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THE EFFECTS OF AGE AND WORD FREQUENCY ON

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OBJECTS BY CHILDREN

APPROVED BY

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CHAPTER I

INTRODUCTION

The study of response time has played an important role in the development of experimental psychology. Since 1850 when Helmholtz (41) studied the speed of nerve conduction in frogs, scientists have measured the time or speed of performance. The interest in response time is understandable; time as a dimension of every mental or behavioral process lends itself to measurement and can be used as an indicator of the complexity of the performance. Furthermore, the study of response time is one of the most direct ways in which the processes of perception, discrimination, and choice may be subjected to quantitative study (13).

Most of the research dealing with the timing of responses has emphasized the simple muscular or motor response while comparatively little attention has been given to verbal response times. In 1886, Cattell (25) investigated how long it took a subject to identify and name objects. Similar investigations were not reported until some eighty years later. The reason for the small amount of research on verbal response times is clear. Previously, experimenters had to content themselves with measuring responses of large muscle groups because the location and accessibility of the large muscle groups lent themselves to such measurements. Not until relatively recently has instrumentation become available which is capable of reacting to the sound of one's voice rather than to bodily movements. Secondarily, compared to simple sensory-motor responses, verbal responses are considerably more complex and, hence, more time-consuming in execution. The complexity of verbal responses may have further delayed verbal response time experimentation.

Recently, studies involving object-naming tasks have appeared in the research literature. This seemingly simple task of naming a pictured object is actually complex. Evoking the same object-name in the course of a sentence is less difficult. In the context of a sentence, the semantic constraints of grammer, syntax, and subject matter necessarily limit the number of alternatives from which to choose the appropriate word. No such assistance is available, however, when naming an object. Consequently, the latter task requires the processing of a greater quantity of information.

Many researchers believe it possible to examine the various steps in the chain of events from receptor to effector mechanism within the subject during verbal responses and, thereby, to estimate the relative contributions of intervening components to the overall results. A few researchers have attempted to measure not only the time it takes to name an object but also the time involved in first recognizing the object.

In studies of verbal response time performance, emphasis on object-naming tasks and visual duration thresholds for pictured objects has been prompted by an interest in the language behavior of the dysphasic patient. The dysphasic is frequently able to evoke a word in a sentence but not in isolated production. Frequently, the dysphasic patient will indicate that he knows what a particular object is by describing it, and yet fail to name the object. To some investigators, this behavior suggests that it is the word retrieval mechanism that is disrupted. The behavior of the dysphasic patient has led to an interest in the nature of the processes which must be involved in object-naming by the mature, healthy, adult. Consequently, most of the results involving the measurement of visual duration thresholds and object-naming latencies have been obtained from normal adults.

Difficulty in word selection is also seen in children who present various language disorders. One wonders if such children are capable of recognizing objects and naming them in normal periods of time. At present, it is not clear what a normal period of time for the recognition and/or naming of objects is for children. Before we can know of what abnormal performance consists, we must first gather data from normal children to have a basis for comparison.

The purpose of this study was to explore the processes of visual recognition and object-naming in children as a function of age. Such an investigation would be a precursor to analyses of these same processes in children who present various speech and language disorders.

CHAPTER II

REVIEW OF THE LITERATURE

Verbal Reaction Time

To understand better the perceptual and coding processes involved in seeing a word or object and naming it, Fraisse (6, 7) and Oldfield and Wingfield (26, 27) have studied verbal reaction time, that is, the elapsed time between the onset of a stimulus and the onset of a spoken response. The stimuli used by these investigators with adult subjects have included pictured objects, printed words, and geometric forms.

Some experimenters have been interested in object-naming latency, that is, the verbal reaction time when the stimulus is an object or a picture of an object and the response is the name of the object. Using simple single-object pictures and normal adult subjects, Oldfield and Wingfield (27) obtained object-naming latencies (ONLs) for twenty-six objects, the names of which were spread over a wide range of frequency of occurrence in print in the English language according to the Thorndike-Lorge (T-L) word count (36). They found that as word frequency increased, mean ONL decreased, with a resultant linear relationship between mean ONL and the $\log_{10}$ of the frequency of word occurrence. This finding confirmed the results of a study conducted by Fraisse (7) using normal adult subjects and pictured objects, the names of which were spread over a range of frequency of occurrence in print in the French language according to the Gougenheim word count (17). While not concerned with ONLs, Rochford and Williams (29) presented pictured objects, the names of which covered a wide frequency range, to adult aphasics and obtained a correlation coefficient of + .79 between the number of correct namings and the frequency of occurrence of words. A similar relationship between word frequency and the per cent of correct namings was later reported by Newcombe, Wingfield and Oldfield (24).

In a related series of investigations, Fraisse (4), using adult subjects, found that time for reading a word was shorter than time for naming the corresponding geometric form which the word represented. Fraisse (7), in another study, found verbal reaction times for object-naming (naming pictured objects) to be longer than for word-naming (reading printed words). Fraisse suggested that the difference between time for naming and time for reading may increase both as a function of the number of alternatives (uncertainty) and discriminability.

Fraisse (7), as part of the same experiment, then studied the effect of uncertainty on verbal reaction time. Four geometric forms and then twelve geometric forms were used as stimuli. As expected, verbal reaction time for reading a word was shorter than the time required for naming the corresponding geometric form. Naming-time for the geometric forms was found to increase with an increase in stimulus uncertainty, that is, an increase in number of alternatives. He found, further, that with uncertainty controlled, the naming-latency increased with the complexity of the geometric form while the reading reaction time remained about the same. In a later investigation, Fraisse (8) studied the latency of different verbal responses to the same stimulus. Subjects were given a series of tachistoscopic presentations in which a response of reading (letter O) or of naming (circle) could be given to the same sign O (the subject was instructed beforehand which response to give). The results showed that verbal reaction time is longer when naming than reading (difference 100 milliseconds), verifying that naming is a longer process than reading, the difficulty of perceiving the stimulus being equal.

Another source of variation considered by Fraisse and his colleagues (10), involves the effect of specific and categorical responses on verbal reaction time. Pictures of sixteen familiar and easy to recognize stimuli were presented tachistoscopically to each of twenty-four adult subjects. Each stimulus (example: rose) belonged to one of four categories (example: flower). Before each series of presentations, subjects were told which type of response, specific or categorical, they were to give. The results showed that verbal reaction times were consistently longer for categorical responses than for specific responses. Fraisse attributed this finding to the categorical response being less readily available than the specific response. He speculated, however, that such an hypothesis may not be true for names of objects whose frequency of occurrence in the language was low.

Wingfield (39), addressing himself to the same question, used pictured objects for which the frequencies of occurrence of the names in the language were high or low according to the T-L word count. Subjects were told beforehand which type of response, specific or categorical, they were to give. The results failed to demonstrate a significant relationship between category-naming and the frequency of the names of the objects used. Verbal reaction times for category-naming were approximately the same for common and rare objects. In the case of rare objects, however, the category-names were more available than specific-names while in the case of common objects, the reverse was true. The specific-name chair, for example, with a high frequency of occurrence, was more readily available as a response than was the category-name furniture. Wingfield hypothesized that in the case of rare objects, no single frequently used name is readily available, and therefore, another response, such as a category-name, may be encountered and produced before a search procedure would eventually lead to the appropriate common name.

Boysen (2) investigated the relationship between ONLs and the frequency of occurrence of the object-names based on the T-L word count with normal-speaking children and stuttering children as subjects. Thirty-four simple-object pictures were randomly presented to each child. The obtained mean ONL across subjects for all words appropriately named was 1359 milliseconds for the normals and 1264 milliseconds for the stutterers. The data corroborate the results obtained previously with adults, namely, the existence of an inverse linear relationship between the time taken to name objects and the $\log_{10}$ of the frequency of occurrence of the names in print. This relationship was not, however, as pronounced in children as it reportedly is in adults. Though the age range of his subjects was small (from seven-years, six-months to nine-years, one-month) Boysen found a tendency for mean ONLs to decrease as chronological age increased, particularly for the least frequent words. Generally, a slightly greater relationship between word frequency and ONLs was found for stutterers than for normals.

Visual Duration Threshold and Verbal Reaction Time

Oldfield and Wingfield's (26) interest in the language behavior of dysphasic and normal adults has led them to ask how "the brain organizes, arranges and indexes the word-store and by what means do we gain access to items in it?" They hypothesized that words may be arranged in such a way that access-times for frequently needed words are shorter than for words needed less frequently. The prevalency of word-finding difficulty in adult dysphasics who may be capable of using the words in continuous speech prompted Oldfield and Wingfield (26) to raise further questions about the retrieval mechanisms of the cerebral "word-store." The observation that the dysphasic patient frequently can describe an object but cannot evoke its name suggested to them that it is the retrieval mechanism rather than the word-store itself that is at fault.

This behavior of dysphasic individuals contributed to an interest in the theoretical distinction between the visual recognition or perceptual identification of an object (as marked by the patient's ability to describe the object's major function and characteristics) and the naming of the object. Wingfield (40) speculated that differences in naming-latencies for common and rare objects might be attributable to the time necessary for the visual analysis and perceptual identification of the objects or to differences in the time required to search for the object's appropriate name, once perceptual identification had been completed. Wingfield designed two experiments in order to test his hypothesis. In the first experiment, subjects were presented pictured objects tachistoscopically and were instructed to name the pictures as quickly as possible. Measures of visual duration threshold (VDT) and ONL were obtained from the same stimulus exposure. Wingfield characterized VDT as a measure of the amount of stimulus exposure necessary for the subjects to "detect enough information to identify objects." Although a linear inverse relationship between $\log_{10}$ frequency of occurrence of the word and VDT resulted, this relationship was small compared to the relationship between word frequency and ONL.

In Wingfield's first experiment, VDTs were obtained using two conditions of presentation. In the first condition, the stimulus-pictures were immediately followed by a plain white field of the same area and light-intensity as the stimulus-field. In the second condition, the post-stimulus field consisted of a visual "noise" pattern: "a nonsystematic array of lines and arcs of approximately the same width and contrast as those in the stimulus-picture." Different subjects were used for each condition. The range of VDTs obtained under the white post-stimulus condition was 5-25 milliseconds while the range of VDTs obtained using the "noise" pattern in the post-stimulus field was 85-110 milliseconds (38).

Neisser (23) has stated that under some conditions, one can easily see a figure exposed for a single millisecond or even less because the visual impression "persists" briefly after the stimulus has terminated. Neisser has labelled this phenomenon the "icon" or "iconic memory." Since such visual variables as stimulus intensity, exposure time, and post-exposure illumination affect performance in a tachistoscopic task, it may be that they do so, in large part, by controlling the duration of the icon. Neisser believes that the post-stimulus field may be especially important since iconic memory may remain present "for as long as five seconds if the post-stimulus field is dark." If the stimulus is followed, however, by a relatively bright post-stimulus field, the tachistoscopic exposure is present less than a second. According to Neisser, the presence of a bright post-stimulus field effectively reduces the brightness contrast of the figure first shown, and thereby makes it less discernible. Furthermore, if the stimulus is followed by a patterned figure rather than a homogeneous field, the subsequent figure will make the earlier one much more difficult to see. Neisser suggests that in this instance, though one stimulus follows the other, the icon and the post-stimulus figure coexist together to some extent, and are processed together. Because the resulting total figure is more complex than the original stimulus alone, it is harder to identify. The data obtained in Wingfield's first experiment clearly support Neisser's observations.

The basis for Wingfield's second experiment (40) involved the hypothesis that the total time for perceptual identification must also include the processing of the information to determine the object's perceptual category. A matching task was designed in an attempt to estimate the effect such processing has on naming-latencies. The procedure consisted of the experimenter saying aloud the names of objects to adult subjects. Five seconds after a name was given, a picture of an object was presented. Each subject was instructed to say "Yes" if the named object was presented or "No" if any other object was presented. Responses were to be made as rapidly as possible and stimulus-pictures remained exposed until the subject responded.

The results of the name-picture-matching experiment showed the mean latencies for "common" and "rare" objects were 504 milliseconds and 522 milliseconds, respectively, (the difference not significant, $p > 0.10$). Naming-latencies for the same objects, on the other hand, were 636 milliseconds for the common objects and 1169 milliseconds for the rare ones (difference significant, $p < 0.001$). Wingfield reasoned that it seemed likely that the stimulus-picture must have been fully identified before the match with the same name could have been made, and since these matching-latencies were uniform across the range of object frequencies sampled, he concluded that identification-time for common and rare objects is constant. He further attributed the major source of variance in naming-latencies for common and rare objects to differences in time needed to search for the objects' names once the perceptual identification was completed.

