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Normative data on the auditory memory performance of three- and four-year old children as measured by the Auditory memory test package (AMTP)

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According to Atkinson and Shiffin (1971), auditory short-term memory plays a critical role in the total learning process and is necessary for the acquisition of speech and language skills. It has been shown that auditory short-term memory skills improve with each progressive year in the five through eight year age range (Wepman and Morency, 1973a), but relatively few investigations have focused on the normative performance of three- and four-year old children.

The purpose of this study was to collect normative data on the audi-

tory memory performance of three- and four-year old children as measured by the Auditory Memory Test Package (AMTP). Specifically, this investigation sought to answer one question: is the AMTP sensitive to age differences when administered to young children ages 3.0-4.11?

Eighty subjects were selected from Portland Metropolitan day care centers and preschools. Twenty children were chosen for each of the four age groups: 3.0-3.5; 3.6-3.11; 4.0-4.5; and 4.6-4.11. Each subject was administered the AMTP, which consisted of three subtests: unrelated words; related words; and sentences. Each subject received a score for each subtest and a total test score.

The results of this investigation showed a significant difference in the auditory memory performance of three- and four-year old children, with the four-year old group achieving higher scores. Overall, mean subtest scores, as well as total test scores for each age group, showed improvement as age increased. The one exception to the growth in scores was for the 4.0-4.5 age group on Subtest Three (Sentences).

The results of this study lend support to Wepman and Morency's (1973a; 1973b) research in which they reported that auditory short-term memory abilities increase with age. Wepman and Morency found that a growth in auditory recall occurs in the five through eight year age range. The results of this investigation indicate that a growth in auditory recall also occurs in the three and four year age range when utilizing the AMTP.

There has been a need to study the auditory short-term memory of normal developing three- and four-year old children. The information obtained in this study suggests that the AMTP may be a viable auditory short-term memory test to aid in describing auditory recall in young

children ages 3.0-4.11. The AMTP was easy to administer and score, and the test items appeared to be of moderately high interest to the subjects. Administration and scoring on the AMTP involved ten to fifteen minutes (including breaks between subtests), depending on the age and attention span of the subject.

Further research utilizing the AMTP may reveal a useful tool for those who emphasize a preventive philosophy in dealing with speech and language disorders. The AMTP may aid in the early detection of possible problem areas so that intervention can start at an early age. In conjunction with other speech and language tests, it may be used in a battery of tests to diagnose possible speech and language deficits. In this way, it would help identify, at an early age, problems that would otherwise go undetected until they manifest themselves in older children, such elementary children, who have difficulty remembering oral directions or who are unable to repeat a simple sequence of events. As Wiig and Semel (1976) suggest, any type of auditory processing problem which existed in kindergarten or first grade tends to persist or increase in severity in subsequent years due to increased demands in the classroom.

NORMATIVE DATA ON THE AUDITORY MEMORY PERFORMANCE OF THREE- AND FOUR-YEAR OLD CHILDREN AS MEASURED BY THE AUDITORY MEMORY TEST PACKAGE (AMTP)

by

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INTRODUCTION AND STATEMENT OF PURPOSE

Introduction

A child first learns language primarily through the auditory modality. Auditory learning is a natural and ongoing process (Zigmond and Cicci, 1968). Attention to sound becomes integrated with meaningful experiences and provides the foundation for much of learning, particularly for language.

The human's response to auditory learning is reflected in his/her earliest reactions to sounds, awareness of sound, capacity to attach meaning to verbal and nonverbal sound patterns in the environment, and ability to learn to speak in the complex sounds of his/her culture (Zigmond and Cicci, 1968).

Memory is involved in all kinds of learning and there are several kinds of memory, including long-term and short-term memory. The most important for acquiring speech and language skills and for learning new information presented auditorily is short-term memory--STM (Ramp, 1981). Auditory STM is involved with virtually every task associated with learning, such as perception, processing, and reproduction of sound (Heasley, 1974). In STM stimuli may be stored for a short period of time (15 minutes or less) and then recalled, transferred to long-term memory, or forgotten (Val Jones, 1979). Auditory STM may be defined as the ability to remember the characteristics of a given sound or series of sounds

(Heasley, 1974). Two subskills of auditory STM are: 1) memory span: the maximum number of digits, letters, isolated words or words in a sentence once can repeat after a single presentation (Cofer, 1976); and 2) memory sequence: the ability to remember a serioes of sounds in the correct order (Aten, 1974). As language develops, a child relies on auditory STM to remember incoming auditory stimuli, to order the stimuli correctly and to respond appropriately (Atkinson and Shiffin, 1971).

Children who have auditory STM problems will experience difficulty recalling or retaining what they have heard (Faas, 1980) and may not be able to follow directions, attend to details of auditory stimuli, or reproduce auditory information.

It is difficult to determine which children have disturbances in auditory STM, particularly in the preschool population. There is still relatively little known about the growth of auditory memory development before the elementary years (Perlmutter, 1980). The documentation that does exist for the preschool population pertains primarily to recognition memory. In a recognition task a subject is shown several pictures, for example, the pictures are removed from the subject's view and then the subject is asked to name the pictures he saw.

Auditory STM appears to be of a developmental nature in the five through eight year age range, as suggested by Wepman and Morency's (1973a) research. They found that as children grow older, their span of auditory recall and their sequential recall increases from year to year. The Auditory Memory Span Test (Wepman and Morency, 1973a) and the Auditory Sequential Memory Test (Wepman and Morency, 1973b) are two instruments which support the developmental nature of auditory STM for that age group.

Statement of Purpose

The purpose of this study was to obtain normative data on the auditory memory performance of three- and four-year old children as measured by the Auditory Memory Test Package (AMTP).

This investigation sought to answer one specific question: is the AMTP sensitive to age differences when administered to young children ages 3.0-4.11?

