory (STM). Several theories have been proposed stating that STM is primarily as auditory storage system (Atkinson & Shiffrin, 1968; Laughery, 1969). That is, information which is encoded is done so through its auditory characteristics These theories are supported by the findings of Wickelgren

(1965). Through the examination of intrusion errors, it was found that incorrect responses tend to possess the same auditory characteristics as the correct responses for which they were substituted. Murdock (1968) examined performance as a function of mode of presentation, that is, auditory or visual, using a probe technique. The results again showed the superiority of auditory presentation and it was suggested that these results were indicative of the difference in storage as opposed to retrieval. Laughery and Fell (1969) in their examination of preference of response mode concluded that subjects prefer to process information in the auditory mode, particularly at faster rates of presentation, and that they perform better on items presented orally than on items presented visually. Breitenstein (1972) examined the effects of mode of presentation and mode of rehearsal, oral or written, on delayed recall of continuously presented paired associates. It was found that only rehearsal facilitated recall and that maximal recall required aural presentation and oral rehearsal.

The opposite conslusion was drawn by Kroll, Parks, Parkinson, Bieber and Johnson (1970) in their examination of short term memory and shadowing. They found that after a retention interval of one second, auditory and visual stimuli were recalled equally well. However, retention after a 25 second interval showed unanimous superiority

of visual stimuli. Similar results were found when examining mode of presentation and mode of recall cue (Siegel & Allik, 1973). In this study, the recall of visual stimuli remained superior for all age subjects from kindergarten children to college students and was unrelated to the mode of recall cue.

Fisher and Karsh (1971) attempted to minimize the temporal dependencies which favor auditory performance by the use of a task which emphasized the importance of spatial relations during encoding and storage. This task resulted in the same level of performance on auditory and visual tasks when the encoding tasks were equated.

Shuell and Giglio (1973) performed several experiments designed to investigate the relationship between individual differences in learning ability and STM. Using a consonant retention task, it was determined for fast and slow learners who have been equated in degree of original learning, that individual differences in performance are not related to individual differences in STM. It was hypothesized that differences in performance of fast and slow learners are due to individual variation in the ability to apply previously learned information or individual differences in what the person has already learned. Shuell and Keppel (1970) found that when normal subjects are equated in the degree of original learning, there is little difference in the rate of forgetting of fast and slow learners. In

a study by Earhard (1970), it was concluded that individual differences in subjective organization that appear during free recall are not due to differences in STM but rather result from some type of individual variable dependent upon the retention and formation of interim associations.

The relationship of visual STM to reading ability has also been assessed using primarily measures of memory for designs (MD) such as that developed by Graham and Kendall (1960). Walters (1961) found a significant difference between MD and reading retardation among second graders. However, there did not seem to be a significant difference between reading retardation, MD and intelligence. Lyle (1968) found a significant difference between average and retarded readers of normal intelligence and MD. Levine and Fuller (1972) studied nine through twelve year olds using the Revised Visual Retention Test (Benton, 1963) and found that only the ten year old disabled readers performed poorer than the normative group. Samuels and Anderson (1973) found children with high visual recognition memory were superior to children possessing a lower ability in this area on paired associate tasks. In addition, it was discovered that good readers were superior to poor readers in visual recognition memory. Golden and Steiner (1969) using the Visual Sequential Memory subtest of the Illinois Test of Psycholinugistic Abilities found no significant difference between good and poor readers when

they were matched by age and intelligence. Similar results were found by Dornbush and Basow (1970) who concluded that reading ability was not related to memory tasks. Rate, modality of presentation and recall were varied in this study while intelligence was held constant.

Carroll (1973) in a review of the research emphasized the divergent and inconsistent findings obtained through experimentation in the area of reading achievement and visual STM. He further questioned the effectiveness of present remedial techniques and recommends continued research in this area.

Of interest to some experimenters has been the relationship of intelligence to STM. Nolan (1973) found no difference in the performance of a group of familial mental retardates and a group of their mental age peers on a STM task involving consonants. However, a group of their chronological age peers correctly reproduced more stimuli than either of the groups. Hayes and Routh (1972) investigated the length of recall interval and intensity level of aurally presented items using both normal and retarded subjects. The two groups demonstrated parallel retention functions while neither was sensitive to changes in intensity. In a study conducted by Borkowski (1965) the decline in STM at a long retention interval for low intelligence and retarded groups was greater than the decline exhibited by the high intelligence and mental age control groups. It

was concluded from this that proactive interference was related to intelligence. Goyen and Lyle (1973) investigated the difference in performance of normal and retarded readers on a visual discrimination task. As was expected, superior performance was exhibited by the group of normal readers. Errors of equivalence, which involves the judging of two non-identical shapes as the same, characterized the mistakes prevalent to the retarded group. However, under conditions of longer delay both groups exhibited errors of non-equivalence or the judging of two identical shapes as different. Comparing superior and average intelligence groups, Fagan (1972) found that differences in performance were limited to the superior recall of high intelligence subjects at the initial and middle serial positions. Ellis, McCarver and Ashurst (1970) using three levels of retarded subjects concluded that primacy performance was directly related to the level of intelligence but that stimulus meaningfulness had no effect.