Frequency of Occurrence and Visual Duration Threshold for Printed Words

Several studies utilizing adult normal subjects and printed words, either real or nonsense syllables, as visual stimuli have indicated that frequency of word usage is related to ease of recognition under conditions of tachistoscopic exposure (34). Using the T-L word count as an index of relative frequency of occurrence, Howes and Solomon (19) demonstrated a strong inverse relationship with product-moment correlation coefficients ranging from - .68 to - .75, between VDTs and logarithm of word frequency. A similar relationship utilizing pronounceable nonsense syllables, experimentally controlled for frequency of usage, was demonstrated by Solomon and Postman (33). Solomon and Howes (32) have also investigated the relationship between VDTs and words selected on the basis of logarithm frequency of occurrence and interest value of the subject. Their data seemed to point in the direction of lower thresholds for words ranked high in interest value. Threshold differences associated with differences in interest value, however, were small compared with those associated with differences in word frequency.

Effects of Stimulus and Age on Visual Duration Threshold

Several researchers have found with children a considerable within-age and between-age variability for the exposure time necessary for recognition of the stimuli. Ghent (14), Ghent and Bernstein (16), and Munsinger (22) each defined VDT as the exposure time at which approximately half of the items presented were recognized. Ghent (14, 15) found it necessary to use longer exposure durations in younger than in older groups. Using pictured objects as stimuli and a dark post-stimulus field, Ghent (14) reported the median exposure-duration (and ranges) for the age groups of three, four, five, and the combined six-seven years, respectively, as 100 milliseconds (20-500 milliseconds), 20 milliseconds (10-200), 5 milliseconds (5-40 milliseconds), and 5 milliseconds (5-40 milliseconds). In the Ghent and Bernstein (16) study, nonrealistic figures were presented tachistoscopically. The median exposure-durations for three-to-five-year-old subjects were identical to those presented above and the range closely approximated those obtained in the previous investigation. It was clearly evident in both studies, that the exposure-duration required to reach a comparable level of recognition was inversely related to age. Munsinger (22), in a similar study, found the duration of exposure among four-and-a-half- and five-year-old children varied from 80 to 400 milliseconds while the duration of exposure for adult subjects varied from 5 to 18 milliseconds.

Haith, Morrison, and Sheingold (18), addressing themselves specifically to the relationship between exposure time and recognition-accuracy with children, found that stable tachistoscopic performance could be obtained from preschool subjects when relatively simple geometric forms were used as stimuli (followed by a bright post-stimulus field). Random presentation of the stimuli occurred at fixed durations of 10, 20 and 30 milliseconds. The preschool subjects were four-and-five-years of age. Adult subjects were also used to gather comparative data. The results indicated that the preschoolers were capable of stable within-group performance. The authors commented that the "most surprising finding of the study was that the additional time required by preschoolers to reach adult performance levels was so slight." All children but one were at or above 50 per cent accuracy at the 20 millisecond exposure duration, whereas all adult subjects were above 50 per cent accuracy at 10 milliseconds.

Fraisse was among the first investigators to study the speed of visual perception as a function of age and type of stimuli employed. Fraisse and McMurray (11), interested in the factors which intervene in what they termed the "speed of perception," obtained VDTs from ninety-nine school-age girls. The children were divided into three groups: seven, nine, and eleven years of age. Four categories of stimuli were used to determine VDTs: simple geometric forms, familiar three-letter words, nonsense syllables and pictures of familiar objects. Four stimuli were contained within each category. The stimuli were presented tachistoscopically. Initially, the exposure-durations were at a level well below the threshold point and then systematically increased until the child gave a correct response at two successive levels of exposure. The lower of these levels was recorded as the threshold value. The longest exposure-duration for any of the stimuli was 77 milliseconds. The authors found that VDT decreases with age, but that the decrease, clearly evident between seven and nine years, is very small between nine and eleven years. For all these age levels, the order of categories of stimuli from smallest to greatest VDT was geometric forms, words, syllables, and pictured objects. Fraisse and McMurray stressed, however, that the differences in VDT between words and syllables was very small. A surprising result was the difficulty in perceiving pictures representing familiar objects. In this instance, age had little influence upon the results. Hence, the authors hypothesized that since the pictures are reproductions of three-dimensional objects (as opposed to geometric forms which belong to general-plane objects) what is required is the perception of a two-dimensional reproduction of a three-dimensional object. Though the pictures represented familiar objects their composition was, compared to geometric forms, extremely complex. This may have accounted then for the longer durations associated with the perception of familiar objects. The authors concluded that the differences in speed of perception may find their explanation in three factors: relative frequency of stimulation, the simplicity of form, and the distance between the pictured stimulus and the represented object (for example, the distance is smaller for geometric forms than for two-dimensional drawings of three-dimensional objects).

In a follow-up study, Fraisse and Elkin (9) investigated the effect of mode of presentation and age on speed of recognition. Four modes of presentation for each of eight stimuli were used: a real object (in three-dimensions), a photograph, a detailed drawing, and an outline drawing. Four groups of twenty-four girls each acted as subjects. The mean ages of the groups approximated seven, eight, ten-and-one-half, and twenty-two years. The procedure was similar to that used in the previous study (11).

The primary results of this investigation indicated that VDT lowers systematically with increase in age regardless of the mode of presentation and that this diminution is especially apparent between the ages of six and eight years. Secondly, the relative difficulty or ease of responding to the modes of presentation does not change as a function of age. Hence, for all age groups, the following order, from the easiest to recognize to the most difficult, was found: (a) detailed drawings which accentuated essential details, (b) the objects themselves, (c) photographs, and (d) outline drawings. In interpreting their findings, Fraisse and Elkin suggested that the outline drawings were most difficult to recognize because of a lack of detail which "undoubtedly created ambiguities." They further speculated that the photographs yielded higher thresholds than did the real objects because the former furnished fewer cues for recognition than the objects themselves. The difference between detailed drawings and objects was tentatively explained as due to the suppression of the colored cues which stress significant details in three-dimensional objects (all stimuli in each mode of presentation were colored black and white or gray and white).

Variables Affecting Reaction Time Behavior and Visual Duration Threshold

Numerous studies have been concerned with the variables which affect reaction-time behavior. The following paragraphs concern only a few of the variables pertinent to the present study. Garrett (13), Woodworth and Shlosberg (41), and Teichner (35) have presented more complete summaries of the pertinent literature.

Several variables associated with readiness for and presentation of visual stimuli have been considered by investigators. Use of a warning signal prior to stimulus presentation has been considered important by several experimenters (31) studying reaction and response times for lever-pulling behavior in preschool-age and kindergarten-age children. Consideration has also been given to the type of warning signal to be used. Karlin and Mordkoff (21) found that decreased reaction time was obtained when the stimulus modality of the warning signal differed from that of the experimental stimulus. Using a tone and a light, with foreperiods of either 0.5 seconds or 2 seconds, they found that this decreased reaction time was obtained only when the interval between the signal and stimulus was relatively short (0.5 seconds).

Garrett (13) considered the foreperiod to be quite important in reaction time work. He notes that if the foreperiod is less than one second the subject may be unprepared, and if greater than ten seconds the subject is likely to lose his "edge" and react too slowly. He places the optimum foreperiod at approximately one-to-two seconds.

Wingfield (38) suggests that experiencing a stimulus establishes a "set" for that stimulus which decays gradually through time. Thus, for example, Postman and Solomon (28) reported significantly lower VDTs for words which had been previously encountered in an anagram solution task than for words of similar frequency not recently experienced. They concluded, in this case, that recency has a significant effect on "perceptual sensitivity."

Neisser (23) has remarked that the orientation or angle of presentation of a stimulus is critical to the process of recognition of the stimulus. To illustrate the point, Neisser referred to a study conducted by Wallach and Austin (37) in which the critical visual stimulus used tended to be seen as a "dog" when presented horizontally and as a "chef" when presented vertically. Presented at a 45^0 angle, the stimuulus became an ambiguous figure. Rock (30), using adult subjects, found that relatively simple stimuli, such as the "chef-dog" figure, can be identified despite any change in orientation, as long as the subject knows which side of the figure is supposed to be "the top." Neisser (23) stated that:

> Phenomenal orientation is all-important....While it is true that patterns can be recognized despite rotation, this accomplishment depends on a rather complex mechanism. The perceiver must isolate from the figure, or construct within the figure, a directed axis of orientation which defines some part as the top and another as the bottom. Only then is he able to identify it as pertaining to an earlier pattern which was also specifically orientated. Without this intervening stage of processing, recognition may not occur (p. 54).

The problem is apparently greater for young children. The research literature suggests that children are indifferent to the orientation of a particular stimulus. Arnheim (1) found that preschoolers often look at pictures without bothering to turn them right-side up, and draw letters in reversed or inverted form. Ghent (14), and Ghent and Bernstein (16) have shown that children are not good at identifying rotated figures. Neisser (23) suggests that children may base orientation of stimuli on critical features which are "orientation-proof." For example, a rotated "A" still has a sharp point, a rotated "P" still has a closed loop, and a "C" remains rounded. A subject who identified all rounded letters as "Cs" would recognize a "C" in any orientation whatever, according to Neisser, though he could not distinguish it from an "O".

Another variable, relating directly to tachistoscopic experimentation is the effect of practice on threshold and reaction times. Howes and Solomon (19) have emphasized that performance on tachistoscopic recognition tasks is enormously influenced by practice. Though they presented four practice trials in their investigation of VDT as a function of word-probability, they observed that only a much longer prefactory list could have stabilized the thresholds. Oldfield and Wingfield (27) indicated that while small amounts of practice at naming objects produces a significant reduction in naming-latencies, up to three practice trials still fail to abolish the latency-log frequency relationship completely.

Two other variables, area and intensity of the visual stimulus, have been studied (41) systematically in association with reaction time experiments involving a simple motor response. With these studies, however, attention has been focused on simple light sources for sensation rather than for perception of objects. Generally, they have found that increases in either area or intensity of light result in shorter reaction times. The various studies dealing with perceptual recognition and naming have approached this variable only by standardizing the area and intensity of the stimulus consistently for all subjects.

The rise-time of the visual stimulus to full brilliance has been different among various investigations involving presentation of words, geometric forms, or pictured objects. Oldfield and Wingfield (27) reported that the lamp switched on to illuminate their picture-stimuli required 60 milliseconds to reach full brialliance. They indicated that although the full-brilliance time was constant for all subjects, it was not possible to estimate or measure whether factors of perception or recognition were active during that 60 millisecond period.

Age, as a factor in reaction time, has received little investigation except as related to simple motor behavior. Woodworth and Schlosberg (41) state that throughout the developmental period up to about twenty-five years of age, motor reaction time decreases, at first rapidly and then more slowly. Though the young child might be expected to respond very quickly due to his short nerve pathways and "general liveliness," this is not necessarily the case with the very young child. They state that it is almost impossible to secure a good series of simple reactions from a child under three years of age. Diffuseness and irregular response prohibit the young child from performing the highly integrated, though restricted act known as the simple reaction. They observed that factors of emotional excitement and general muscular tension are essentially outgrown by the age of seven or eight years. The studies cited previously (14, 15, 16) involving tachistoscopic recognition as a function of stimulus orientation suggests, however, that investigations of this type may be difficult with young children. Ghent (14) reported that three of her subjects (two of three years of age and one of four) could not sustain attention long enough to complete a session comprising sixteen test figures.

In summary, an opportunity to understand better the processes involved in verbal behavior has been made available through the means of tachistoscopy. The body of information relating to visual recognition and perceptual identification continues to expand. Recently, scientific inquiry into the processes inherent in the activity of seeing an object and naming an object have added a further dimension to the study of verbal behavior in normal individuals as well as those who present language disorders due to damage or disease to the brain.

CHAPTER III

DESIGN OF THE INVESTIGATION

This study was designed to investigate certain of the processes involved in the object-naming response. Attention was focused on the visual duration thresholds, name-picture-matching response latencies and object-naming latencies of children as a function of age and of the frequency of words in print as given in the Thorndike-Lorge (T-L) word count (36). The visual stimuli to which each subject responded were simple-object, line-drawn pictures. The following research questions were formulated for this investigation:

1. What is the relationship for children between visual duration thresholds for pictured objects and the frequency of occurrence of the objects' names in the English language?

2. Is there a change in visual duration thresholds with an increase in age for children?

3. What is the relationship for children between verbal reaction times, obtained in a name-picture-matching task, and the frequency of occurrence of the objects' names in the English language?

4. Is there a change in verbal reaction times, obtained in a name-picture-matching task, with an increase in age for children?

5. What is the relationship for children between object-naming latencies and the frequency of occurrence of the objects' names in the English language?

6. Is there a change in object-naming latencies with an increase in age for children?

7. Do mean object-naming latency and the relationship between object-naming latency and word frequency in the English language change from one session to another for children?

Subjects

Two groups of normal male children, ages six-years to six-years, eleven-months and nine-years to nine-years, eleven-months served as subjects for this study. Each group consisted of fifteen subjects. The subjects were obtained from Oklahoma City schools. The investigation was limited to males due to reported differences in performance between male and female children on tasks involving tachistoscopic recognition of visual stimuli (14). Added criteria for selection of subjects included the following: (a) normal articulation, as screened by the *Hejna Articulation Test*; (b) an I.Q. of at least 90 on the *Peabody Picture Vocabulary Test*, Form A (3); (c) each child was required to pass a visual acuity screening test (American Optical Co., No II969), with aided vision allowed during the screening test if glasses were to be worn during the experimental tasks; and (d) no reported speech and hearing problems.