CHAPTER II

REVIEW OF THE LITERATURE

Auditory Memory Development

A child learns to sort out auditory stimuli from the mass of information in the environment at an early age. He learns to differentiate general environmental sounds from the more specific sounds used in communication, i. e., the sounds that come from people (Zigmond and Cicci, 1968). The normal development of language comprehension depends upon the normal functioning of auditory processes for receiving and transmitting sounds, perceiving and remembering sound, and integrating sound experiences. In the normal hearing population it is after listening skills have begun to develop and the child becomes aware of specialized sounds and the differences between sounds, that auditory language comprehension is seen. As a part of the processes involved in language development, the child pays close attention to auditory stimuli and makes differentiated responses to them. As language skills continue to develop, the child's auditory perceptual and memory abilities also develop (Zigmond and Cicci, 1968).

As auditory processing matures, the child develops the capacity for storage of auditory sounds and experiences. In the process of speech and language acquistion, the individual must focus on and attend to complex auditory stimuli, distinguish figure from ground, sort, compare, discriminate, remember phonetic elements, and recall temporal sentences (Witkin,

Butler, and Whalen, 1977).

Information about the environment is received and processed by the various sensory systems and is entered into short-term memory (STM). At least three authorities have indicated time limitations in STM. Weener (1969) reported that if information that enters STM is not attended to within a brief period of time after stimulation, the information will be lost through a process of rapid decay. Wiig and Semel (1976) appear to concur with Weener by suggesting that a minimum auditory retention span seems to be required for adequate intellectual functioning and for the development of speech and language skills. Mecham and Willbrand (1979) tend to support both Weener and Wiig and Semel in that they are of the opinion that the length of time that information can be held in STM (without recycling through the rehearsal process) has an upper limit of 15 seconds in normal adults. Additionally, they note that STM is much shorter in very young children, increasing with maturation.

Learning Problems Associated With An Auditory Memory Deficit

Intact sequencing ability is one element which leads to normal language development and verbal skills; conversely, a disability in sequencing will delay or prevent normal language acquisition and expression (Aten, 1974).

The reception of spoken language involves a sequential series of acoustic events occurring along a time dimension. Research indicates that the integrity of this function may be critical to the accurate comprehension of spoken language (Monsees, 1968). Students with auditory sequential memory problems may have difficulty remembering oral directions, attending to the details of auditory material, and reproducing a series

of auditory impressions after hearing it (Faas, 1980). In some case study reports, children cannot repeat a simple sequence of three words immediately after hearing them. This kind of auditory memory deficit seriously affects the learning process (Gearhart, 1973). Children rely, in part, on auditory STM to learn numbers, the alphabet, telephone numbers and addresses, and in a more complex way, to learn to talk, count and read (Hurley, Hirshoren, and Hunt, 1976). Learning to read involves remembering words and ideas heard, as well as the ability to discriminate between similar auditory symbols (Kirk, 1940).

Deficits in sequential memory have been identified by many researchers as being a characteristic deficit in learning disabled children (Swanson, 1979; McLeod and Greenough, 1980). In his research Swanson (1979) found that the ability to recall verbal stimuli in order differentiated normal and learning disabled children with reading problems.

Faas (1980) agreed with Swanson (1979) that students who have auditory STM deficits often experience mild to moderate difficulty in reading. These auditory STM deficits may include problems in one or more areas, such as auditory discrimination or sequential memory.

The development of reading and spelling skills requires not only gross discrimination of sameness and difference in an auditory pattern, but, more importantly, the precise conceptualization of how and where patterns are different (Lindamood and Lindamood, 1971). If an individual cannot perceive contrasts in speech sound units, or if he cannot conceptualize the order of sounds in syllables and words, he cannot easily associate the sound units with written symbols. Lindamood and Lindamood (1971) cite Orton (1937) to support the theory that a factor common to problems in reading, writing, and speech is the inability to rebuild, in

the order of presentation, sequences of letters and sounds.

Aten (1974) described intact sequencing ability as an important element in the development of language and verbal skills. In the classroom, children must learn to attend, discriminate, and to listen to separate the various and different aspects of words, phrases, questions, and directions (Wiig and Semel, 1976). Much of the material presented to young children orally and visually involves seeing and understanding relationships, auditory and visual closure, and auditory and visual sequential memory (Paraskevopoulos and Kirk, 1969).

As Wiig and Semel (1976) suggest, auditory memory functions often need attention in children with learning disabilities. When a child enters the second grade, the demands on auditory processing and verbal recall increase significantly. Any type of auditory processing problem which existed in kindergarten or first grade tends to persist or increase in severity due to the increased demands. At the same time, less classroom time is spent with visual material, requiring the student to rely more and more on information presented auditorily. In addition, new information must be acquired rapidly from verbal presentations and increasingly complex verbal directions must be followed accurately.

Auditory Memory Performance In Children

It appears that the ability to recall related words more efficiently than unrelated words is established early and persists throughout life (Smith, 1984). Perlmutter and Myers (1975) found that children as young as two-years old recalled related word lists more completely than unrelated lists. In addition two- and five-year old subjects exhibited shorter latencies between recalled items that were from the same semantic

category. Even the youngest children appeared fairly proficient at encoding and retaining rudiments of ault-like semantic organization by the end of the second year. They stressed, however, that mneumonic activities necessary for proficient recall are not yet under effective control until after age four. According to Perlmutter and Myers, an increase in performance capacity will observed between the ages of two years, nine months, and four years, nine months. They attributed this increase in memory performance to the growth in semantic category knowledge which occurs between the ages of two and five years.

In a later study, Myers and Perlmutter (1978) again found that a growth in general knowledge was responsible for the improved recall ability evident between two and five years of age. They found that, although recall was poor in this age group, it improved within these years. Their research indicated that four-year old children's recall performance was statistically significant over the three-year old's performance.

Several other researchers have conducted studies in an attempt to determine the auditory memory performance of young children.

Rossi and Rossi (1965) reported that the majority of their subjects, ages two through five years, did not use serial order in their recall until the age of four. In addition, they reported that an overwhelming majority of two-year olds used clustering (categorization) as an almost exclusive technique for recall.

A study conducted by Perlmutter (1980) revealed that young children, from among a group of two- through five-year olds, encoded substantial amounts of stimulus information, although they did so more slowly than older children and were limited by ineffective attention and searching skills. Furthermore, two- and three-year olds appeared to have sub-

stantial difficulty retrieving information upon demand and did not make extensive use of semantic information to organize stimuli for encoding and retrieval.