Orn and Das (1972) examined the relationship of IQ and socioeconomic status and STM. Using both auditory and visual STM tasks, they found that for subjects of average IQ, the high socioeconomic group performed better than the low socioeconomic group. However, for the low IQ level subjects the opposite was found. These results were interpreted in terms of Jensen's hypothesis explaining the distribution of associative and reasoning ability to

different socioeconomic groups. It seems that for the purpose of this study, the low IQ, low economic group possessed associative ability superior to that of the high economic, low IQ group. Schutz and Keislar (1972) investigated the immediate recall of nouns, verbs and function words using preschool through second grade children from low and middle socioeconomic groups. Their findings revealed significantly greater recall of nouns and verbs for the low economic group in comparison with the middle class children. The difference was attributed to the use of relatively few function words in poverty situations compared with more affluent homes.

Studying the effects of practice on STM has led experimenters to conclude that forgetting decreases as the number of repetitions increases (Kintz, 1965). In a study by Butterfield, Wambold and Belmont (1973) it was found that retardates do not rehearse spontaneously nor do they "properly sequence rehearsal and essential non-rehearsal learning techniques, and they neither intercoordinate multiple retrieval strategies with strategies of acquisition" (p. 667). However, by teaching retardates to sequence the processes adequately, their performance on STM tasks can be substantially improved.

Fergenson and Teichner (1971) using college students examined the effect of sex differences and reward on performance on a sequencing task involving the Russian alphabet.

They found an inverse relationship between the percentage of correct responses and the number of responses required to complete the sequence. They also concluded that women may be more highly motivated by certainty of reward while men may be highly motivated by competition.

Task variables which are considered to have an effect on retention are numerous and diverse. Some of these variables include: mode of presentation, list length, nature of the stimuli (familiatity, pronounceability, meaningfulness), rate of presentation, duration of retention interval and intervening activities during the retention interval (Hall, 1971; Chalfant & Scheffelin, 1969). The practice of requiring different periods of activity during the retention interval has been used by experimenters in an effort to reduce or eliminate rehearsal (Peterson & Peterson, 1959; Bruning & Schappe, 1965; Whimbey & Leiblum, 1967). Decrements in recall under these conditions have been shown to be related to the length of the intervening task (Peterson & Peterson, 1959) as well as the type of intervening activity (Bruning & Schappe, 1965). It appears, however, that individual differences in memory span are stable regardless of the use of intervening variables (Whimbey & Leiblum, 1967). Hasher and Thomas (1973) found no significant difference in forgetting for children between the ages of three and nine. These results would lead one to expect an age difference in retention.

Previous research performed by this author attempted to assess memory span in learning disabled children as it is effected by the mode of presentation and recall and the length of the intervening retention interval involving activity (Arthur & Worthington, 1974). Three modes of presentation and recall (visual-visual, auditory-auditory and auditory-visual) were examined under four retention intervals (3,6,9 and 12 seconds). During each recall interval, a counting task was performed similar to the Peterson and Peterson (1959) design. The results revealed a significant increase in the number of errors for the auditory-auditory task as compared to the visual-visual and auditory-visual tasks. An assessment of the recall interval found a significant increase in the number of errors occuring between the 3 and 6 second intervals but not between the 9 and 12 second intervals.

The present study will attempt to assess the effect of educational ability and practice on STM. For purposes of this study, practice will be considered as the completion of the DISTAR reading program. This program was designed by SRA specifically for the educationally disadvantaged student. A phonetic approach is used which focuses on basic sound symbols and the learning of each letter by the sound it represents. The students receive a great deal of individual attention and are frequently exposed to a rapid presentation of visual and auditory stimuli.

Educational ability will be measured by the Short Test of Educational Ability (STEA). The STEA is the single score ability component on the SRA Assessment Survey. This test was specifically designed to provide a reliable estimate of general educational ability.

This study will, therefore, examine memory span as it is influenced by educational ability and practice. Two modes of presentation and recall (auditory-auditory and auditory-visual) will be examined under three intervals of retention (4,8 and 12 seconds) involving counting activity. It is hypothesized that educational ability and practice will result in an increase in STM for both the auditory-auditory and auditory-visual tasks but that subjects will find the auditory-auditory task more difficult than the auditory-visual task. A decrement in recall is also expected for the longer retention intervals.