Test Stimuli

The test stimuli (see Appendix A for complete list) consisted of seventy-two pictures of simple line-drawn objects, considered easily recognized by young children. The names of these pictured objects represented a range of frequency of occurrence in the English language, according to the T-L word count (36). Black line-drawn tracings of these objects were made on white tracing paper from commercially prepared picture cards (3, 20) (see Appendix B for three samples of pictures used). The size of the pictures was relatively uniform. The tracing paper containing each picture was cut to a uniform size of 3 3/4 inches and then taped to the center of a plain white card whose dimensions were 8 1/2 inches by 11 inches.

The T-L frequency distributions have been differentiated according to occurrence of words in general reading material appropriate to adults and according to material appropriate to children. The frequency of a given item differs, of course, depending on whether the adult or juvenile norms are used. Boysen (2) used both the adult and juvenile T-L norms to obtain correlation coefficients for word frequency and object-naming latencies for normal-speaking and stuttering children. He found that only a slight difference existed between the correlation coefficients obtained with the adult norms and those obtained with the juvenile norms for both subject groups. Furthermore, in view of the recent influence of television, radio, and motion pictures on the language of children, as well as the influence on language of an expanded school curriculum for children, it may be that the juvenile norms which were presented by Thorndike and Lorge over twenty-five years ago are more outdated than the adult norms. For these reasons the adult norms were used in the present study.

Presentation of Stimuli

The stimulus pictures were presented using a two-room sound-treated suite connected by a door and a two-way window. The subject, an experimenter's assistant, and the exposure cabinet of a two-field Harvard tachistoscope (Model T-2B) were in one room, the experimental room. A Harvard four-channel digital timer (Model 300-4T) and the lamp driver (Model 402) were in the adjoining room, the control room. The exposure cabinet of the tachistoscope was positioned on a table directly in front of the window and, thus, the subject and the experimenter were unable to see each other. The experimenter's assistant was responsible for monitoring the subject, insuring that the subject was prepared to respond to each stimulus presentation. A two-way intercom system enabled the experimenter to communicate with the subject and the assistant. The two-room arrangement served to eliminate much auditory distraction for the subject.

Four white lamps, each with a power of four watts, were used in the exposure cabinet, with two lamps positioned in each field. The lamps provided uniform illumination for each field and, according to the manufacturer's specifications, had a rise and decay time within .0002 seconds. The maximum light output per lamp was eighty lumens with the apparent brightness of each field approximately seven-to-eight foot-candles. The Model 402 lamp driver, designed to supply sufficient power to drive the lamps, consumed approximately fifty-five watts.

Connected to the lamp driver was a digital timer (Model 300-4T) capable of providing independent control of each field of the tachistoscope. Through manipulation of the front panel controls of the digital timer, it was possible to select intervals of duration from one millisecond to 9900 milliseconds in any one of four channels. Two channels were output channels and provided the intervals that timed the duration of the exposure fields. The other two channels were delay timers and provided the "blank" intervals between the exposure intervals. The delay timers were provided with a "start-end" switch which made it possible to start the delay at either the onset or the offset of the preceding channel. Hence, the exposure fields could be set to completely or partially overlap each other or to be separated.

To insure that the tachistoscope was in calibration, a solar battery (Bell Laboratories) and a Tektronix storage oscilloscope (Type 549) were used to record the onset and duration of tachistoscopic exposures as brief as five milliseconds.

While seated before the exposure cabinet, the subject was instructed to look into the viewing aperture. The aperture was surrounded by a small rubber hood which served to minimize visual distraction and to control for environmental light intensity. The viewing distance from the aperture to each field was twenty-one inches. The assistant insured that the subject was in proper position to carry out the prescribed tasks. A multiple-card-back, that is, a card-holder designed to hold a number of cards, was attached to the exposure cabinet for use in Field I. The plain white cards, upon which were centered the black-line drawings of pictured objects were placed in the card-holder. Though the cards measured 8 1/2 by 11 inches, the exposure area of the card-holder for both fields was 7 3/4 x 7 3/4 inches. After a card had been exposed and responded to by the subject, the assistant pulled the card out of the holder and advanced the next card into position. During the Visual Duration Threshold task, described below, a single card-back which held the card containing the post-stimulus "masking" pattern was attached to the cabinet for use in Field II.

Procedure

Each child participated in three experimental tasks: (1) Visual Duration Threshold (VDT) task, (2) Object-Naming-Latency (ONL) task, and (3) Matching-Response-Latency (MRL) task. Since the completion of the three tasks might have resulted in fatigue, particularly for the younger children, and, therefore, have adversely affected their performance, the tasks were completed in two sessions for each child. During the first session, each child participated in the VDT task and in the ONL task. During the second session, each child participated in the MRL task and in a repetition of the ONL task. Hence, though each subject performed two tasks during each session, one task in the initial session was duplicated in the second session. The two sessions were separated by an interval of from twenty-four hours to one week. At the beginning of each session, the subject was familiarized with the testing room. Several minutes were allowed for conversation about school and other topics until the subject appeared to be at ease in the test situation and with the experimenter.

Visual Duration Threshold Task

Each subject was seated before the exposure cabinet and instructed that a series of pictures would appear on a screen inside the cabinet and that he was to name them. He was also told that each picture would go by very quickly and if he were not able to see it, that the picture would be shown again. The experimenter explained that each time the picture appeared on the screen it would stay on longer than the previous time and would become easier to recognize. The child was told to respond to the stimulus presentation either by saying the name of the picture or by responding "No" if he were unable to recognize the picture.

Following the instructions, each subject was shown, by means of tachistoscopic presentation, a series of eight practice-pictures. These items were presented to familiarize the child with the procedure. Preceding each presentation, the child's attention was alerted by a "Ready" signal spoken aloud by the experimenter. Then, following a two-to-three second interval, the presentation of the stimulus occurred. Following a "No" response the child was instructed to "Look again" and another stimulus presentation would occur. Each picture was presented initially at a duration below the child's threshold of recognition. Time of exposure was then systematically increased by 5 millisecond increments up to 100 milliseconds duration and because of limitations in the instrument, by increments of 10 milliseconds above 100 milliseconds duration, until the picture was recognized by the subject.

The presentation of each stimulus-picture was immediately followed by the exposure of a "masking" pattern in the post-stimulus field. The "masking" pattern was similar in design to the one used by Wingfield (40) and was introduced in an attempt to curtail the visual after-image or icon of the pictured object. The post-stimulus "masking" pattern was exposed for a duration of one second.

Following a short rest, the subject was presented the experimental condition consisting of twelve stimulus-pictures. The procedure was the same as that described in the practice condition. In the event the child did not specifically name the pictured object but gave a related response, such as, "animal" rather than "bear", the experimenter asked the child if he could correctly name the "animal". If he could not, the picture was presented at an increased visual duration until the child was able to name the picture. When the subject gave a correct response for two successive levels of exposure, the first of the two levels was recorded as the threshold value. The stimulus-pictures were randomized differently for each subject (see Appendix A for sample of randomized schedule). The task was completed in approximately thirty minutes.

Object-Naming Task

Following a short rest, each child was given the Object-Naming task. The subject was told that he was to name another series of pictures. The experimenter informed the subject that, unlike the previous task, each picture would be exposed long enough to be recognized. The child was then instructed to name the picture as rapidly as possible.

During the practice condition, eight pictures (see Appendix A for sample schedule), different from those used in the Visual Duration Threshold task, were presented tachistoscopically. Prior to each exposure, the child was given a "Ready" signal by the experimenter. Following a two-to-three second interval, a five-second tachistoscopic presentation occurred and the child named the picture. A dark post-stimulus field immediately followed the termination of each stimulus presentation.

Following the practice condition, each subject was presented the experimental condition consisting of twenty-four pictured objects. To maintain a high degree of subject vigilance the subject was encouraged throughout the task to respond as quickly as possible. The stimulus-pictures were randomized differently for each subject. The task was performed in approximately ten minutes and marked the completion of the first session.

Name-Picture-Matching Task

In the second session, each child was initially presented the

Name-Picture-Matching task wherein the names of objects were presented aloud by the experimenter. The child was informed that after the presentation of each name, he was to repeat the name, to insure that he had heard the experimenter correctly. The child then was shown a picture flashed on the screen in the exposure cabinet. He was instructed to say the word "Yes" as quickly as possible if the name spoken by the experimenter were appropriate for the object in the picture. In the event the name and the picture were not the same, the child was instructed to say the word "No" as quickly as possible.

The Name-Picture-Matching practice condition consisted of eight name-picture stimuli. After the child repeated the name of an object spoken by the experimenter, there was an interval of two-to-three seconds followed by a tachistoscopic presentation of a pictured object. The child then responded as instructed. The stimulus-pictures were exposed for a duration of five seconds and were immediately followed by a dark post-stimulus field.

Following a short rest, the subject was presented the experimental condition which was identical to the practice condition with the exception that the former included twelve name-picture stimuli. Again, prior to each name-picture presentation, the subject's attention was alerted by a "Ready" signal spoken aloud by the experiment. In the experimental condition, six of the stimulus-pairs required a "Yes" response and the remaining six pairs required a "No" response. An attempt was made to approximate the frequencies of occurrence of each member of a stimulus-pair such that a name whose frequency of occurrence is low was paired with a picture, the name of which has a frequency of occurrence which also is low. Conversely, those pictures whose T-L frequency of occurrence is high were matched with name-stimuli having high frequencies. To insure that potential differences in MRLs between "Yes" and "No" responses were due to the response required and not to differences in the amount of time required to recognize the stimulus-picture, each picture was presented under both positive and negative conditions. This was accomplished by reversing the six positive name-picture stimuli and the six negative name-picture stimuli for seven of the subjects from each group. Consequently, the stimulus-pair finger-finger, for example, was presented to eight subjects and the stimulus-pair baby-finger to the remaining seven subjects from each age group. The stimulus-pairs were randomized differently for each subject (see Appendix A for sample schedule). The task was completed in approximately ten minutes.

After another short break, the Object-Naming task initially presented in the first session was presented again. The procedure was identical to that employed during the first session and included the presentation of the same practice and experimental stimulus-pictures. As in the previous tasks, the pictures were randomized differently for each subject.

Recording of Responses

In order for both ONL and MRL measurements to be made, the subject's vocal responses were recorded on magnetic tape. The recording of such measurements involved the use of an Ampex two-channel tape recorder (Model 440), a stimulus signal source, and a microphone. The depression of the "stop/start" control of the digital timer which initiated the presentation of the stimulus-picture, simultaneously initiated a stimulus voltage which was recorded on one channel of the tape recorder. The verbal response was picked up by an Electro-Voice cardioid microphone (Model 664) and recorded on the other channel of the same tape recorder. The tape recorder was located in the control room with the experimenter. The microphone was in the experimental room beneath the viewing hood and the aperture for the subject's face. An approximate mouth-to-microphone distance of four inches was maintained.

The recorded speech samples were then transferred to a Sanborn oscillographic strip-chart recorder (Model 7702A) for the ONL and MRL measurements. Signal amplitude settings on both the Ampex tape recorder and Sanborn recorder were uniform for all subjects' taped responses. Paper speed was 100 millimeters per second. The start of each taped sample was delayed so that at least 30 millimeters of paper preceded the onset of the recorded signals. This delay was to insure that peak paper speed (reached within 10 millimeters) was constant before the signal was recorded. The stimulus voltage was recorded on one channel while the verbal response voltage was recorded on a second channel of the strip-chart recorder.

Criteria of Measurement

Though all strip-chart recordings were carefully monitored visually while listening to the auditory signal from the tape recorder, in some instances the onset of word production was difficult to determine. Frequently, just prior to a vocal response, the sound of physical movement or sighing by the children was introduced on the magnetic tape, resulting in premature movement of the stylus. As a result, the stylus fluctuated about zero baseline as the response was made. In such instances, it was difficult to locate the point where the onset of response occurred. By closely monitoring the visual and auditory signals it was possible to determine the approximate location of the onset of the response. In other instances it was impossible to separate the noise signal from the verbal response signal, hence, the response was discounted completely. This occurred particularly with words having a fricative consonant sound in the initial position. For example, the strip-chart recording of the onset of the word fork was characterized by minute, random fluctuations. Frequently, the concluding portion of a noise signal appeared to have these same characteristics. When these two signals were connected it was extremely difficult to determine the point where the noise signal ended and the onset of response began.

Onset of word production for the latency measurement was defined as the following: (a) the sudden movement of the stylus which may initially consist of a wide excursion (Figure 1, I, a) or sharp peaking from zero baseline (Figure 1, II, a); (b) the point from which a gradual rise in the stylus occurs from zero baseline (Figure 1, III, a); (c) the point from which minute fluctuations in zero baseline occur before a sudden movement of the stylus in a vertical direction (Figure 1, IV, a); (d) fluctuations corresponding to sounds of articulators contacting or separating, respiration, or subvocalizations which connect with or immediately precede the response signal by 50 milliseconds or less (Figure 1, V, a) and (e) the sudden movement of the stylus due to the vocalization of the vowel sound /ə/ connecting or immediately preceding the response signal within 50 milliseconds (Figure 1, VI, a).