Taking a different approach, Scholes, Rasbury, Scholes, and Downing (1976) observed that the ability of children to recall and comprehend sentences depended upon several factors, including: experience with language, maturation, acquisition of a lexicon, and development of syntactical skills. They also noted that individual children acquired information, at varied rates, dealing with the sequential frequencies and probabilities of language. All of these factors were involved in the ability to recall sentences.

Hoeman, DeRosa, and Andrews (1974) studied the recall of three-year olds. They reported that the subjects recalled significantly more words in semantically similar groups than in phonetically similar groups. They concluded that the symbolic value of words is a salient feature in the perceptual and memory behavior of children at this age, a finding which is in agreement with research by Perlmutter and Myers (1975) and Myers and Perlmutter (1978). Huttenlocher and Lui (1979) also reported evidence that young children, including three- and four-year olds, were better at remembering items which were from one semantic category than items which were unrelated in meaning.

As a result of their research, Wepman and Morency (1973a; 1973b) have reported means and standard deviations for the auditory memory span and sequence of children in the five through eight year age range. Their results revealed that a higher percentage of items were passed by children at each progressive age level.

Wepman and Morency (1973a) used digits in their study of auditory

memory span. In a similar study, Munn (1956) also used digits as the stimulus material. He found that, in general, the average span for auditory presentation and vocal recall of digits increased from 4 digits between the ages of four and five, to 6 digits between the ages of nine and twelve. Beyond twelve years, the average span was 7 digits.

In their study with three- and eight-year olds, LaBenz and Fay (1980) used digits, syllables, and spondaic words. They reported that 2-digit series were passed by 93% of the children and 3-digit series were passed by 74% of the subjects. 95% of the children passed the 2-syllable series and 78% of the subjects passed the 3-syllable series. The authors had expected better performance rates on the digit task since most three-year olds would likely have had some familiarity with numbers, and because the syllable task was nonsense material. They noted, however, that the better performance on syllables was perhaps due to a learning effect since digits were always presented first. This allowed the aubjects to better understand the task by the time syllables were presented.

Zinchero (1969) used both pictures and words as the stimulus material in his study. He suggested that recall increases irregularly with age; however, among preschool children a more significant increase is noted in the period from age four to five years. In contrast, Zinchero observed no significant differences between three and four years of age or between five and six years of age.

Summary

It would appear that few of the researchers agree on the precise ages and numbers of units a child can recall at a given age. All seem to agree,

however, that a general increase in recall abilities is evident between the ages of two and five years.

CHAPTER III

METHODS AND PROCEDURES

Methods

Subjects

Seven out of eight day care centers and preschools contacted were willing to participate in the study. Eighty subjects for this study were selected from these Portland Metropolitan day care centers and preschools: Learning Tree Day School; Tinkertots Preschool; Maywood Park Day Nursery; Kinderland Preschool; School of Montessori; Northeast Christian Preschool; and Rainbow Day Care. Twenty children were chosen for each of four age groups: 3.0-3.5; 3.6-3.11; 4.0-4.5; and 4.6-4.11.

The subjects met the following criteria:

1. The parent or guardian signed a release form giving permission for the child to participate in the study (see Appendix A).

2. The child passed a bilateral, puretone and audiometric screening test administered at 25dB HL for the frequencies of 500, 1000, 2000, and 4000 Hz.

3. The child passed a screening for speech intelligibility.

Instrumentation

Subtest One: Unrelated Words. A test consisting of unrelated, single-syllable words.

Subtest Two: Related Words. A test comprised of semantically related single-syllable words.

Subtest Three: Sentences. A test of short sentences, comprised of single-syllable words.

Each subtest consisted of two sample items and twelve test items. The subtests were constructed specifically for this investigation and included items at the suggested age levels from the Peabody Picture Vocabulary Test-Revised, Forms L and M (Dunn, 1981) and from the Dolch Basic Sight Vocabulary (Dolch, 1955).

Procedures

Test Administration

Audiometric screening of all subjects and an informal speech intelligibility screening were completed prior to the administration of the AMTP. The screenings and the administration of the AMTP were completed at the individual day care centers and preschools when the permission forms were returned. Those subjects who passed the screenings were individually administered the AMTP.

The examiner escorted each subject to the testing room and engaged the subject in conversation to establish rapport. The examiner then tested the subject's hearing. If the subject passed the hearing screening, the examiner proceeded with the intelligibility screening.

The speech intelligibility screening procedures consisted of asking the subject to:

1. say his/her name.

2. name the toys shown by the examiner. (This examiner showed five toys: a car, ball, teddy bear, wind-up train, and a fireman figure.)

Criteria for passing the speech screening were:

1. the subject said first and/or last name.

2. the subject gave a name (correct or incorrect) to at least three of the toys.

3. the examiner subjectively judged the subject's speech to be 75-80% intelligible during activities 1 and 2 above.

The testing occurred in a subjectively quiet room, (as judged by the examiner), in each of the day care centers or preschools. The examiner gave the following instructions prior to beginning the test:

> We are going to play a listening game. I'll say some words and when I stop, you say exactly what I said. I can only say it once, so you have to listen.

The procedure for each subtest was as follows:

1. The examiner administered both sample items of Subtest One. If the subject correctly repeated one of the two items, the examiner proceeded with the subtest until the subject made three consecutive errors.

2. If the subject failed both sample items of Subtest One, the examiner administered the samples of Subtest Two. If the subject failed both of these, the testing was discontinued. If one of the sample items was correctly repeated, testing proceeded as in number 1 above. Subtest Three was administered following the completion of Subtest Two.

3. The examiner then readministered sample items from Subtest One. If one was correctly repeated, Subtest One was administered. If both were failed again, testing was discontinued.

4. If a subject completed Subtest One, then failed both sample items on Subtest Two, the examiner administered Subtest Three sample items. If the subject correctly repeated one of the samples, the examiner proceeded until completion of the subtest. The examiner then readministered Subtest

Two sample items to recheck the subject's ability to complete this subtest.