Chapter II

METHOD

Subjects

The Ss consisted of 18 male and 18 female students who attended the fourth grade in the Lynchburg Public School System. These children were classified into one of three groups on the basis of their educational ability as measured by the November, 1974, administration of the STEA; a reading readiness factor as measured in October, 1969, by the Metropolitian Reading Readiness Test, Form A; and on the basis of participation in the DISTAR reading program. The groups were as follows: 1.) Children who achieved a score of A or B (raw score of 64 and above) on the Metropolitian Reading Readiness Test with an STEA score between 90 and 110. These children would not have been eligible for participation in the DISTAR program. 2.) Children who achieved a score of D or E (raw score of 44 or below) on the Metropolitian Reading Readiness Test with a STEA score between 75 and 89 who have satisfactorily completed the DISTAR reading program. 3.) Children who achieved a score of D or E (raw score of 44 or below) on the Metropolitian Reading Readiness Test and scored between 75 and 89 on the STEA who were not exposed to the DISTAR reading program. Each group was further subdivided into an equal number of male and female Ss.

Materials

Twenty-four consonant syllables with a Witmer association value between 13% and 33% (Hilgard, 1951) comprised the verbal items tested for recall. The CCC's were randomly divided into two groups of twelve each and assigned to each of the presentation-recall modes (auditory-auditory or auditory-visual). Within each mode, the CCC's were further randomly divided into groups of four and assigned to each of the three retention intervals (4,8 and 12 seconds). Two additional CCC's were randomly selected for use in practice trials for each of the two tasks.

The visual recall task required the S to choose from five response alternatives. The five alternatives exhibited the following within item order: ABC (order of the stimulus item), CAB, BCA, and CBA (reverse order of the stimulus item). The fifth alternative response consisted of two consonants from the original stimulus and a third which was not among the original three consonants, arranged in random order. The association value of the fifth response item was again between 13% and 33% as measured by Whitmer. The five responses were printed vertically in random order on 8½ by 11 inch paper with letter height of approximately one inch. Each possible response was separated by a solid vertical line.

Procedure

Each child was presented with two tasks involving

particular modes of presentation and recall. The tasks were as follows: 1.) auditory presentation and auditory recall, and 2.) auditory presentation and visual recall. The order of presentation was counterbalanced.

Each S received instructions prior to the initiation of testing. In these instructions the S was told that he was to begin counting forward immediately after the termination of the E's auditory stimulus presentation. This was to continue until the S was instructed to stop. At which time, he was to repeat the auditory stimulus or choose the correct alternative depending on the task. Each S was tested four times at each retention interval (4,8 and 12 seconds). Two practice trials were administered prior to each task.

The auditory presentation of the stimulus items consisted of the E reading the CCC's to the S at a rate of approximately one per second. Auditory recall involved the repetition from memory of the stimulus item upon completion of the retention time interval. Visual recall required the S to choose his response from the five alternatives, again upon completion of the retention time interval.