Stimulus onset was defined as the point where a minute peak from zero baseline appeared immediately before the stylus moved in an extended upward direction (Figure 1, I, c). In almost all cases, a

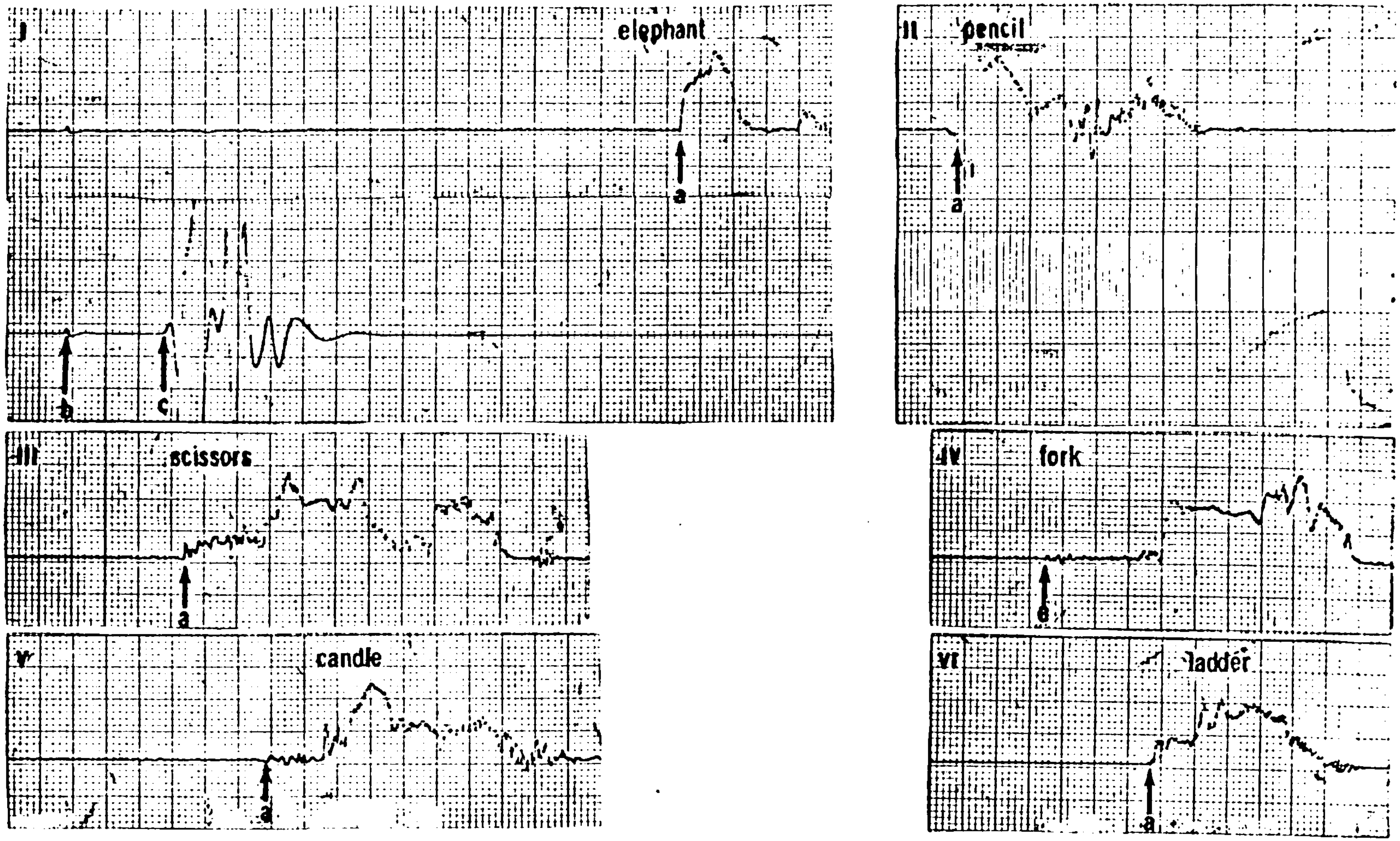

Figure 1--Examples of the strip-chart recordings for six single-word responses, demonstrating the definition of the onset of words, as well as the stimulus onset.

small irregular fluctuation preceded the minute peak referred to above (Figure 1, I, b). This initial fluctuation represented a voltage signal which occurred as the "stop-start" lever on the digital timer was depressed. It was observed that a slight depression of the lever produced this signal without triggering the onset of the stimulus picture.

To check the reliability of the ONL measurements, another judge who was familiar with the measurement criteria and procedures independently measured the latencies for 57 responses chosen at random from 20 of the series of ONL recordings. For 22 of the 57 responses, the two judges agreed perfectly, for 20 responses the measurements differed by 5 milliseconds, for 11 responses by 10 milliseconds, and for 3 responses by 15 milliseconds. For only 1 of the 57 responses did the judges differ by more than 15 milliseconds. Thus 98 per cent of the measurements differed by 15 milliseconds or less.

CHAPTER IV

RESULTS AND DISCUSSION

Results

This study explored the effects of subject's age and frequency of occurrence of words on visual duration thresholds and verbal reaction times in children. Two groups of normal-speaking male children, age six-years to six-years-and-eleven-months and nine-years to nine-years-and-eleven-months, served as subjects. The test stimuli consisted of simple-object line-drawn pictures and were presented using a Harvard tachistoscope (Model T-2B). The names of the pictured objects represented a wide range of frequency of occurrence in the English language according to the Thorndike-Lorge (T-L) frequency distribution. Different stimuli were used for each of three tasks. The stimuli for practice and experimental conditions for each task were presented according to a different random schedule for each subject. The following measurements were obtained for each subject: (1) visual duration thresholds (VDTs), (2) name-picture-matching response latencies (MRLs), and (3) object-naming latencies (ONLs).

Visual Duration Thresholds

In this task, each subject in each age group was presented a random series of twelve stimulus-pictures. To curtail the visual after-image which occurs immediately following the exposure of a stimulus picture, a masking "noise" pattern was presented after each stimulus. The visual duration threshold (VDT; the duration of exposure necessary to detect enough information to identify the stimulus-object) was obtained for each correctly named response. The obtained thresholds for all pictures for all subjects in the two age groups are contained in Tables 9 and 10 in Appendix C. In Table 1 are presented the stimulus pictures, the frequencies of occurrence of the names of the pictured stimuli according to the T-L word count, the mean and median VDT measures (in milliseconds) and the standard deviations (in milliseconds) for each age group. The mean VDT across subjects and stimuli was 86 milliseconds for the six-year-old children and 76 milliseconds for the nine-year-old children. The difference between the means was significant (paired-t, $p < .05$).

Pearson product-moment correlation coefficients for quantifying the relationship between $\log_{10}$ frequency of occurrence and VDTs were obtained for six- and nine-year-olds and for means and medians and are reported in Table 2. The obtained correlation coefficients for the means and the medians are greater for the six-year-old than for the nine-year-old children but the differences between age groups are not significant ($p > .05$). An examination of the coefficients suggests that the time taken to recognize pictured objects is negatively correlated with the logarithm of the frequency of occurrence of the names in the English language for both six-year-old and nine-year-old male subjects. None of the correlation coefficients, however, was significantly different from zero ($p > .05$).

Due to the relatively small number (N=12) of stimuli used, if

TABLE 1

STIMULUS WORDS, WORD FREQUENCIES, MEAN AND MEDIAN VISUAL DURATION THRESHOLDS* (IN MILLISECONDS) AND STANDARD DEVIATIONS (IN MILLISECONDS) FOR FIFTEEN SIX-YEAR-OLD AND FIFTEEN NINE-YEAR-OLD SUBJECTS

			Visual Duration Threshold					
			Six-Year-Olds			Nine-Year-Olds		
	Stimulus Word	Frequency Norms[a]	Mean	Median	SD	Mean	Median	SD
1.	chair	100+	50	50	16	49	50	10
2.	door	100+	138	120	98	138	110	92
3.	nail	50–100	61	55	22	60	55	24
4.	pig	44	62	55	29	84	65	72
5.	drum	40	55	50	18	43	40	10
6.	deer	35	80	60	52	50	50	12
7.	snake	28	63	60	21	54	55	12
8.	comb	19	86	80	48	74	70	25
9.	turtle	17	65	55	27	59	50	25
10.	clown	15	63	50	33	48	45	12
11.	fire engine	1	209	190	76	166	150	70
12.	roller skate	.39	99	80	51	87	80	38

* Obtained with a post-stimulus masking pattern comprised of a nonsystematic array of lines and arcs.

[a] Frequency per 1,000,000 words of text.

TABLE 2

PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENTS FOR AVERAGE VISUAL DURATION THRESHOLD (IN MILLISECONDS) AND LOG_{10} FREQUENCY OF OCCURRENCE OF WORDS

	Six-Year-Olds	Nine-Year-Olds
Means	- .54	- .41
Medians	- .50	- .49

the mean and median VDTs for just one of the words were aberrant in relation to the mean and median values for the other stimulus-pictures, as was the case for the words door and fire engine, one might expect the VDT-log frequency relationship to be greatly affected. This is borne out by noting that the correlation coefficient using the mean VDTs and excluding the values for door and fire engine was - .80 ($P < .01$) for the six-year-olds and - .57 ($P > .05$) for the nine-year-olds. By including the mean value for the word door but still excluding that for fire engine the correlation coefficients decreased to - .19 and - .04 for the six- and nine-year age groups, respectively, both coefficients nonsignificant ($P > .05$).

The VDT task was replicated with a second group of nine-year-old boys. The number of stimuli was increased to eighteen and the stimuli were chosen to represent better the range of frequency, that is, a greater proportion of stimuli with low frequency names was chosen (see Appendix A for list of words). In addition, an effort was made to eliminate stimuli which appeared to be unusually ambiguous, such as, door and fire engine. Because the number of pictures used in the second VDT task exceeded the number used in the previous task, the possibility of fatigue adversely affecting the subjects' performance was increased. To minimize this possibility, the post-stimulus field was changed from a "noise" pattern to a plain white field. A white post-stimulus field has some but much less of a masking effect on iconic memory than does a "noise" pattern, enabling the subject to continue processing the visual stimulus following the exposure (23). As a result, subjects will have lower VDTs. The procedure was the same as that used in the previous VDT task with the exception that the time of exposure of each stimulus presentation was systematically increased by single millisecond increments up to ten milliseconds duration and by increments of five milliseconds above ten milliseconds duration, until the picture was recognized by the subject. Under these conditions, the complete task, though containing more stimuli, was performed in approximately the same amount of time as the previous VDT task.

The obtained VDTs are contained in Table 11 in Appendix C. In Table 3 are presented the stimulus-pictures, the frequencies of occurrence of the names of the pictured-stimuli according to the T-L word count, the mean and median VDT measures (in milliseconds) and the standard deviations (in milliseconds). The mean VDT across subjects and pictures was 29 milliseconds. An examination of Table 3 indicates that the mean and median VDTs for the picture belt were much greater than were the means and medians for the other stimulus-pictures. The obtained Pearson product-moment correlation coefficients for average VDTs and $\log_{10}$ frequency of occurrence were − .04 and + .13 for mean and median VDTs, respectively. Neither correlation coefficient was significantly different from zero ($P > .05$).

TABLE 3

STIMULUS WORDS, WORD FREQUENCIES, MEAN AND MEDIAN VISUAL DURATION THRESHOLDS* (IN MILLISECONDS) AND STANDARD DEVIATIONS (IN MILLISECONDS) FOR THE SECOND GROUP OF FIFTEEN NINE-YEAR-OLD SUBJECTS

	Stimulus Word	Frequency Norms[a]	Visual Duration Threshold		
			Mean	Median	SD
1.	shoe	100+	13	8	14
2.	chair	100+	9	8	3
3.	cake	50–100	12	10	7
4.	nail	50–100	12	10	6
5.	belt	48	144	140	102
6.	pencil	40	14	15	6
7.	hammer	34	8	8	3
8.	ladder	19	9	8	4
9.	shovel	14	25	10	54
10.	turtle	13	36	10	63
11.	magnet	9	47	50	24
12.	scissors	8	9	9	3
13.	flashlight	3	58	15	87
14.	calendar	2	19	15	13
15.	hanger	1	9	6	6
16.	fire engine	1	35	20	48
17.	fire cracker	.79	29	15	33
18.	screwdriver	.33	36	15	53

* A plain white card served as the post-stimulus masking field.

[a] Frequency per 1,000,000 words of text.

Name-Picture-Matching Response Latencies

In this task the name of an object was presented verbally by the experimenter to each subject, followed approximately 2 to 3 seconds later by a pictured object, presented with the tachistoscope for a period of 5 seconds. The subjects responded with the word "Yes" if the name and the picture were the same and "No" if the name and the picture were different. The subjects were instructed to respond as quickly as possible. Eight name-picture pairs were presented in a practice condition followed by the presentation of twelve experimental pairs.