During the testing situation, the examiner sat in front of the subject. Each sample and test item was presented with a half-second pause between words, as suggested by Kirk, McCarthy, and Kirk (1968). The examiner used a downward inflection at the end of each item and no specific cue was used to signal the subject to begin recall.

The examiner used verbal (social) reinforcement as necessary to keep the subject on task. The examiner randomly used such phrases as "You're doing a good job" to keep the subject's interest and to give encouragement to continue with the task. The examiner stopped between subtests to allow the subject to play with a toy for one minute and then testing resumed. In addition, the examiner judged when individual subjects appeared to require a break before a subtest was completed. The individual was allowed to play with a toy for one minute, and then the subtest was completed.

The examiner cued the subject to listen before each sample item, but varied the amount of cueing for test items as necessary to keep the individual subjects' attention. The examiner used such phrases as "Listen; ready?; here are some more words" and "Now say these words" to cue the the subjects.

If a subject responded to an item with "What?" or a similar response, the examiner replied, "Say what you think you heard me say" or "Say whatever you remember." After the subject's response, or after no response, the examiner reminded the subject that she could only say it once, so he had to listen.

Scoring Procedures

During the administration of the AMTP the examiner recorded responses on the test form (See Appendix B). The subtests were scored according to the following procedures:

1. The order of repetition was indicated by writing a small number above the corresponding word.

2. A line was drawn through an omitted word.

3. Added words were written in as well as a number above the word to indicate order.

4. A correct sample item was indicated by writing a plus (+) in the space provided.

5. An incorrect sample item was indicated by writing a minus (-) in the space provided.

6. A correct test item was indicated by circling the corresponding number to the right of the item.

7. An incorrect test item was indicated by slashing the corresponding number to the right.

Criteria for correct answers were:

1. All words were repeated in correct order with no semantic additions or substitutions.

2. Articulation errors (other than those which constituted a semantic change in a test word) were not counted wrong.

Errors included:

1. Semantic additions, substitutions, or ommissions.

2. Incorrect order of repetition.

The total score for each subtest and for the total test was calculated at a later time. The maximum score for each subtest was 42 and the maximum

total test score was 126.

Data Analysis

Scores from Subtests One. Two, and Three and from the test total were obtained for each of the eighty subjects. The data were analyzed as follows: a Pearson Product Moment Correlation Coefficient (r) was computed for each subtest and for the total test score for each of four age groups to examine interjudge and intrajudge reliability. In addition, a *t*-test was performed on the total test scores of the three-year old group and the total test scores of the four-year old group to determine if a significant difference existed between the two age groups.

CHAPTER IV

RESULTS AND DISCUSSION

Results

The purpose of this investigation was to obtain normative data on the auditory memory performance of three- and four-year old children as measured by the Auditory Memory Test Package (AMTP).

This study sought answer one specific question: is the AMTP sensitive to age differences when administered to children 3.0-4.11 years of age? In an effort to answer this question, the results of the investigation follow.

To investigate interjudge reliability of the AMTP, a Pearson Product Moment Correlation Coefficient was calculated. Results for each subtest and for the total test ranged from r=.70 to r=.98 (see Table I).

Subtests One (Unrelated Words) and Two (Related Words) each showed a strong positive correlation (r=.98), as did the total test score (r=.96). Subtest Three (Sentences) showed a moderately strong positive correlation (r=.70). All Pearson r's were computed at the .01 level of confidence.

In Table II are to be found the intrajudge reliability results for each subtest and for the total test scores.

TABLE I

PEARSON r VALUES, MEANS, AND STANDARD DEVIATIONS
FOR INTERJUDGE RELIABILITY

Subtest	r	$\bar{X}$	SD
One	.98	21.60 21.86	6.17 6.32
Two	.98	18.73 19.20	8.03 7.79
Three	.70	39.06 39.46	3.21 3.24
Total Score	.95	79.40 80.33	13.87 14.10

TABLE II

PEARSON r VALUES, MEANS, AND STANDARD DEVIATIONS
FOR INTRAJUDGE RELIABILITY

Subtest	r	$\bar{X}$	SD
One	.73	18.20 21.85	7.72 7.88
Two	.75	17.05 18.25	7.16 7.65
Three	.43	39.85 38.20	3.63 3.27
Total Score	.84	75.10 78.30	15.85 16.59

Pearson r figures ranged from r=.43 to r=.84. Subtests One and Two both showed strong positive correlations, with r=.73 and r=.75, respectively. Similar to the interjudge reliability results, Subtest Three showed the lowest correlation, (r=.43) but still a moderately strong one at the .01 level of confidence. The total test score, however, revealed a strong positive correlation, with r=.84. In all cases above, the Pearson r figures for interjudge reliability exceeded those for intrajudge reliability.

To determine if there was a significant difference in total test scores of three- and four-year olds, the two three-year old groups were collapsed into one group (forty, three-year olds) and the two four-year old groups were collapsed into one group (forty, four-year olds). A t-test was performed to compare the total test scores of these two groups. Table III compares the three-year old population with the four-year old population. Out of a possible 126 points, the three-year old subjects achieved scores ranging from 17-96 and the four-year old subjects achieved scores ranging from 44-111. The mean scores were spproximately nine points apart: the mean for the three-year olds was 70.82 and the mean for the four-year olds was 80.15. The standard deviation for the three-year olds was slightly greater (17.13) than the standard deviation for the four-year old group (16.61).

Statistical analysis of the total test scores of the age groups using the t-test showed a significant difference beyond the .01 level of confidence (p .01) between the two age groups. These results indicated a significant increase in the ability of four-year olds to recall these same units.

TABLE III

MEANS, STANDARD DEVIATIONS, AND t-TEST SCORES FOR TOTAL TEST SCORES OF THREE- AND FOUR-YEAR OLD GROUPS

Age		$\bar{X}$	SD	t-test score*
3.0-3.11	(n=40)	70.92	17.27	2.43
4.0-4.11	(n=40)	80.15	16.61	

*Significant beyond .01 level with DF=78

The differences in the mean subtest and mean total test scores across age groups are presented in Table IV. The mean scores of Subtest One (Unrelated Words) distinguished the three oldest age groups (3.6-4.11) with fairly equal interval increases. The mean scores between the two youngest groups, 3.0-3.5 and 3.6-3.11, however, did not discriminate as clearly as did the other three mean scores.