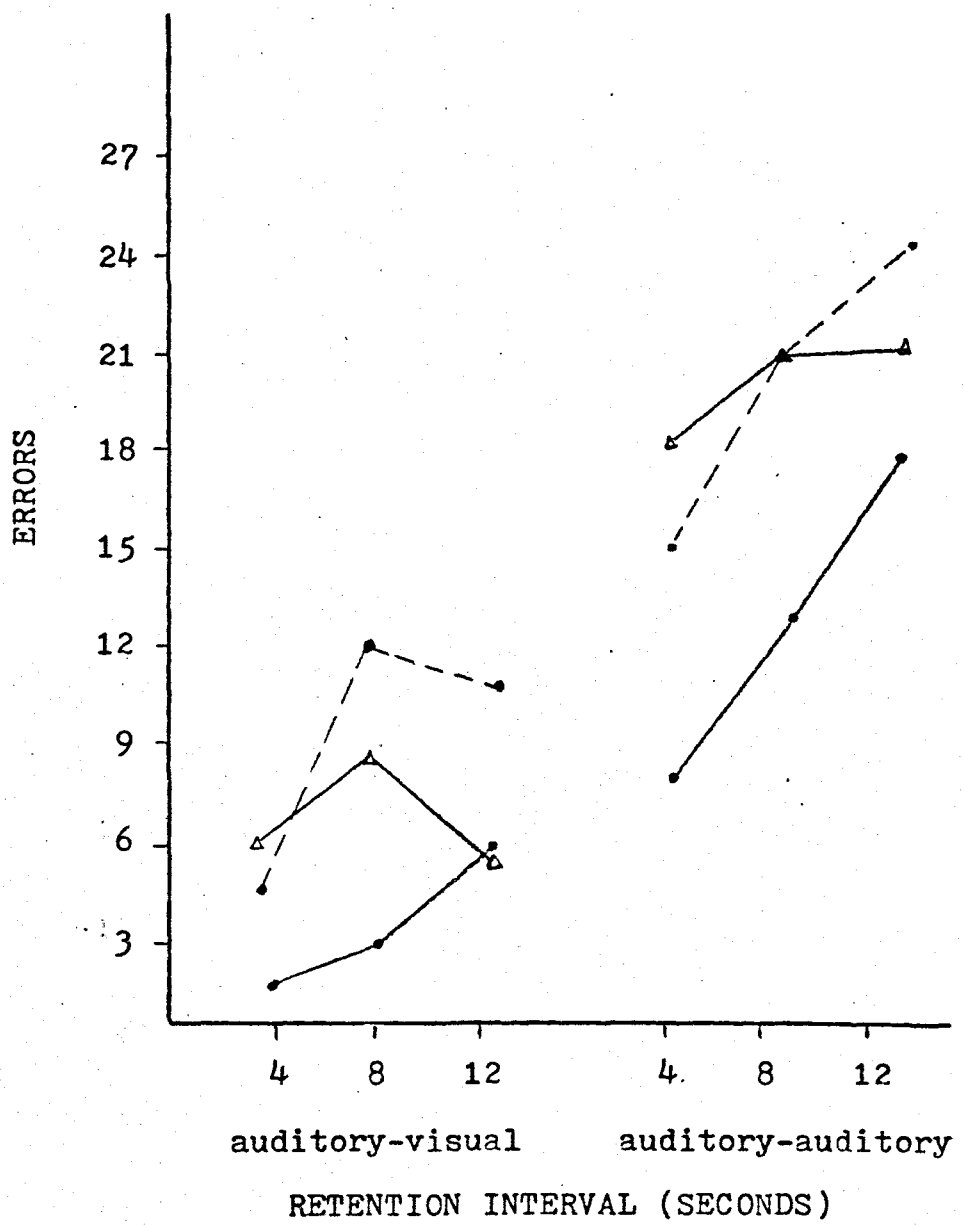
Chapter III

RESULTS

The data for each S was scored on an item by item basis for each mode of presentation and recall. Performance was scored on the basis of incorrect responses. The results were compared by means of 2(task) by 3(retention interval) by 3(groups) by 2(sex) analysis of variance design with repeated observations for the factors of task and retention.

Figures I and II graphically represent errors made at each retention interval for each group, task and sex. Table I shows that the main effects of retention interval, $F(2,60)=17.71$, $p<.01$, and task, $F(1,30)=289.81$, $p<.01$, are significant. The main effect of group while not significant, however, did indicate a trend in the expected direction. No significant interactions were found.

Orthogonal comparisons were then performed comparing the retention intervals for each task. For the auditory-auditory task, a significant difference was found between the 4 second interval compared to the 8 and 12 second intervals, $F(1,6)=12.92$, $p<.01$. Fewer errors being made after the shorter interval. No significant difference was found between the 8 and 12 second intervals. Similar analysis of the auditory-visual task failed to discover differences among the retention intervals.