The name-picture-matching response latencies (MRLs) for each stimulus-pair for subjects within each age group are contained in Tables 12 and 13 in Appendix D. Erroneous responses were not used in any of the analyses. In Table 4 are presented the stimulus-pairs, the frequencies of occurrence of each member of a pair according to the T-L word count, the mean and median latencies (in milliseconds) and the standard deviations (in milliseconds) for the affirmative and negative responses, and the number of subjects who correctly responded to each paired stimulus for each age group. The mean MRL across subjects for all correct affirmative responses was 1026 milliseconds for the six-year-old children and 753 milliseconds for the nine-year-old children. The mean MRL across subjects for all negative matches correctly identified was 1109 milliseconds for the six-year-old children and 763 milliseconds for the nine-year-old children. The results of Wilcoxin's matched-pairs signed-ranks test indicated that the difference between means and the difference between medians for positive and negative responses, within each age group, were nonsignificant ($P > .05$). For the six-year-old subjects five of the mean MRLs for affirmative responses were greater, and six

TABLE 4

NAME-PICTURE-MATCHING STIMULUS-PAIRS, WORD FREQUENCIES, NUMBER (N) OF CORRECT RESPONSES, MEAN AND MEDIAN LATENCIES (IN MILLSECONDS) AND STANDARD DEVIATIONS (IN MILLISECONDS) FOR "YES" AND "NO" RESPONSES FOR SIX-YEAR-OLD AND NINE-YEAR-OLD SUBJECTS

	Stimulus-Pair		Frequency			Six-Year-Olds				Nine-Year-Olds			
	Word	Picture	Norms		Response	N	Mean	Median	SD	N	Mean	Median	SD
1.	finger	finger	AA[a]	AA	Yes	8	1098	1005	571	8	696	750	173
	hat	finger	AA	AA	No	6	1015	872	396	7	825	910	206
2.	shoe	shoe	AA	AA	Yes	6	895	872	248	7	691	685	234
	bird	shoe	AA	AA	No	7	1003	890	302	8	618	635	87
3.	key	key	A[b]	A	Yes	5	1011	1025	257	7	751	795	309
	wagon	key	A	A	No	8	970	972	199	8	768	735	137
4.	feather	feather	44	44	Yes	8	983	972	402	8	649	610	169
	rabbit	feather	43	44	No	7	1284	1080	623	7	823	840	213
5.	spoon	spoon	33	33	Yes	6	856	725	420	7	654	720	214
	tiger	spoon	30	33	No	7	1024	1040	223	8	648	675	136
6.	squirrel	squirrel	24	24	Yes	8	985	985	281	8	773	732	155
	envelope	squirrel	22	24	No	7	1316	1400	406	6	706	780	146
7.	butterfly	butterfly	22	22	Yes	7	1012	1035	344	7	875	852	211
	closet	butterfly	20	22	No	8	1012	1005	249	8	743	750	141
8.	banana	banana	13	13	Yes	7	788	715	253	8	781	752	236
	pumpkin	banana	13	13	No	7	1039	850	358	7	726	725	192

TABLE 4--Continued.

	Stimulus-Pair		Frequency			Six-Year-Olds				Nine-Year-Olds			
	Word	Picture	Norms		Response	N	Mean	Median	SD	N	Mean	Median	SD
9.	razor	razor	7	7	Yes	7	1536	1235	836	6	887	880	152
	puppet	razor	6	7	No	7	1529	1600	799	8	931	852	271
10.	toothbrush	toothbrush	3	3	Yes	8	871	827	138	8	668	640	152
	bookcase	toothbrush	3	3	No	7	1140	1090	218	7	822	820	271
11.	calendar	calendar	2	2	Yes	6	1047	1065	324	6	991	782	776
	watermelon	calendar	1	2	No	8	964	940	98	8	767	723	128
12.	paintbrush	paintbrush	.33	.33	Yes	7	1212	1035	738	8	704	662	259
	sandbox	paintbrush	.22	.33	No	6	1046	997	219	7	783	745	165

[a]Frequency of 100+ per 1,000,000 words of text.

[b]Frequency of 50 to 100 per 1,000,000 words of text.

less, than for the negative responses for the same pictures. In one instance (butterfly), the mean MRL for the positive stimulus-pair and mean MRL for the negative stimulus-pair were the same. For the nine-year-old children six of the mean "Yes" MRLs were greater, and six less, than the mean "No" MRLs for the same pictures.

The differences between age groups are readily apparent for mean MRLs for positive responses and for negative responses. An inspection of Table 4 demonstrates that for positive responses, the least of the mean MRLs in the six-year-old group exceeds nine of the twelve mean MRLs in the nine-year-old group. For negative responses, the least of the mean MRLs for the six-year-olds exceeds the largest of the mean MRLs for the nine-year-olds.

Pearson product-moment correlation coefficients were obtained for estimating the relationship between average MRL and $\log_{10}$ frequency of occurrence and are presented in Table 5 for six- and nine-year-old

TABLE 5

PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENTS*
FOR AVERAGE NAME-PICTURE-MATCHING RESPONSE
LATENCY (IN MILLISECONDS) AND LOG_{10}
FREQUENCY OF OCCURRENCE OF WORDS

	Six-Year-Olds		Nine-Year-Olds	
	Mean	Median	Mean	Median
"Yes" Responses	- .31	- .20	- .30	+ .10
"No" Responses	- .08	- .15	- .31	+.002
Combined "Yes" and "No" Responses	- .23	- .18	- .37	+ .07

* None of the correlation coefficients is significantly different from zero (t, $P > .05$).

male subjects, for means and medians, for "Yes" responses, for "No" responses, and for combined "Yes" and "No" responses. None of the coefficients is significantly different from zero ($P > .05$).

Object-Naming Latencies

In this experimental condition each subject in each age group was presented a series of twenty-four stimulus-pictures twice, with an interval of from twenty-four hours to one week between sessions. The object-naming latency (ONL) was measured for each subject for each of twenty-four randomly presented pictures named correctly during either of the two trials. The obtained latency measures are contained in Tables 14 and 15 in Appendix E. In Table 6 are presented the stimulus words, their frequencies of occurrence according to the T-L word count, the mean and median latencies (in milliseconds), the standard deviations (in milliseconds), and the number of subjects correctly naming each item for the six- and nine-year-old subject groups. For the first trial, the mean ONL across subjects for all correctly named words was 1091 milliseconds for the six-year-old children and 911 milliseconds for the nine-year-old children. The mean ONLs for the second trial were 959 milliseconds and 815 milliseconds for the six- and nine-year-olds, respectively. For 92 per cent of the words (22 of 24) on both trials, the mean ONLs for six-year-old children were greater than for the nine-year-old children. For 67 per cent (16 of 24) of the words for six-year-old children and 79 per cent (19 of 24) of the words for the nine-year-old children, the Trial I mean ONLs were greater than the Trial II ONLs. The median ONLs for each trial were usually shorter than the corresponding mean ONLs with relatively large differences for some words, such as

TABLE 6

STIMULUS WORDS, WORD FREQUENCIES, MEAN AND MEDIAN OBJECT-NAMING LATENCIES (IN MILLISECONDS), STANDARD DEVIATIONS (IN MILLISECONDS) AND THE NUMBER OF CORRECT RESPONSES TO EACH WORD (N) FOR SIX-YEAR-OLD AND NINE-YEAR-OLD SUBJECTS FOR TRIALS I AND II

				Object-Naming Latency							
				Six-Year-Olds				Nine-Year-Olds			
Stimulus Word		Frequency Norms[a]	Trial	Mean	Median	N	SD	Mean	Median	N	SD
1.	bed	100+	I	958	840	15	445	849	855	15	230
			II	894	755	15	441	731	730	15	105
2.	ring	100+	I	839	840	15	135	763	775	15	90
			II	775	715	15	121	746	730	15	126
3.	bell	50-100	I	880	828	14	203	738	730	15	79
			II	953	825	14	315	683	715	15	91
4.	cake	50-100	I	868	816	14	258	733	705	15	186
			II	882	735	14	308	687	700	15	102
5.	doll	46	I	1058	1075	13	286	1091	1082	12	201
			II	860	865	11	210	1096	930	13	735
6.	candle	43	I	1332	1100	15	743	1002	935	15	237
			II	944	870	15	273	830	725	15	269

TABLE 6--Continued.

	Stimulus Word	Frequency Norms[a]	Trial	Object Naming Latency: Six-Year-Olds Mean	Median	N	SD	Nine-Year-Olds Mean	Median	N	SD
7.	pencil	40	I	948	790	12	408	827	780	15	159
			II	1082	985	15	506	754	725	15	113
8.	elephant	35	I	1022	815	15	632	855	755	15	342
			II	882	750	15	309	876	815	15	292
9.	hammer	34	I	929	945	15	277	624	635	13	101
			II	795	790	15	158	679	665	14	73
10.	fork	31	I	924	875	15	293	859	800	15	240
			II	979	817	14	382	834	820	15	148
11.	leaf	27	I	774	750	14	209	672	675	15	121
			II	853	787	14	205	695	702	14	139
12.	sandwich	23	I	1109	910	13	475	875	850	12	331
			II	982	880	14	571	736	690	15	144
13.	ladder	19	I	916	905	15	225	898	865	14	174
			II	966	795	13	249	807	810	15	171
14.	camel	18	I	1533	902	14	151	1488	1102	14	885
			II	1388	992	14	994	1054	840	13	813
15.	shovel	14	I	1025	910	15	272	1020	885	15	382
			II	1107	925	15	689	838	800	15	266

TABLE 6--Continued.

Stimulus Word	Frequency Norms[a]	Trial	Object Naming Latency							
			Six-Year-Olds				Nine-Year-Olds			
			Mean	Median	N	SD	Mean	Median	N	SD
16. rake	13	I	1058	795	15	543	1073	980	15	373
		II	1024	850	15	409	924	785	14	495
17. sock	12	I	772	775	15	121	719	710	15	117
		II	812	755	15	231	690	640	15	122
18. kite	10	I	1140	750	14	1096	774	765	15	91
		II	907	785	15	374	698	680	15	85
19. carrot	9	I	1508	815	15	1710	855	850	15	184
		II	970	825	15	515	774	755	15	104
20. scissors	8	I	856	675	15	537	643	660	14	98
		II	767	762	14	150	647	625	15	156
21. kangaroo	2	I	1335	1145	13	685	1273	1045	14	742
		II	1045	832	12	389	1008	850	13	527
22. hanger	1	I	1343	875	14	1297	976	937	14	325
		II	882	832	14	264	781	750	13	155
23. toaster	1	I	1240	1165	14	403	1139	960	15	493
		II	1030	875	13	356	1080	835	15	994
24. screwdriver	.33	I	2330	1705	9	1269	1180	1125	13	375
		II	1327	1380	11	288	1016	935	13	228

[a] Frequency per 1,000,000 words of text.

camel and carrot for the six-year-old and camel for the nine-year-old children. Thus, the distributions of ONLs, at least for some words, were considerably skewed. An inspection of the standard deviations in Table 6 indicates that ONLs are considerably more variable for the six-year-old than for the nine-year-old subjects.

Pearson product-moment correlation coefficients for relating average ONL and $\log_{10}$ frequency of occurrence were obtained and are reported in Table 7. For the first trial data, the correlation coeffi-

TABLE 7

PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENTS FOR AVERAGE OBJECT-NAMING LATENCY (IN MILLISECONDS) AND LOG_{10} FREQUENCY OF OCCURRENCE OF WORDS

	Six-Year-Olds		Nine-Year-Olds	
Trial	I	II	I	II
Means	- .69[a]	- .41[a]	- .46[a]	- .44[a]
Medians	- .58[a]	- .55[a]	- .49[a]	- .37

[a] $p < .05$

cients are greater for the six-year-old than for the nine-year-old children. The only instance in which the correlation coefficient for the nine-year-old group exceeded the corresponding coefficient for the six-year-old group occurred when using the means for the second trial data. This difference, however, is comparatively small. None of the differences are significant ($P > .05$). In all cases the correlation coefficients obtained in the second trial are lower than the corresponding coefficients obtained in the first trial. In all instances but one, for both age groups, for Trials I and II, and for means and medians, the correlation coefficients were found to be significantly different from zero ($p < .05$). The time taken by normal males, six and nine years of age, to name objects apparently is negatively correlated with the logarithm of the frequency of the names in the English language.

Lines of regression of average ONL on $\log_{10}$ frequency of occurrence were obtained and are presented in Figures 2 and 3 for six- and nine-year-olds, means and medians, and Trials I and II. The slopes of the lines for means and medians in Trial II are less than the slopes of the lines in Trial I for both age groups. The difference is especially apparent when comparing the slopes of the regression lines for the means for the six-year-olds.