As in Subtest One, Subtest Two (Related Words) mean scores again revealed fairly equal interval growths, but for the three youngest age groups only (3.0-4.5). The largest interval increase occurred between the 4.0-4.5 and 4.6-4.11 age levels, which was approximately four times larger than the intervals of the three youngest groups.

Subtest Three (Sentences) showed a different direction in outcome than did Subtests One and Two. The largest interval difference occurred between the two youngest groups (3.0-3.5 and 3.6-3.11). At the age levels 4.0-4.5 and 4.6-4.11, the mean score of the older group was greater than the younger group. The mean scores of age groups 3.6-3.11 and 4.0-4.5,

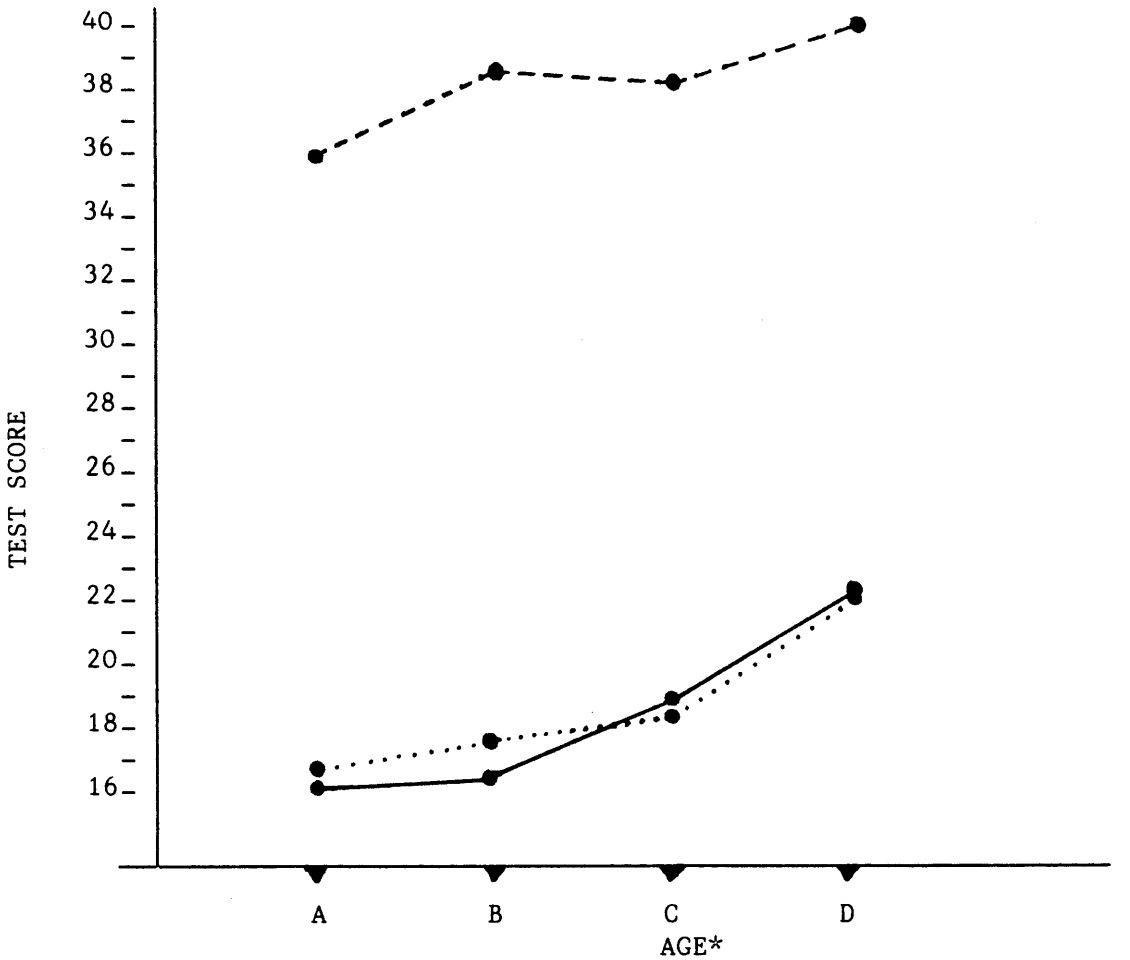
TABLE IV

MEANS AND STANDARD DEVIATIONS OF
SUBTESTS AND TOTAL TEST FOR EACH AGE GROUP

Subtest One: Unrelated Words		
Age	$\bar{X}$	SD
3.0-3.5	16.15	7.26
3.6-3.11	16.30	6.50
4.0-4.5	19.10	7.73
4.6-4.11	22.40	6.50
Subtest Two: Related Words		
Age	$\bar{X}$	SD
3.0-3.5	16.65	5.74
3.6-3.11	17.30	6.73
4.0-4.5	18.45	6.70
4.6-4.11	22.30	8.85
Subtest Three: Sentences		
Age	$\bar{X}$	SD
3.0-3.5	35.85	10.77
3.6-3.11	38.50	6.85
4.0-4.5	38.10	6.91
4.6-4.11	39.95	3.33
Total Test Score		
Age	$\bar{X}$	SD
3.0-3.5	69.75	18.80
3.6-3.11	72.10	15.99
4.0-4.5	75.65	16.88
4.6-4.11	84.65	15.44

however, were very similar. The mean of the older group was only .40 of a point less than the mean of the younger group.

The above information is also visually represented in Figure 1. Figure 1 represents the contribution of each subtest to the total test scores.