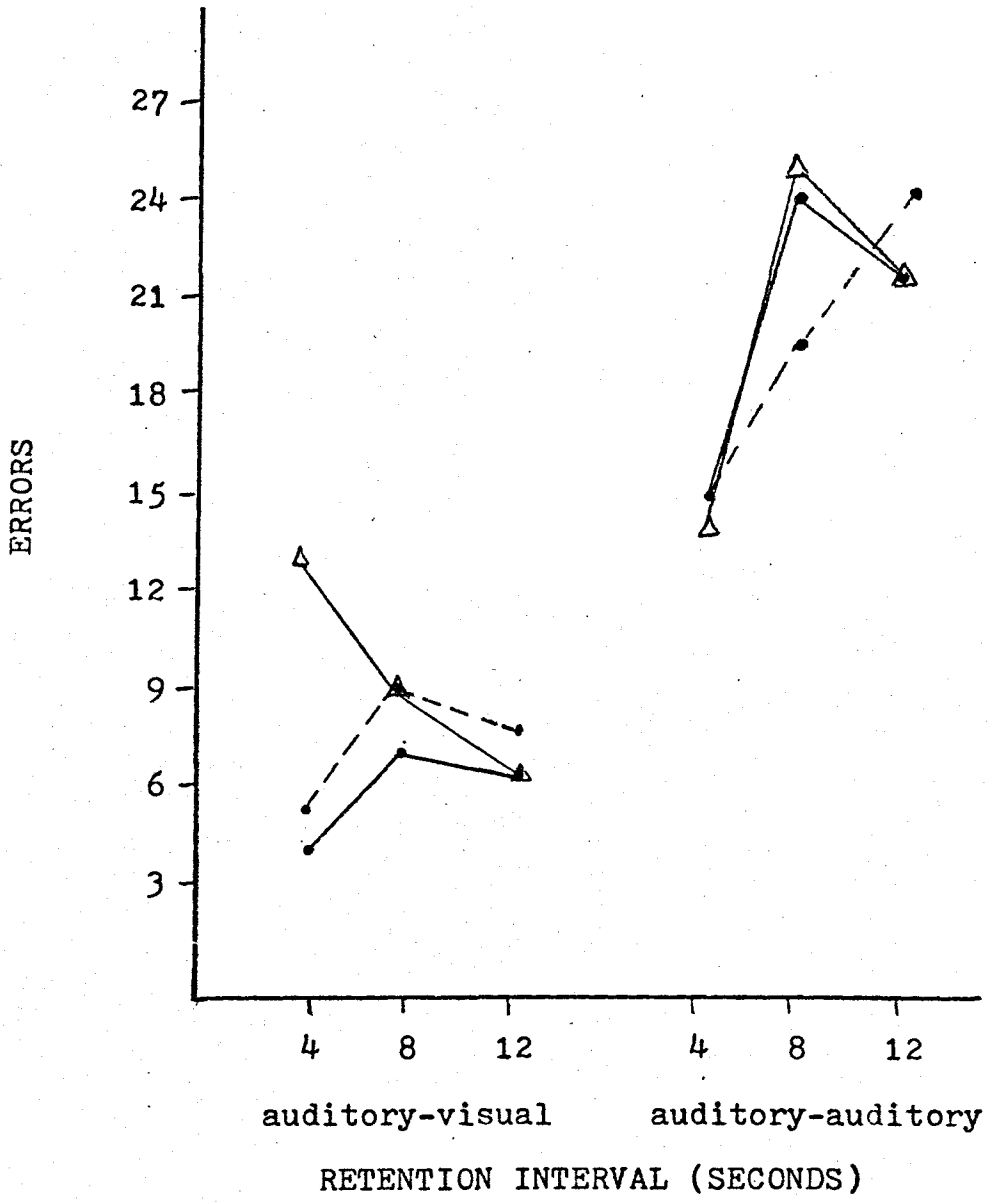


Metropolitian Reading Readiness score A or B, STEA between 90 and 110.

Metropolitian Reading Readiness score D or E, STEA between 75 and 89, no exposure to the DISTAR program.

Metropolitian Reading Readiness score D or E, STEA between 75 and 89, completed the DISTAR program.

Figure 1. Error frequency of male groups as a function of task and retention interval.



Metropolitian Reading Readiness score A or B, STEA between 90 and 110.

Metropolitian Reading Readiness score D or E, STEA between 75 and 89, no exposure to the DISTAR program.

Metropolitian Reading Readiness score D or E, STEA between 75 and 89, completed the DISTAR program.

Figure 2. Error frequency of female groups as a function of task and retention interval.