The Object-Naming task was replicated using the same group of fifteen nine-year-old males used in the replication of the Visual Duration Threshold task. For this replication, twenty stimuli (see Appendix A for list of words) were chosen such that there was a greater proportion of stimuli with low frequency names. In addition, stimuli were chosen only if the object-names began with vowels or plosive consonants. This was done to facilitate the measurement of the onset of the response which for words beginning with fricative sounds was not as clearcut.

The ONL was measured for all subjects for each of the pictures named correctly. Three of the twenty pictures (razor, clothespin, roller skate) were misnamed by at least five of the subjects and were not included in the analyses of the data. The obtained latency measures are contained in Table 16 in Appendix E. In Table 8 are presented the stimulus words, their frequencies of occurrence according to the T-L adult norms, the mean and median latencies (in milliseconds), the

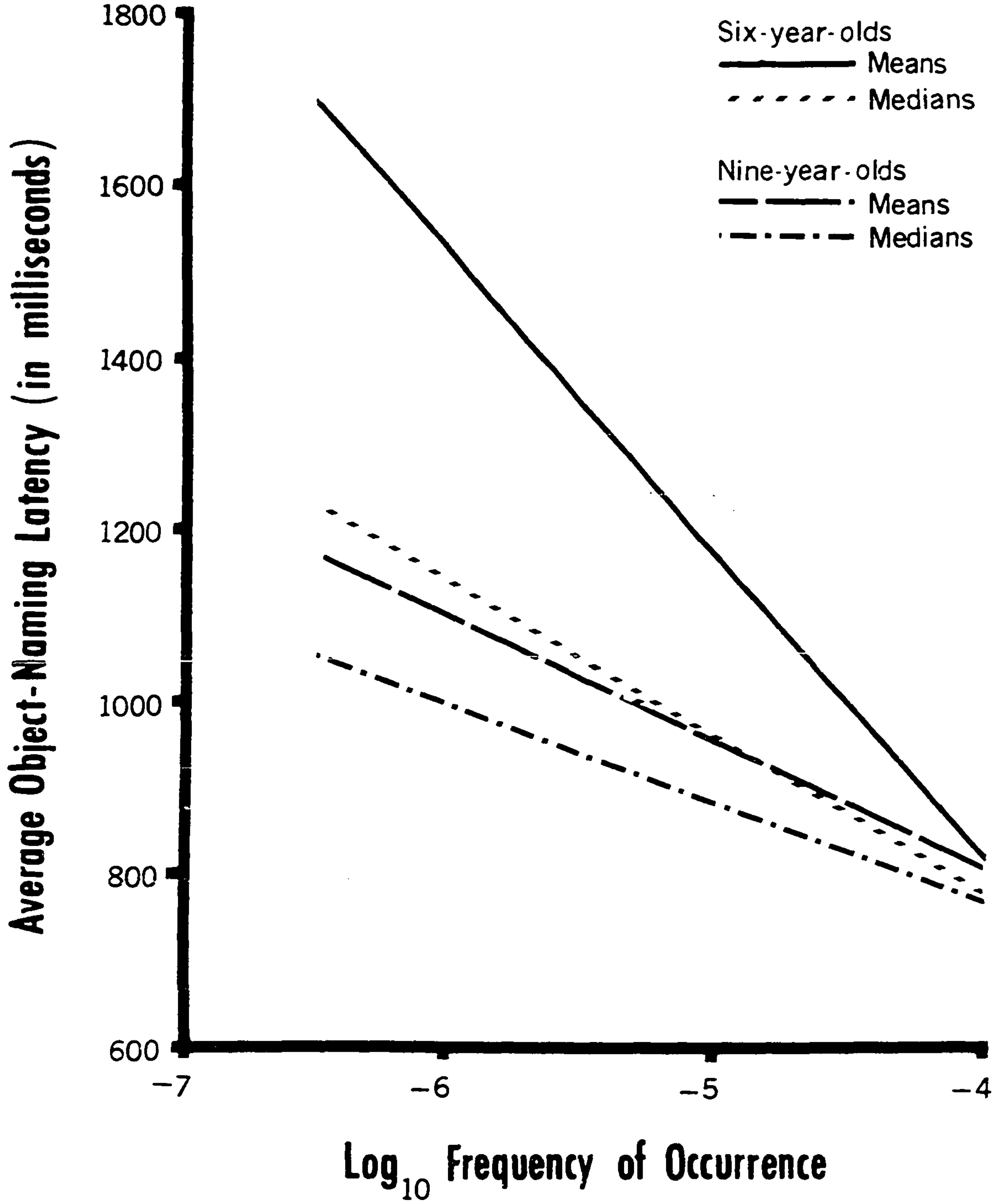

Figure 2.--Lines of regression of mean and median ONLs on $\log_{10}$ frequency of occurrence for six- and nine-year-old children for Trial I.

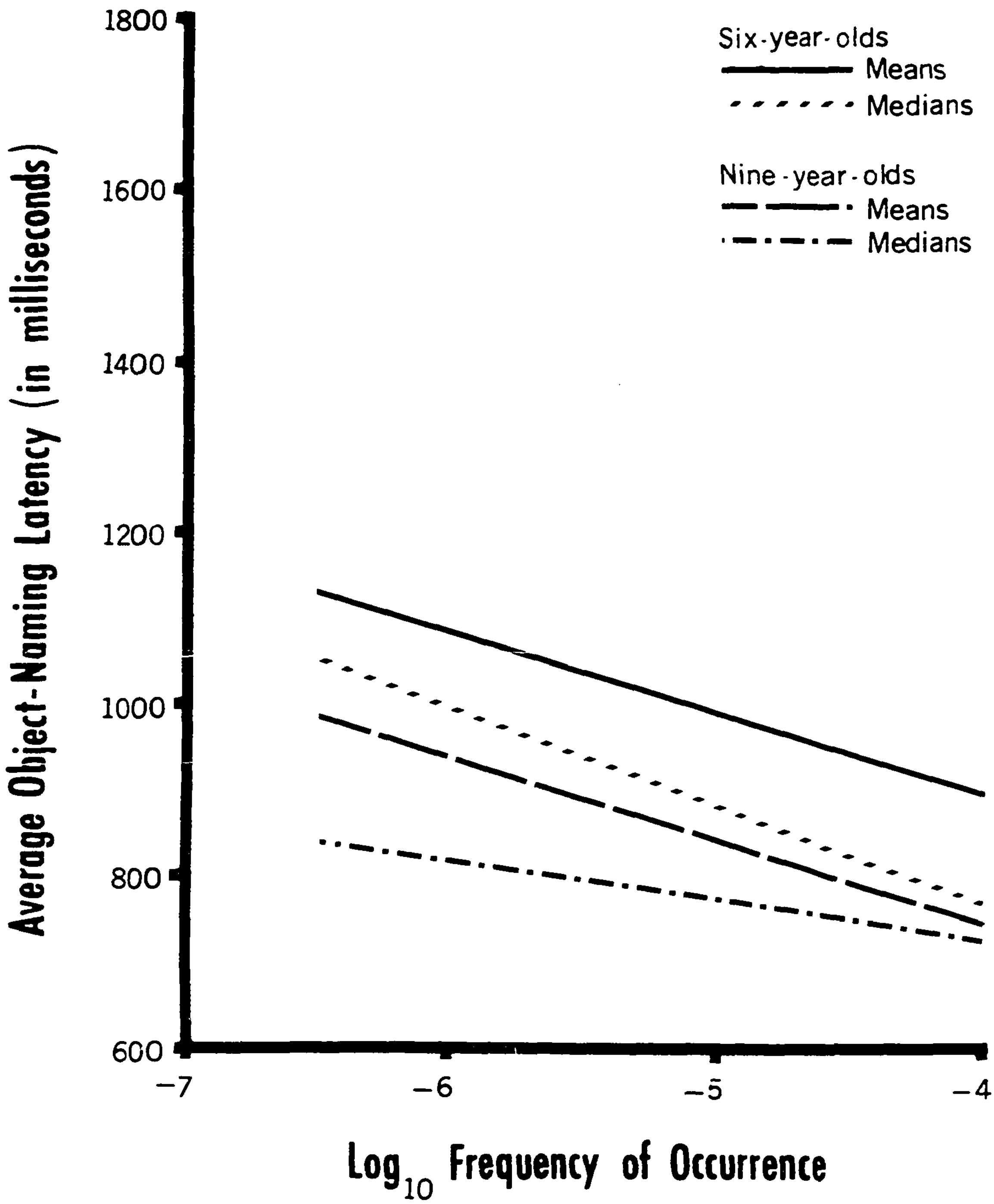

Figure 3--Lines of regression of mean and median ONLs on $\log_{10}$ frequency of occurrence for six- and nine-year-old children for Trail II.

TABLE 8

STIMULUS WORDS, WORD FREQUENCIES, MEAN AND MEDIAN OBJECT-NAMING LATENCIES (IN MILLISECONDS), STANDARD DEVIATIONS (IN MILLISECONDS) AND THE NUMBER OF CORRECT RESPONSES TO EACH WORD (N) FOR THE SECOND GROUP OF NINE-YEAR-OLD SUBJECTS

	Stimulus Word	Frequency Norms[a]	Object-Naming Latency Second Group Nine-Year-Olds			
			Mean	Median	N	SD
1.	bed	100+	806	755	15	184
2.	ring	100+	936	945	15	124
3.	key	50-100	866	820	15	170
4.	bell	50-100	804	770	15	106
5.	pig	44	858	785	15	177
6.	drum	40	962	840	15	407
7.	elephant	35	851	835	15	194
8.	butterfly	22	823	795	15	132
9.	umbrella	13	1024	920	15	305
10.	kite	10	836	860	15	167
11.	carrot	9	1015	935	15	348
12.	toothbrush	3	1040	1030	14	199
13.	kangaroo	2	932	888	14	168
14.	giraffe	1	1145	830	11	647
15.	toaster	1	1231	1060	12	542
16.	bathtub	1	1014	953	14	345
17.	paintbrush	.33	1182	1115	11	211

[a] Frequency per 1,000,000 words of text.

standard deviations (in milliseconds) and the number of subjects correctly naming each item. The mean across subjects for all correctly named words was 950 milliseconds. The corresponding mean median across subjects was 885 milliseconds. As was the case in the first ONL task, the differences between means and medians for some words, such as, drum, giraffe, and toaster, were relatively large, indicating that the distribution of ONLs for some words were considerably skewed.

Lines of regression of average ONL on $\log_{10}$ frequency of occurrence were obtained and are presented in Figure 4 for means and medians. An examination of the lines indicates that a negative relationship exists between the time taken to name objects and the logarithm of the frequency of occurrence of the names in the English language. A comparison of the slopes of the lines for first and second groups of nine-year-olds (Figure 5) indicates that the slopes of the lines for the first group differ only slightly from the slopes of the lines for the second group. Obtained Pearson product-moment correlation coefficients for the second group of nine-year-olds for the mean and median were $-.81$ and $-.71$, respectively. Both measures are significantly different from zero ($P < .05$).

Discussion

Wingfield (40) presented twenty-six pictured objects to adult subjects with the object-names representing the high-and-low ends of the word frequency range according to the T-L word count. In one condition, a "noise" pattern served as the post-stimulus field, while in another condition, a plain white card served as the post-stimulus field. For the two conditions, he reported correlation coefficients between