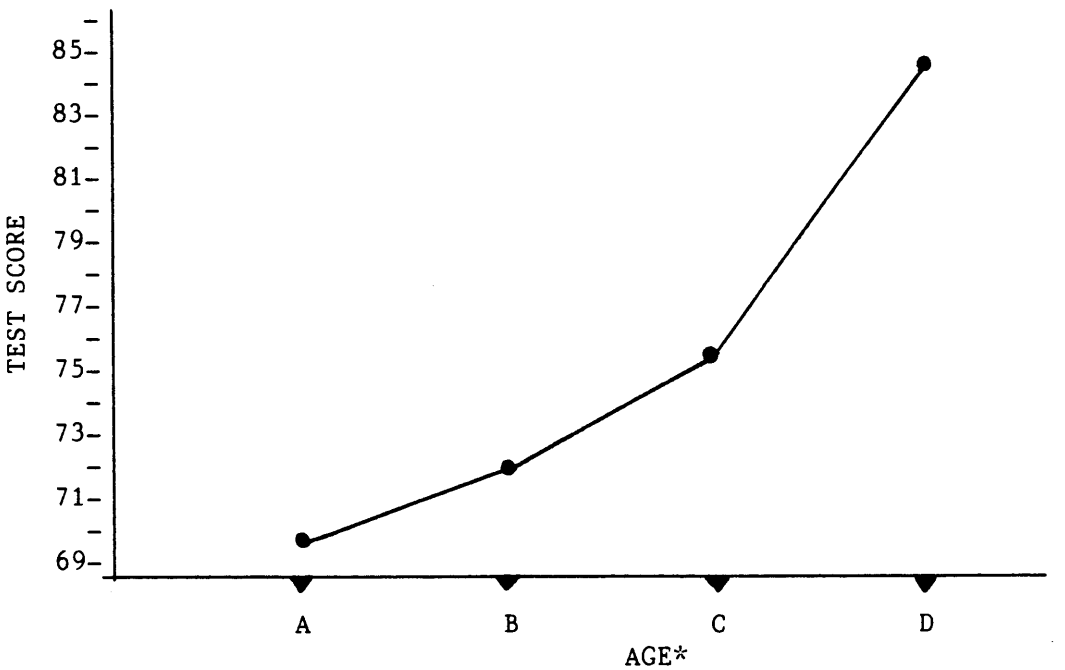
*A=3.0-3.5; B=3.6-3.11; C=4.0-4.5; and D=4.6-4.11

Subtest One: ——
Subtest Two: . . . . .
Subtest Three: -----

Figure 1. Comparison of mean subtest scores for each age group.

The mean total test scores discriminated each age group with increasing scores from the youngest to the oldest age levels. The means of the three youngest groups (3.0-4.5) were separated by interval differences of two or three points. The means of the two oldest groups, however, were separated by a much larger interval of nine points.

The mean total test scores are also visually represented in Figure 2.



*A=3.0-3.5; B=3.6-3.11; C=4.0-4.5; and D=4.6-4.11.

Figure 2. Mean total test scores for each age group.

In general, the mean total test and subtest scores revealed an upward progression. As age increased, so did the total or subtest scores. The only exception to this upward direction was Subtest Three (Sentences) for the 4.0-4.5 age group. It was noted that the mean score for this group was .40 of a point below the mean of the 3.6-3.11 group.

The scores of the youngest group (3.0-3.5) and the oldest group (4.6-4.11) revealed fairly substantial numerical differences. For all subtests and for the total test, the numerical values of the youngest and the oldest groups clearly distinguished these two age levels. The scores within the three- and four-year old groups, however, were not as substantial and conclusions cannot presently be drawn as to their significance.

Discussion

Once again, it is to be recalled that the primary question the present investigation sought to answer was: is the Auditory Memory Test Package (AMTP) sensitive to age differences when administered to children ages 3.0-4.11? Based on the data, the answer to the question posed is clearly indicated in Tables I and IV and in Figures 1 and 2. A significant difference was found between three- and four-year old subjects on the total test scores and on the subtest scores, with the exception of Subtest Three (Sentences) between the 3.6-3.11 and 4.0-4.5 groups. The results of the investigation indicated that the four-year olds recalled the items on the AMTP more efficiently than the three-year olds.

These results appear to be in agreement with Wepman and Morency's (1973a; 1973b) research with children five through eight years, suggesting that auditory recall ability increases as a function of age. The findings of this investigation also support those of Myers and Perlmutter (1978) that the auditory recall of four-year old children was statistically significant over that of three-year old children.

In reviewing the results of interjudge and intrajudge reliability, it is interesting to note that the figures for interjudge reliability were consistently higher than those for intrajudge reliability. The higher interjudge figures suggest that the subjects' performances varied in the two test sessions. As a result, the same judge's ratings from the first testing situation to the second corresponded less than did ratings between two different judges in the same testing situation.

As revealed in Figure 1 and Table IV, each subtest made a contri-

bution to the upward direction of the total test scores, with the exception of Subtest Three (Sentences) at the 4.0-4.5 age level. This slight decrease in mean scores could be the result of a variety of factors, including a weakness in the test construction, or perhaps several subjects in the 3.6-3.11 age group matured slightly ahead of their peers, which may have resulted in the higher scores. Similarly, several subjects in the 4.0-4.5 group may have matured slightly behind their peers, which could have resulted in the lower group mean score. At the age level margins, then, children in either age group may have made the differences in Subtest Three scores.

The variances in both interjudge and intrajudge reliability figures for Subtest Three indicate that an artifact may be present in the test itself. Such a weakness might explain the inconsistency of the results obtained.

In addition, this examiner questions whether the sentences were actually more difficult to recall than the words of Subtests One and Two, even though the added context of Subtest Three should have made them easier to recall. Perhaps, in an attempt to make equal and balanced sentences the examiner may have constructed artificial sentences that did not have true semantic interrelationships.

The interjudge and intrajudge reliability figures, then, indicate that Subtest Three needs further analysis and validation before it is used in future research.

In summary, the question posed by this study was clearly answered by the data collected. There was a significant difference in the ability of three- and four-year old children to recall auditory units of the AMTP, with the four-year olds showing more efficient recall.

These findings are compatible with those of Wepman and Morency (1973a; 1973b) which suggest that auditory recall skills improve as a function of age. Results of this study revealed an increase, for all age groups, in the ability to recall auditory units of the AMTP. The results also support Myers and Perlmutter (1978) research that recall skills in four-year old children are statistically significant over recall skills in three-year old children.