Table I

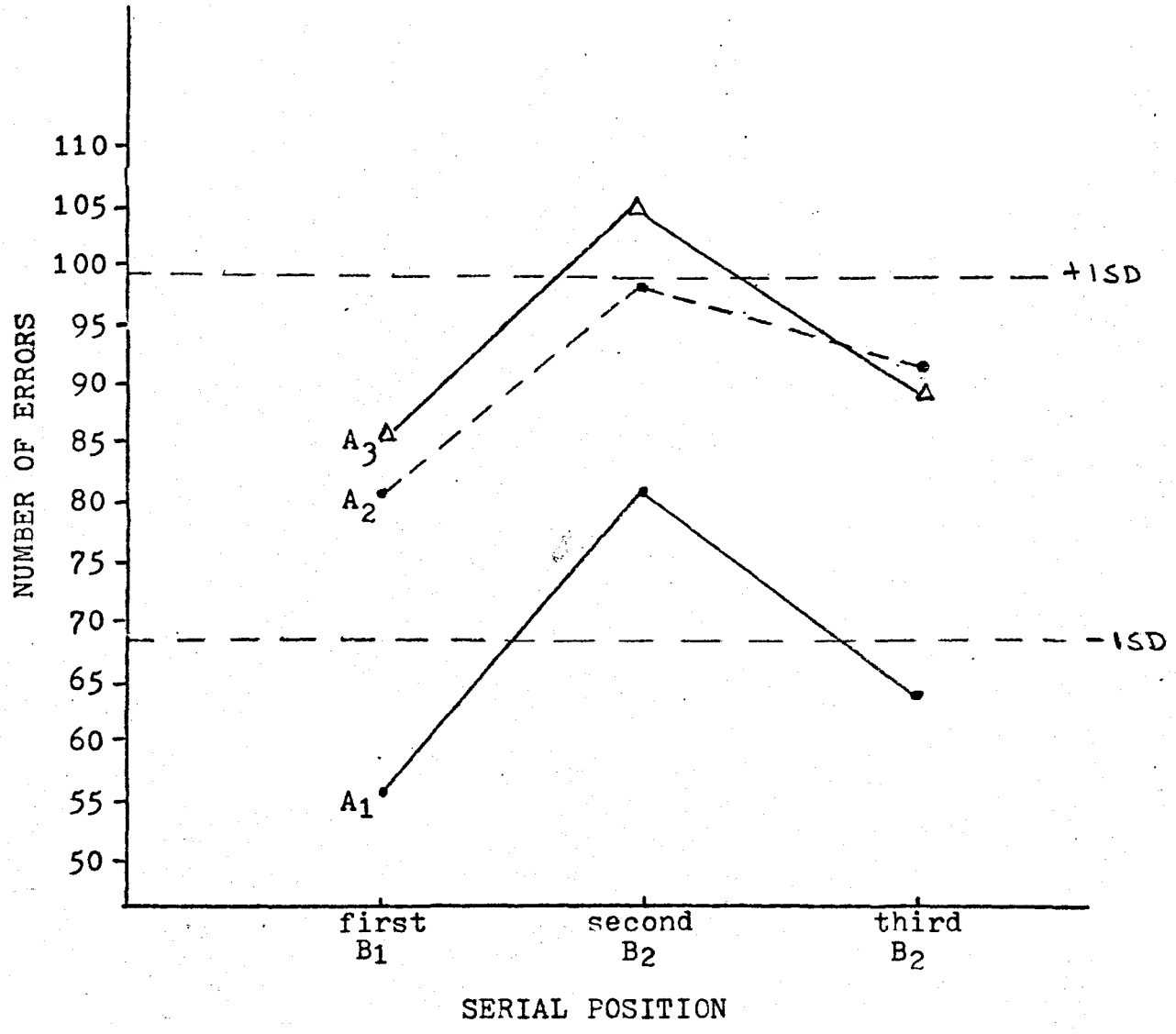
ANALYSIS OF VARIANCE: TOTAL ERRORS

Source of variation	df	MS	F
Between subjects	35		
A (Sex)	1	4.46	1.78
C (Group)	2	8.01	3.19
AC	2	4.31	1.72
subject w. groups	30	2.51	
Within subjects	180		
B (Retention interval)	2	10.45	17.71*
D (Task)	1	179.68	289.81*
BD	2	2.25	3.00
AB	2	1.61	2.74
BC	4	1.22	2.07
ABC	4	.44	.75
AD	1	.77	1.24
CD	2	0.00	0.00
ACD	2	1.59	2.56
ABD	2	.34	.45
BCD	4	.70	.93
ABCD	4	1.16	1.55
B×subj. w. groups	60	.59	
D×subj. w. groups	30	.62	
BD×subj. w. groups	60	.75	

* $p < .01$

Comparison of errors

For purposes of illustrating expected differences in the data, post hoc analyses of S errors were performed. To assess the errors made on the auditory-auditory task, examination was made of errors found in each of the three serial positions. That is, first, second or third placement in the CCC stimulus group. Errors were counted and totaled for each position. Orthogonal comparisons, however, indicated no difference between the number of errors made in any of the three positions. Figure III graphically represents these results. Next, individual errors were examined on the basis of their similarity to the correct stimulus letter. A frequency count was taken of errors at each serial position that were "e" phoneme substitutes. That is, the number of "e" phoneme errors which were substituted for the correct "e" phoneme stimulus letter according to each serial position. The results of this investigation are reported in Table II in terms of percentage. As can be seen, the percentage of "e" phoneme substitutes decreases in the second position for all Ss who received a Metropolitian Reading Readiness score of A or B or who had completed the DISTAR program and for female Ss who were not involved in DISTAR. This same trend continues to exist for female Ss when the number of errors was combined over groups. However, combining the errors made by male Ss in all groups shows an increase in "e" phonome



●—● Metropolitian Reading Readiness score A or B, STEA between 90 and 110.

●–● Metropolitian Reading Readiness score D or E, STEA between 75 and 89, no exposure to the DISTAR program.

△—△ Metropolitian Reading Readiness score D or E, STEA between 75 and 89, completed the DISTAR program.

Orthogonal Comparisons:

I. $B_1(A_1+A_2+A_3)+B_2(A_1+A_2+A_3)=2B_3(A_1+A_2+A_3)$ F=.07

II. $B_1(A_1+A_2+A_3)=B_2(A_1+A_2+A_3)$ F=1.40

Figure 3: Error frequency of the auditory-auditory task as a function of serial position.