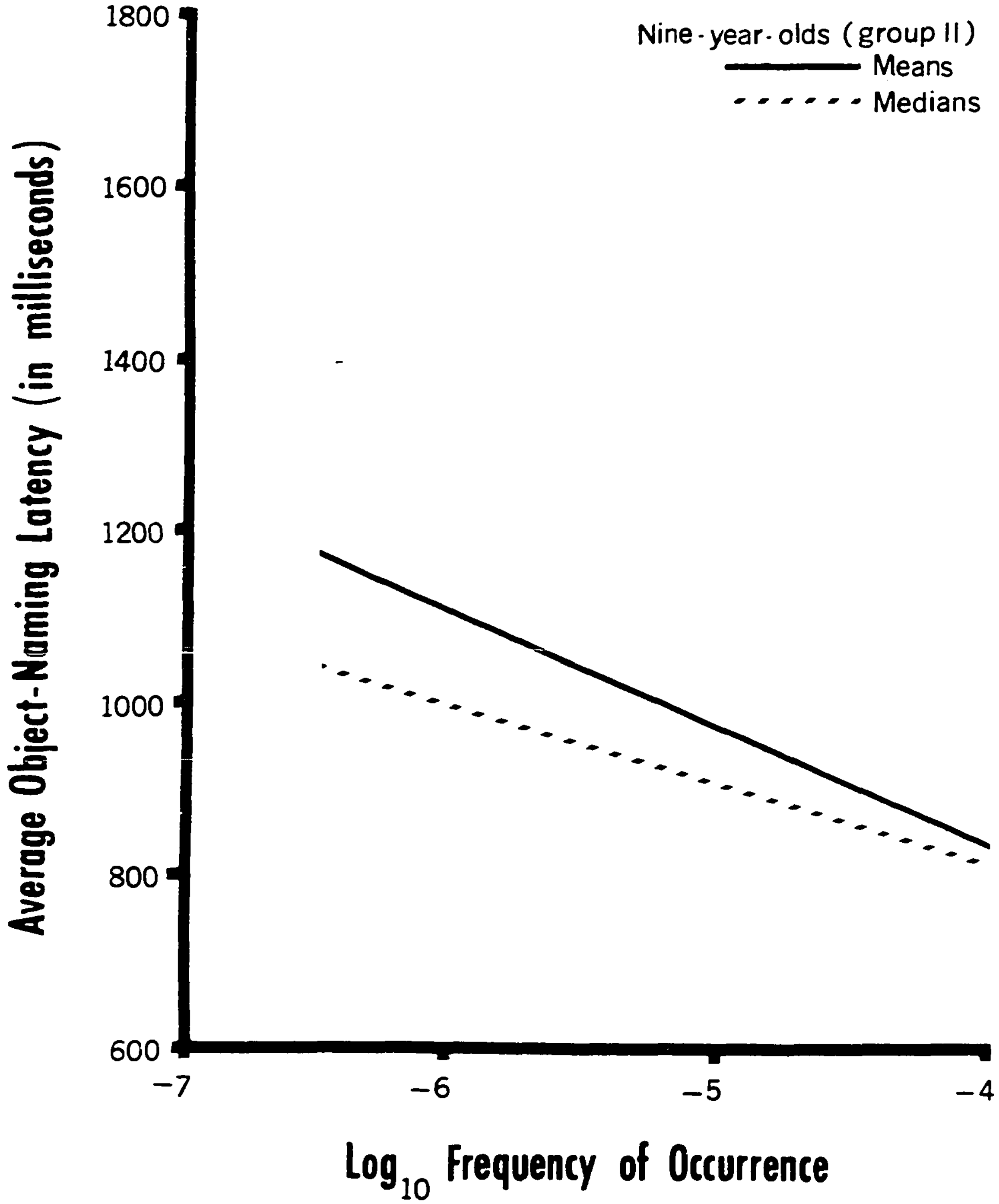

Figure 4—Lines of regression of mean and median ONLs on $\log_{10}$ frequency of occurrence for the second group of nine-year-old children.

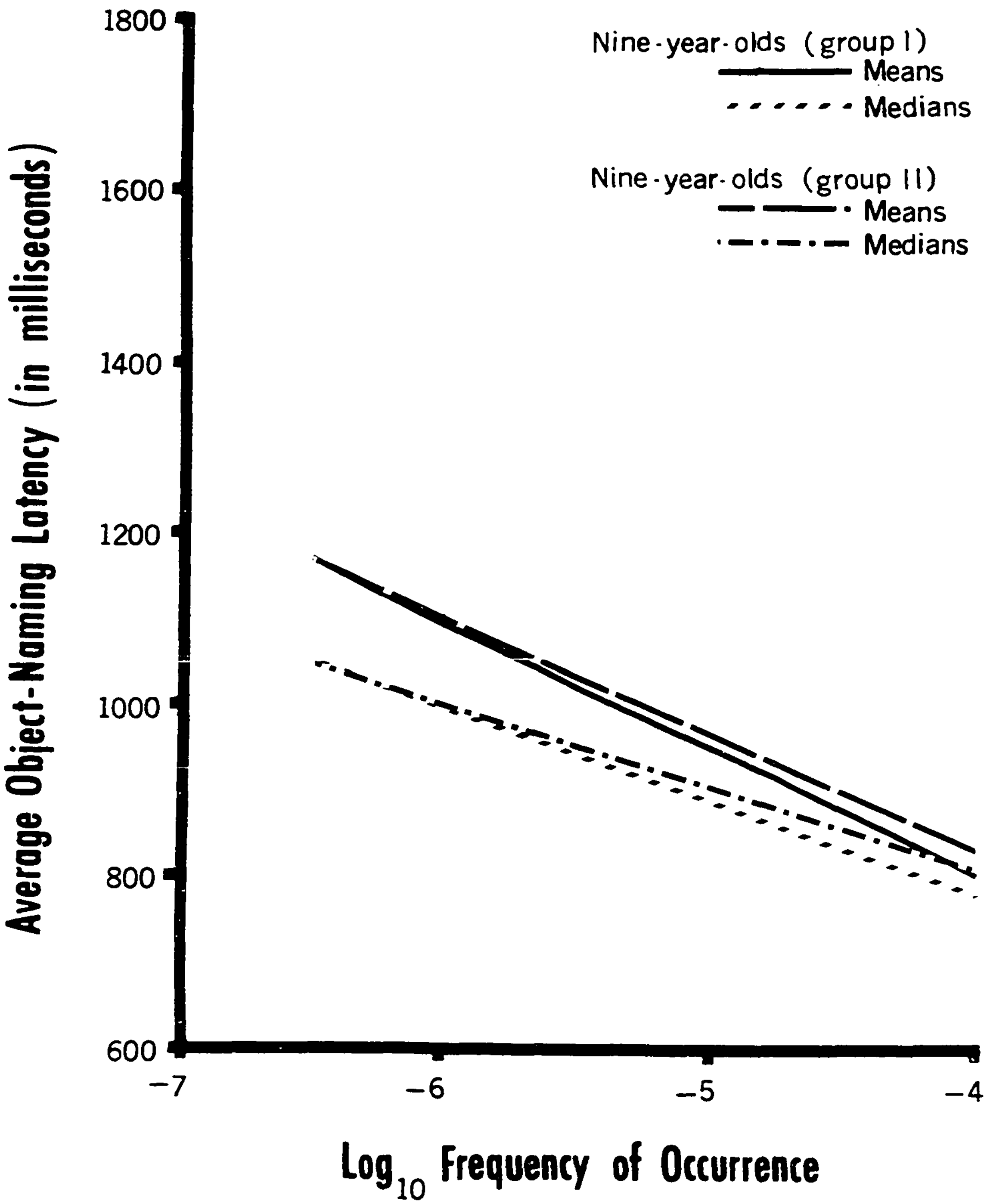

Figure 5--Comparison of lines of regression of mean and median ONLs on $\log_{10}$ frequency of occurrence for the first and second group of nine-year-old children.

VDTs and T-L log frequency of occurrence of $-.44$ ($p < .05$) and $-.53$ ($p < .05$), respectively.

In the original VDT task in the present study, in which a post-stimulus "noise" pattern was used to curtail the iconic memory of each stimulus presentation, the time taken to recognize pictured objects appeared negatively correlated with the logarithm of the frequency of occurrence of the names in the English language. None of the correlation coefficients, however, were significantly different from zero. This might be due, in part, to the number of stimulus-pictures used in the experimental task, the number being limited to twelve in an attempt to minimize subject fatigue. In addition the majority of the stimuli used fell nearer the high frequency end of the frequency range.

The application of the VDT task to the second group of nine-year-old male children involved the presentation of an increased number of stimulus-pictures with the names of the picture-stimuli more thoroughly representing both ends of the word frequency range. A plain white card served as the post-stimulus masking field rather than the "noise" pattern used previously. The results for this second group of nine-year-olds suggests a weaker relationship between average VDTs and $\log_{10}$ frequency of occurrence of words than was suggested by the original data. Iconic memory is less affected by a bright post-stimulus field than by a masking pattern in the post-stimulus field (<u>23</u>). Because the icon is present for a longer period of time under the former than it is under the latter condition, the subject would be given more time to identify objects under the former condition. Though the subject may not need the longer duration of the icon to identify high frequency items, it may be especially important to him when confronted with pictures whose object-names have a low frequency of occurrence. The persistence of the icon under conditions of a bright post-stimulus field may enable the subject to identify both high frequency and low frequency items in what would appear to be the same amount of time, that is, at approximately the same VDTs. Hence, in the VDT task presented to the second group of nine-year-olds, the use of a bright post-stimulus field may explain the presence of a weaker relationship for VDTs and word frequency of occurrence as compared to that obtained in the first VDT task in which a masking pattern was used in the post-stimulus field.

The failure to demonstrate a significant relationship between VDTs and $\log_{10}$ of the frequency of word occurrence in this study may have been the result of the influence of the pictured objects themselves upon VDTs. The relationship between the particular drawings of the objects and VDTs, in some instances, may have overshadowed the relationship between VDTs and word frequency. In the first VDT task, the mean and median VDTs for the words door and fire engine deviated greatly from the average VDTs for the other words. The experimenter's impression was that in these two instances, the subjects' VDTs were influenced more by some aspects of the pictures than by the frequency of occurrence of the names of the pictures. The presentation of the pictures of door and fire engine precipitated the utterance of several erroneous responses by all subjects before each picture was named correctly.

When viewed tachistoscopically for the shorter periods of exposure, most of the subjects initially said "box" or "square" or "windows" when presented the picture of door. This apparently was due in part to the artist's drawing of the object. The picture (see Appendix B) consisted of the outer frame of the door with three large panels positioned within the frame. To give the impression of depth to the panels, they were set slightly inward. Viewed at short durations it is understandable that the subjects saw a "window" or what appeared to be "boxes." Also, an object such as door does have a relatively common shape, namely, "squareness." This, in itself, may have created some degree of ambiguity for the subjects. Since the incorrect responses represented the names of objects which have the same shape, it is reasonable to assume that the subjects focused their attention on this one dominant feature to the exclusion of other smaller details. Conceiveably, until the smaller details, such as, "door-handle," were recognized, the subjects were unable to identify the picture.

The subjects experienced much the same difficulty with the picture of a fire engine. What distinguished the picture of the fire engine from that of some other vehicle, according to some of the subjects, were the ladders resting on top of the vehicle. Until the ladders or some other salient feature were recognized, responses such as "panel truck," "wagon," "pick-up truck" and even "dune buggy" were uttered. In this instance, it may be that the subjects quickly recognized the wheels in the drawing, as reflected by their responses, but failed to identify such important details as the hose attached to the side of the fire engine or the spot-light atop the roof of the cab.

That pictured objects, apart from the frequency of occurrence of the object-names, may affect the VDTs of male children is apparent also in the analysis of the data obtained in the second VDT task with a different group of nine-year-olds. The obtained VDTs for the words belt and hanger are incongruous, if, in fact, the frequency of occurrence of words is the primary determinant of VDT. The subjects experienced the same kind of difficulty with belt as with the pictures of door and fire engine in the previous VDT task. The picture of a belt brought repeated responses of "rope," "whip," and "snake" before the correct identification was made. These erroneous responses perhaps indicated that the children noticed only the"roundness"of the object and were unable to distinguish the critical feature of the stimulus, namely, the "belt buckle" until the picture was presented at longer durations. The mean VDT for the pictured object hanger was considerably shorter than other words with a similar frequency of occurrence. In this instance, the unambiguous shape of the object may provide the reason for its easy recognition. There seem to be few objects similar in shape to that of a hanger.

No less important in this discussion are the effects of "perceptual set." After identifying the dominant features of a particular stimulus presentation, the subjects may have been "set" to "see" the same features on repeated stimulus presentations to the point of excluding other important details. Neisser (23) suggests that a subject may maintain a particular set as though he were committed to it. Perceptual set may be an important factor in explaining the subjects' performance on such items as door, fire engine and belt.

Other words in the second VDT task, such as, scissors, hammer, and ladder prompted short VDTs from the subjects. These words are of infrequent occurrence according to the T-L word count and yet each was recognized very quickly by the second group of nine-year-olds. It may be that these words possess characteristic features which facilitate the objects' recognition, but another possibility is that for these words, the T-L word count is simply more inaccurate than for other words used. Since the T-L word count was published in 1944, one can assume that not all the T-L frequencies have remained stationary but have shifted position either in an upward or downward direction.

The data for the two age groups in the first VDT task suggested a significant trend towards lower VDTs with an increase in age. The results of the tachistoscopic studies reported by Fraisse (9, 11), in which he used female subjects ranging in age from six years to twenty-two years, indicated a systematic decrease in VDTs as age increased. In one experiment (11), he reported the sharpest decline in VDTs occurred between the ages of seven and nine years while in the other experiment (9), the diminution in VDTs was especially apparent between the ages of six and eight years.

It has been observed that an inverse linear relationship exists for adults (27, 39) and for children (2) between object-naming-latency and $\log_{10}$ frequency of occurrence of words in print in the English language. The correlations obtained in the present study for Trial I for the six- and nine-year-old children are not as high as the correlations reported by Oldfield and Wingfield (27) for adults but are more in line with the correlations reported by Boysen (2) for seven- to nine-year-old males. The correlations using mean ONLs in Trial I for the six-year-olds and nine-year-olds were - .69 and - .46, respectively, while the corresponding correlations using the medians were - .46 and - .58. Boysen (2), using normal children, the T-L word count and a series of thirty-four items representing a wide range of frequency of occurrence, obtained a correlation of - .35 for means and - .44 for medians. In contrast, Oldfield and Wingfield (27), using two groups of adult subjects, the T-L word count and a series of twenty-six items to cover a range in frequencies similar to that used in the present study, obtained correlations of - .89 and - .80. In a later study, Wingfield (39) presented thirteen stimulus-pictures to adult subjects and reported an even higher negative correlation, - .92. The correlation coefficients obtained with the second group of nine-year-olds in the present study are noticeably higher than those reported in Trial I or for those reported by Boysen. The obtained correlation coefficients for the means and for the medians for the second group of nine-year-olds are - .81 and - .72, respectively, and compare more favorably with those reported by Wingfield.