Discussion of Related Results

Although not a part of the initial investigation, the information included in this section was obtained. It is reported here so that it might provide direction for a future replication or research of the development of such an instrument.

This investigator undertook an analysis of different ways subjects responded to the items of the AMTP, including those who: recalled unrelated and related words with equal proficiency; recalled unrelated words better than related words; repeated items out of sequence; and showed marked improvement with recall of sentences over related and unrelated words.

All but two subjects received the highest scores on Subtest Three and the overall high scores (ranging from a mean of 35.85 to 39.95 out of a possible 40 points) indicated that context played a significant role in the subjects' performances. From the youngest subject, 3.0 years of age, to the oldest subject, 4.11 years of age, recall of sentences was the easiest of the three tasks.

Twenty-nine of the eighty subjects obtained higher scores on Subtest One (Unrelated Words) than on Subtest Two (Related Words)--see Table V.

In addition, seventeen subjects achieved the same score on Subtests One and Two (see Table VI). These results are not in complete agreement with Huttenlocher and Lui (1979) who reported that three- and four-year old children were better at remembering items from one semantic category than items unrelated in meaning. The majority of subjects in this investigation did, however, recall more items which were related in meaning than unrelated in meaning, giving some support to Huttenlocher and Lui's findings.

TABLE V

SUBJECTS WHO RECALLED UNRELATED WORDS
BETTER THAN RELATED WORDS

Age	Number who recalled unrelated words better than related words
3.0-3.5	8
3.6-3.11	6
4.0-4.5	8
4.6-4.11	7
Total:	29

This investigator wonders why some subjects obtained a higher score for recall of unrelated words than for related words. This is contrary to what is known about recall in adults (recall of related words is superior to unrelated words) and so this leads the investigator to question whether semantic knowledge had developed. Perhaps, there was a develop-

mental delay or disorder in acquiring semantic knowledge in those subjects who apparently did not rely on it to recall the related words.

TABLE VI

SUBJECTS WHO RECEIVED THE SAME SCORE
FOR RELATED AND UNRELATED WORDS

Age	Number of subjects who received the same score
3.0-3.5	4
3.6-3.11	6
4.0-4.5	5
4.6-4.11	2
	Total: 17

During administration of the AMTP, each response was numbered to determine if some subjects repeated all items, but in a different order. (A correct response required the subject to repeat all items in proper sequence.) A total of twelve subjects repeated items out of sequence. Table VII shows how many subjects in each age group and on which subtest repeated elements in an order other than that which was presented by the examiner. These results do not concur with Rossi and Rossi (1965) who reported that three-year old children did not use serial ordering of related and unrelated words, but that four-year olds did. As shown in Table VII, only seven three-year olds and five four-year olds did not use serial ordering in their recall. These results suggested that the

young children in this study were capable or reproducing auditory units in the correct order a majority of the time. In addition, they experienced no difficulty in ordering sentences.

TABLE VII

SUBJECTS WHO REPEATED ITEMS OUT OF SEQUENCE

	3.0-3.11 (n=40)	4.0-4.11 (n=40)
Subtest One:	3	3
Subtest Two:	4	2
Subtest Three:	0	0
	Total: 7	Total: 5

The subjects made various types of errors when administered the AMTP. The most common errors were both from Subtest Three (Sentences). Seven subjects, ranging in age from 3.8-4.11, substituted "could" for "can" on the test item "I can read my book" (see Appendix B). Six subjects, raning in age from 3.2-4.0, added "I" prior to repeating "Want some milk" (see Appendix B). The two above samples were the most frequently used; other errors were individual, differing from subject to subject.

Several subjects were able to repeat only 2- or 3-word series of unrelated and related words, but recalled at least two 4- or 5-word sequences for sentence repetition. Table VIII shows the level at which these subjects recalled at least two of the three test items at a par-

TABLE VIII

SUBJECTS WHO RECALLED 2- OR 3-WORD SERIES ON SUBTESTS ONE AND TWO BUT RECALLED 4- OR 5-WORD SERIES ON SUBTEST THREE

Age	Poor recall on Subtests One and Two	Recalled 4-Word Sentences	Recalled 5-Word Sentences
3.0-3.5	9	2	7
3.6-3.11	6		6
4.0-4.5	9	1	8
4.6-4.11	6	1	5

ticular level, reflecting the longest sequence each could recall. Furthermore only one subject in each of the three youngest age groups showed poor recall (2- or 3-words sequences only) on all three subtests. None of the subjects in the oldest age group exhibited recall problems for sentences.

Additional observations noted during administration of the AMTP were as follows:

1. When a subject hesitated because he forgot a word, this seemed to interfere with any further recall of the sequence. If a subject forgot the second word in a 4-word series, for example, he could not recall the third and fourth words.

2. In examining the recall of 5-word series for unrelated and re-

lated words, it was interesting to note that in the three-year old group (forty subjects) only one subject recalled a 5-word sequence of related words and none recalled 5-word sequences of unrelated words. In the four-year old group, fourteen subjects recalled unrelated and related words at the 5-word level. In the 4.0-4.5 group, two subjects recalled unrelated 5-word series and three recalled related 5-word series. In the 4.6-4.11 group, four subjects recalled unrelated 5-word sequences and five subjects recalled related 5-word sequences. Overall, four-year olds recalled 5-word sequences significantly better than three-year olds.

Although no subjects showed a definite pattern in which primacy or recency effects seemed to play a role in their recall, several subjects recalled only the final two or three items on two or three occasions. Nine subjects in the youngest age group recalled the final items on the 4- and 5-word sequences of related and unrelated words. Three of the youngest subjects also recalled the final items on several occasions on Subtest Three. Four subjects in the 3.6-3.11 group may have exhibited a recency effect for Subtests One and Two, but not recency or primacy patterns were evident for sentence recall.

In the 4.0-4.5 age group, only two subjects recalled the final items on Subtests One and Two, and only one subject may have exhibited a recency effect for sentence recall. In the oldest age group, neither recency nor primacy effects seemed to play a part in the subjects' recall.