Table II

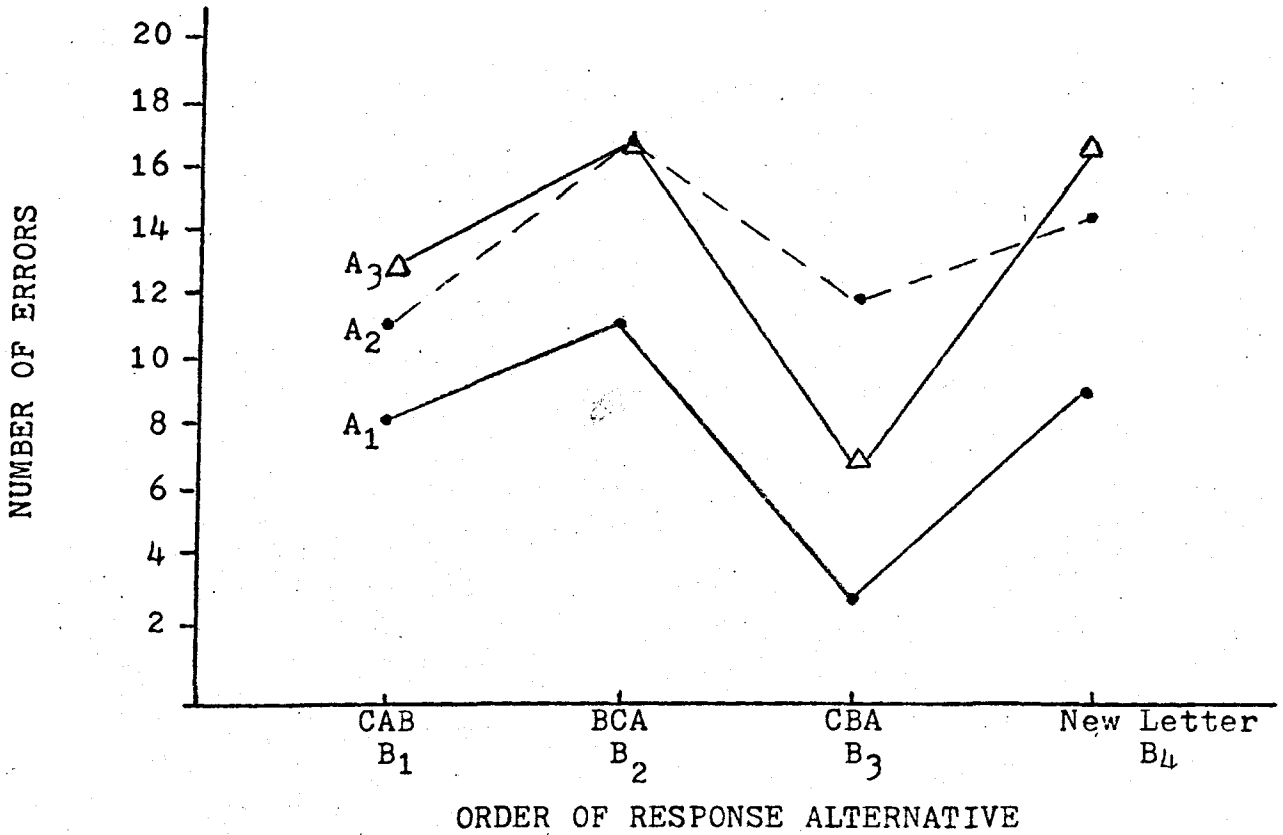
PERCENTAGE OF "E" PHONEME STIMULUS ERRORS

	First	Second	Third	(Serial Position)
Female Subjects				
Metropolitian score A or B	55%	35%	48%	
Completed DISTAR	30%	20%	44%	$X^2=8.826$
No DISTAR	60%	25%	59%	
Total	48%	25%	50%	
Male Subjects				
Metropolitian score A or B	33%	23%	73%	
Completed DISTAR	27%	23%	57%	$X^2=10.316*$
No DISTAR	18%	38%	56%	
Total	24%	27%	60%	
Total Subjects	38%	26%	55%	$X^2=8.397*$

*p .05

substitutes over position. For the purpose of a more thorough evaluation, a chi square analysis was performed. A significant difference was found between the frequency of "e" phonome substitutes at the differing serial positions for male Ss (X^2=10.316, p .05) but not for female Ss. A difference was also indicated between the total percentages (X^2=8.397, p .05).

To study the errors made on the auditory-visual task, a frequency count was taken for each of the four alternatives provided to the ABC stimulus order (1. CAB, 2. BCA, 3. CBA and 4. two original stimulus consonants combined with a third which was not a member of the original stimulus group). Orthogonal comparisons found that of the four alternatives, fewer CBA errors were made, F(1,8)=6.73, p .05, while there was no significant difference between the remaining alternatives. The frequency of occurance for each error type is illustrated in Figure IV.



Metropolitian Reading Readiness score A or B, STEA between 90 and 110.

Metropolitian Reading Readiness score D or E, STEA between 75 and 89, no exposure to the DISTAR program.

Metropolitian Reading Readiness score D or E, STEA between 75 and 89, completed the DISTAR program.

Orthogonal Comparisons:

I. $B_1(A_1+A_2+A_3)+B_2(A_1+A_2+A_3)+B_3(A_1+A_2+A_3)=3B_4(A_1+A_2+A_3)$ F=.87

II. $B_1(A_1+A_2+A_3)+B_2(A_1+A_2+A_3)=2B_3(A_1+A_2+A_3)$ F=5.87

III. $B_1(A_1+A_2+A_3)=B_2(A_1+A_2+A_3)$ F=3.24

Figure 4: Error frequency for the auditory-visual task as a function of response alternatives.

Chapter IV

DISCUSSION

Meuhl and Kremenak (1966) in their evaluation of performance as it is effected by both the visual and auditory modalities concluded that recall was best on tasks involving only the visual modality while performance was weakest on tasks involving strictly the auditory modality. Mixed modality matching resulted in a level of intermediate difficulty. Although only auditory presentation was used in this study and a completely visual task involving visual presentation and visual recall was excluded, results are supportive of the Meuhl and Kremenak (1966) findings. The auditory-auditory task did result in greater difficulty for the Ss than did the auditory-visual task. These results are consistent with the findings of previous research performed by the author (Arthur & Worthington, 1974). It can, therefore, be concluded that when the visual modality is involved in recall, performance is elevated as compared to the involvement of the auditory modality in recall. It should, however, be remembered that visual recall involved the selection on the part of the S of one of five alternatives. Thus, free choice was restricted and the number of errors may have been falsely depressed. Although fewer errors resulted from the use of this method of recall, the more sensitive

measure may be that of complete freedom of response as was used for auditory recall.