In summary, results from this study showed that most of the subjects recalled items which were related in meaning more efficiently than items unrelated in meaning. These results lend support to Huttenlocher and Lui's (1979) findings that three- and four-year olds recall semantically related items better than items which are not related. In addition re-

sults do not support the research of Rossi and Rossi (1965) which suggests that while four-year olds use serial ordering in their recall of unrelated and related words, three-year olds do not. Most of the subjects in this investigation, both three and four years of age, did use serial ordering in their recall of unrelated and related words.

CHAPTER V

SUMMARY AND IMPLICATIONS

Summary

According to Atkinson and Shiffin (1971), auditory short-term memory plays a critical role in the total learning process and is necessary for the acquisition of speech and language skills. It has been shown that auditory short-term memory skills improve with each progressive year in the five through eight year age range (Wepman and Morency, 1973a), but relatively few investigations have focused on the normative performance of three- and four-year old children.

The purpose of this study was to collect normative data on the auditory memory performance of three- and four-year old children as measured by the Auditory Memory Test Package (AMTP). Specifically, this investigation sought to answer one question: is the AMTP sensitive to age differences when administered to young children ages 3.0-4.11?

Eighty subjects were selected from Portland Metropolitan day care centers and preschools. Twenty children were chosen for each of four age groups: 3.0-3.5; 3.6-3.11; 4.0-4.5; and 4.6-4.11. Each subject was administered the AMTP, which consisted of three subtests: unrelated words; related words; and sentences. Each subject received a score for each subtest and a total test score.

The results of this investigation showed a significant difference in the auditory memory performance of three- and four-year old children,

with the four-year old group achieving higher scores. Overall, mean subtest scores, as well as total test scores for each age group, showed improvement as age increased. The one exception to the growth in scores was for the 4.0-4.5 age group on Subtest Three (Sentences).

Implications

Clinical

The results of this study lend support to Wepman and Morency's (1973a; 1973b) research in which they reported that auditory short-term memory abilities increase with age. Wepman and Morency found that a growth in auditory recall occurs in the five through eight year age range. The results of this investigation indicate that a growth in auditory recall also occurs in the three and four year age range when utilizing the AMTP.

There has been a need to study the auditory short-term memory of normal developing three- and four-year old children. The information obtained in this study suggests that the AMTP may be a viable auditory short-term memory test to aid in describing auditory recall in young children ages 3.0-4.11. The AMTP was easy to administer and score, and the test items appeared to be of moderately high interest to the subjects. Administration and scoring of the AMTP involved ten to fifteen minutes (including breaks between subtests), depending on the age and attention span of the subject.

Further research utilizing the AMTP may reveal a useful tool for those who emphasize a preventive philosophy in dealing with speech and language disorders. The AMTP may aid in the early detection of possible problem areas so that intervention can start at an early age. In conjunc-

tion with other speech and language tests, it may be used in a battery of tests to diagnose possible speech and language deficits. In this way, it would help identify, at an early age, problems that would otherwise go undetected until they manifest themselves in older children, such as elementary children, who have difficulty remembering oral directions or who are unable to repeat a simple sequence of events. As Wiig and Semel (1976) suggest, any type of auditory processing problem which existed in kindergarten or first grade tends to persist or increase in severity in subsequent years due to increased demands in the classroom.

Research

The present investigation lends itself to research in several areas. First, a need to conduct internal consistency reliability studies is evident. An item analysis would be helpful to determine if certain words of a subtest item or an entire test item would consistently alter the subtest score. Second, an investigation into the occurrence of the low intra- and interjudge reliability scores on Subtest Three (Sentences) is warranted. In addition, a study to investigate the small, but definite, drop in scores for the 4.0-4.5 age group on Subtest Three is needed. Third, an investigation into the occurrence of the higher scores in some cases for Subtest One (Unrelated Words) over Subtest Two (Related Words) could be conducted in a replication study. Fourth, a study in which the order of subtest presentation is varied may reveal important findings. In the present investigation, unrelated words were always presented first, followed by related words, which were followed by sentences.

In conclusion, there appears to be an overwhelming need for a standardized, auditory short-term memory test for young children three and

four years of age. The AMTP may provide the foundation for such a test. This kind of test would be used as part of a battery of tests to identify possible auditory memory problems at an early age.

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APPENDIX A

PARENT PERMISSION FORM

I agree to let my child _____ participate as a subject in the study entitled "Normative Data on the Auditory Memory Performance of Three- and Four-Year Old Children". This study is carried out by Pat Davis under the supervision of Dr. Robert English, thesis director, Speech and Hearing Sciences Program, Portland State University.

The purpose of the study is to obtain information and normative data on the auditory memory performance of three- and four-year old children as measured by the Auditory Memory Test Package. This information will be of value to those working with the preschool population.

There are no risks or danger inherent in the procedures of the study and I am free to withdraw my child at any time. It is my understanding that anonymity will be maintained. My child will be given a hearing screening and an informal speech intelligibility screening. The investigator will then administer the Auditory Memory Test Package.

_____
Signature of Parent/Guardian

_____
Date

Birthdate of Child _____-_____-_____
Mo. Day Year

Please return this form with your child tomorrow, indicating your approval. If you have any questions, leave a message with the director at the day care center/preschool and I will contact you or you can call me at 282-6515. Thank you.

Pat Davis
Graduate Student
Portland State University

APPENDIX B

AUDITORY MEMORY TEST PACKAGE (AMTP)

Subtest One: Auditory Memory for Unrelated Words

Samples: bed-car _____ cup-cow _____

bus-snake 2

boat-knee 2

toy-ear 2

cage-tire-book 3

nose-juice-bee 3

ball-coat-pig 3

plant-car-shirt-hand 4

boy-fish-bath-milk 4

shoe-house-sun-eye 4

hair-bird-hat-cake-door 5

key-bush-game-foot-cat 5

ear-fork-girl-block-chair . . . 5

Subtest Two: Auditory Memory for Related Words

Samples: bus-train _____ juice-milk _____

boy-girl 2

milk-cake 2

dog-cat 2