Carroll (1973) in a review of the research emphasized the divergent and inconsistent findings obtained through experimentation in the area of reading achievement and visual STM. Although for the purposes of this experiment a visual memory for designs task was not employed, this study does not support research which substantiates a relationship between the factors of reading achievement and visual STM. As would be expected, Ss who received a score of A or B on the Metropolitian Reading Readiness Test are reading at a higher grade level that Ss who received a lower score on this same test (Table III). The difference in reading ability between the groups ranged from one year five months to two years. Analysis did not find a significant difference between the performance of the three groups on STM tasks although significance was approached. Therefore, a relationship between reading achievement and STM cannot be inferred. It may be that had the differences in reading level been greater, a relationship would have been established.

Neither did this study lend support to the relationship between intelligence and STM. Nolan (1973) and Brokowski (1965) found a significant difference between the performance on STM tasks of Ss functioning at different levels of cognitive ability. For purposes of this study,

Table III

AVERAGE READING GRADE LEVEL AS MEASURED BY THE SRA ASSESSMENT SURVEY

	Male	Female
Metropolitian score A or B	4-4	4-2
Completed DISTAR	2-4	2-7
No DISTAR	2-9	2-5
Total subjects	3-2	3-1

the measure most closely related to intelligence is that of educational ability. Although this measure is not directly related to or dependent upon intelligence, it is not unreasonable to assume there is some connection between the two. Since analysis failed to find a significant difference between the performance of the groups, a relationship between intelligence and STM is not suggested. It should, however, be noted that the range of educational ability in this study was not as diverse as the range of intelligence used in previous studies where this relationship was found (Table IV). This study incorporated Ss within what is considered the average to low average range of educational ability while Nolan (1973) and Brokowski (1965) examined Ss differing two or more standard deviations in their cognitive ability.

And finally, due to the lack of significance between the groups, there is no reason to assume that practice is a means of remediation for STM. Although the DISTAR program encompasses a great deal of auditory and visual STM, it is not the purpose of this program to remediate STM but reading and language arts skills. It would appear from the results, therefore, that remediation of STM is not a by product of this program. This is not to conclude, however, that STM can in no way be remediated but that the DISTAR program does not provide the necessary emphasis for this type of remediation.

Table IV

AVERAGE STEA FOR GROUPS

	Male	Female
Metropolitian score A or B	97.5	99.83
Completed DISTAR	82.6	83.16
No DISTAR	81.5	82.50

Wickelgren (1965) in his examination of intrusion errors found that incorrect responses tend to possess the same auditory characteristics as the correct responses for which they were substituted. Thus, lending support to the theory that STM is primarily an auditory storage system. Although the present study examined only one aspect of response similarity, that of "e" phoneme substitution, findings are in partial support of Wickelgren's conclusion. A significant difference was found between the percentage of "e" phoneme substitutes for male Ss indicating a deviation from the normal curve. The results of error evaluation conflict with the findings of Fagan (1970) and McCarver and Ashurst (1970) who concluded that superior performance was limited to high intelligence Ss at the initial and middle serial positions. According to the number of errors made on the auditory-auditory task, correct recall of the middle stimulus letter resulted in greatest difficulty for all three groups.

A significant difference was found between the types of errors made on the auditory-visual task; complete reversal of the stimulus being less confusing to the Ss than the other alternatives. Thus, indicating that the S often partially remembered the correct stimulus order.

As hypothesized, a significant difference was found between retention intervals but only for the auditory-auditory task at the 4 second interval as compared to the

longer retention intervals. This, however, is in accordance with previous research performed by this author (Arthur & Worthington, 1974) which resulted in a significant difference between the shorter 3 and 6 second intervals but not between the longer 9 and 12 second retention intervals. Although counting activity during the retention interval was designed to eliminate or decrease rehearsal, subvocalization on the part of the Ss observed by the E was still prevailant usually prior to the beginning of the counting activity or after the presentation of each of the stimulus letters. This may be reduced in further studies by presenting the stimulus letters at a faster rate than one per second and by providing an additional cue for the S to start counting immediately after the termination of the stimulus. The presence of subvocalization may have also resulted in a reduction of recall differences between the groups.

In conclusion, it would appear from the results obtained from this study that performance on STM tasks does not reflect differences in reading achievement or educational ability nor is this process remediated by participation in the DISTAR program. These factors, however, should not be entirely excluded from their role in STM for it is entirely possible that group differences in this study were not substantial enough to produce observable differences in recall. Further reaserch should

account for this by either providing greater diversity between the groups or by establishing a more sensitive measure of STM.

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