The weaker relationship between ONLs and frequency of occurrence of words for children than for adults may only be apparent. One of the most likely reasons for this is that the frequency norms may be more inadequate for children than for adults. Adult norms were used in the present study because it was speculated that children's vocabularies have probably changed more in the past twenty-five years than the adult vocabularies and because Boysen found no difference in the ONL-log frequency relationship regardless of which set of norms was used. Words listed in the T-L word count, furthermore, represent all uses of a word, not merely its use as a name. It would seem that more adequate norms are needed for both adults and children.

It should also be pointed out that the frequency with which a word is encountered in print does not necessarily represent the relative frequency with which the object or a picture of the object is encountered in everyday life. This one fact alone could play an important part in explaining the lower ONL-log frequency relationship for children compared to adults. Because of the vocabulary limitations of children, selection of low frequency words had to be limited to those the experimenter felt that the children would know, that is, to names of objects which the children may have frequently seen or for which pictures are commonly seen by children. Thus, while gyroscope could be used for adults (27), even though an adult may not have seen one or a picture of one for many years, it could not be used very well for children. The low frequency words used in this study, and in Boysen's study, with children are no doubt encountered more frequently in everyday life than are the low frequency words used in studies with adults. The high frequency words used in studies with adults and with children probably do not differ as much in the frequency with which they are encountered. The expected effect of the difference in low frequency words would be to reduce the magnitude of the correlation between ONL and log frequency.

One of the major difficulties encountered in the present study was finding enough low frequency object-names that a child would know. The fact that compound names, such as, fire engine, roller skate, and paintbrush were used in this study is indicative of the extent of the problem encountered by the experimenter. Compound names were less preferred than singular names as stimuli because of the possibility of obtaining responses which were only partially correct. Roller skate, for example, might generate the response "skate" and paintbrush might initiate the response "brush." In fact, several responses of this type were elicited and had to be discounted.

While the children's limited vocabularies affected word selection, the pictured objects as well had to be relatively simple in design, especially when compared to the pictured objects used in the Wingfield (39) and Oldfield and Wingfield (27) studies. In the present study, for example, such items as _screwdriver_, _toaster_, _hanger_, and _kangaroo_ (items which are near the lower end of the word frequency range) appear to be relatively simple in design. By comparison, such pictured objects as _microscope_, _windmill_, _octopus_, and _bagpipe_ (items which are also near the lower end of the word frequency range) used in the Wingfield and Oldfield studies are clearly more complex in design. It is reasonable to assume that a simple drawing is easier to recognize and name than is a complex one. The possibility that the relative simplicity of the pictured objects used in the present study contributed to the weaker relationship between ONLs and word frequency of occurrence for children than for adults should be considered.

Another factor which may have contributed to the weaker relationship between ONL and word frequency of occurrence for children than for adults is the greater variation among ONLs for children than for adults. This finding was previously reported by Boysen (_2_) and is corroborated in the present study. Noteworthy, however, is a trend toward less variation in response latencies with an increase in age as indicated by a comparison of standard deviations of ONLs for the six-year-olds and the nine-year-olds. It has been observed that variation in reaction time for simple motor behaviors tends to decrease with age from childhood to adulthood (_41_). The results of the present investigation suggests a similar reduction in variability when the motor behavior involves a complex verbal response such as the naming of an object.

Some of the stimulus-pictures used with the six-year-old subjects and the first group of nine-year-old subjects were not among the items presented to the second group of nine-year-olds. For the first groups, several of the object-names (_sock_, _sandwich_, _fork_, _shovel_, screwdriver, and scissors) began with a fricative consonant sound. The experimenter found that the detection of the onset of response of these words was often rather difficult. Consequently, these items were replaced by words whose initial sound consisted of a plosive or vowel sound.

The picture of doll was also excluded from the revised ONL task since the performance of the subjects in both trials indicated that the drawing of doll was obviously ambiguous. Though the picture of doll represented a word whose T-L frequency of occurrence is common, it obtained high mean and median ONLs from all subjects. Incorrect responses, such as, "girl" and "baby" made by several of the subjects indicated that those who responded appropriately had to sift through other alternatives before doing so.

Other erroneous responses made by six-year-olds in Trial I suggested that they experienced some ambiguity with the picture of screwdriver. In this instance, however, the ambiguity seemed attributable to the shape of the real object rather than to the artist's representation of the object. Responses such as "pencil" and "nail" were common. It may be that the straight-line configuration of the object prompted these alternative responses. A comparison of the data in Table 6 with the data provided by Oldfield and Wingfield (27) demonstrates a higher proportion of misnamed items for children than for adults. Boysen (2) also found a higher proportion of misnamed items for his seven- to nine-year-olds than was reported by Oldfield and Wingfield for adults.

Both groups of nine-year-olds obtained shorter ONLs than the six-year-olds for the same stimulus-pictures. This finding exists whether the comparison be with means or medians or for Trials I or II.

These results agree with the statement of Woodworth and Schlosberg (41) concerning simple motor performance, that throughout the developmental period up to about twenty-five years of age, reaction time decreases.

To study the effect practice might have on response latencies, Oldfield and Wingfield (27) repeated (up to three trials) the ONL task on five of their adult subjects. The presentation order of the picture-stimuli was changed in each case. The authors reported that considerable improvement in ONL took place between the first and second trials. The results of the present study show a similar relationship between practice and ONL for male children. In all cases, for means and medians, and for six- and nine-year-old subjects, the correlation coefficients obtained for Trial II are consistently lower than the correlation coefficients obtained for Trial I as reported in Table 6. An inspection of Figures 2 and 3 indicates that the slopes of the regression lines obtained for Trial II are less than the slopes of the regression lines obtained for Trial I for means and for medians and for six- and nine-year-old subjects. The observation that the greatest improvement in ONL between the first and second trials accompanies the least common names, for example, screwdriver, a decrease of 1003 milliseconds from the first to the second trial for the six-year-old subjects, and much less for the most common names is in general agreement with the findings of Oldfield and Wingfield. Logically, there is greater room for improvement on those names which have the greatest ONLs. Furthermore, if a subject is twice-presented a pictured object with a low frequency of occurrence and twice-presented a pictured object with a high frequency of occurrence, it follows that the object-name which will undergo the greatest change in frequency will be the low-frequency one rather than the high-frequency one.

The results of this study suggest that average MRLs are not related to the frequency of word occurrence for either age group, particularly when the medians are used in the analyses. This is consistent with Wingfield's finding for adult subjects(40). While Wingfield reported a trend toward longer MRLs for "No" responses than for "Yes" responses, in neither his study nor the present study were the differences between the latencies for "Yes" and "No" responses statistically different.

The significantly shorter MRLs for the nine-year-old than for the six-year-old children for both "Yes" and "No" responses clearly indicate that in a name-picture-matching task, response latencies are negatively correlated with chronological age, at least for the age range used. When Wingfield's results concerning MRLs and ONLs for adults are compared with the results for the children in the present study (see Figure 6), it appears that as the age of the subjects is decreased, the average value of the MRLs increases and approaches the average value of the ONLs. In fact, for the six-year-old subjects the average MRLs for the high frequency words were greater than the average ONLs for words with similar frequencies.

Wingfield stated that in the ONLs, there is a confounding of the time required for the perceptual identification of the object, which time he defines as the MRL, and the time required to search for the appropriate name for the object. This point of view seems to assume that since the subjects know beforehand what the two possible verbal responses are, the greatest proportion of the matching response time is spent in processing the visual information rather than in the selection and utterance of the appropriate response. It would appear also that the

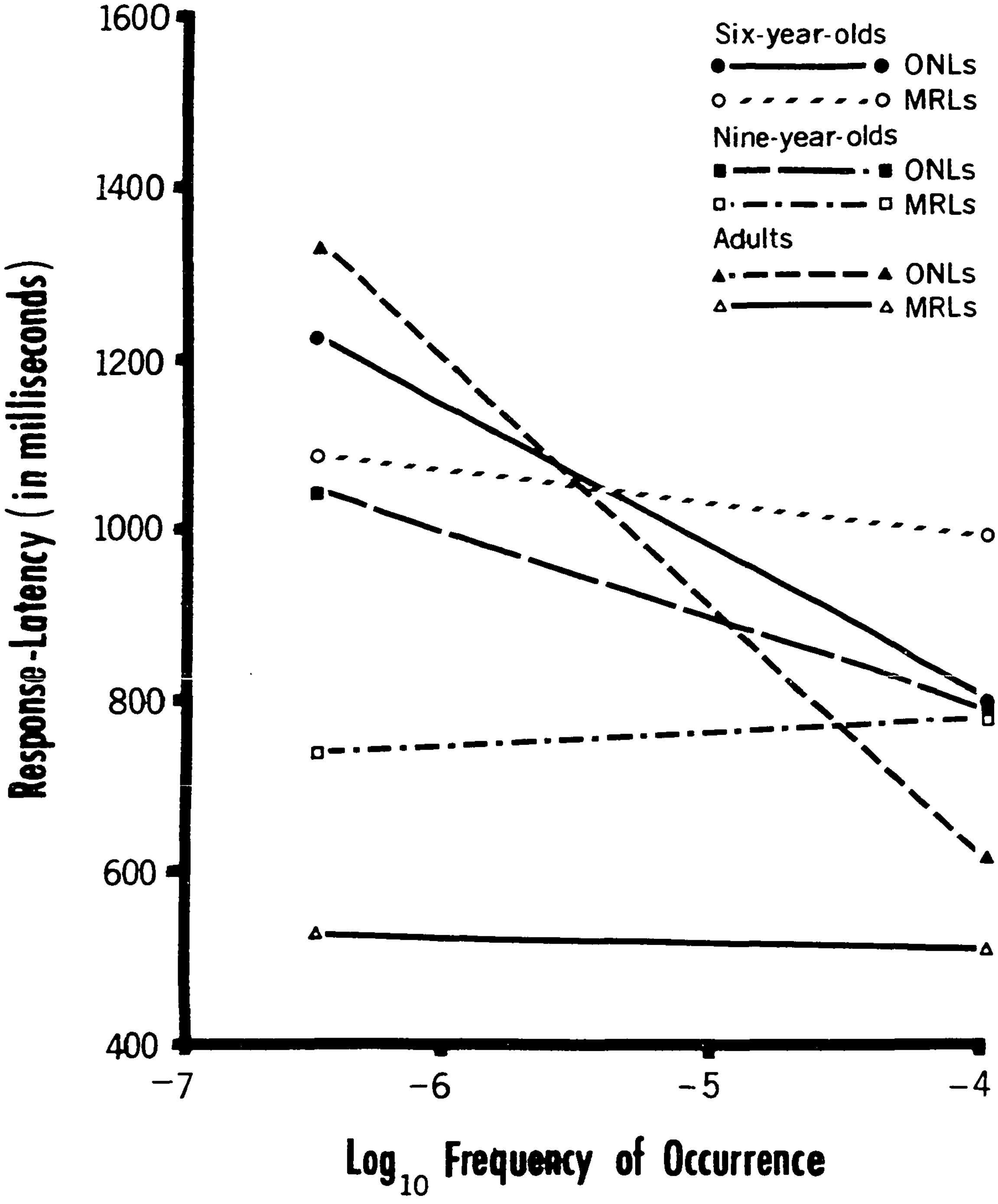

Figure 6--Comparison of lines of regression of median MRLs and ONLs (Trial I) on $\log_{10}$ frequency of occurrence for six- and nine-year-old children and lines of regression representing mean naming- and matching-latencies as a function of $\log_{10}$ frequency of occurrence for Wingfield's (40) adults.

assumption is made that the perceptual identification occurs before the name of the object is searched for and/or found. Wingfield (40) interpreted his results as follows:

> It seems likely that the stimulus-picture must have been fully identified before the match with the name could have been made. Since these matching-latencies were uniform across the range of object-frequencies sampled, it would follow that identification-time for common and rare objects is constant. This conclusion would attribute the major source of variance in naming-latencies for common and rare objects to differences in time to search for the objects' names once the perceptual identification was completed (p. 233).

Insofar as the results of the present study suggest that MRLs are not related to word frequency, the results support Wingfield's conclusion that the major source of variance in ONLs for common and rare words is not attributable to whatever is measured by the MRLs. The question arises, however, as to just what is measured by the MRL. If the search for the name of the pictured object is not a necessary part of the matching response, then, in the case of the six-year-olds, and probably also at least in part for the nine-year-olds, the search must be going on concurrently with the making of the matching responses. If the search for the appropriate name is necessary for the matching response to be made by children, and if variations in search time are responsible for the inverse relationship of ONLs with logarithm frequency, then MRLs should also be negatively correlated with logarithm frequency. Since this was not found to be the case, it must be concluded that the search for the names is not a necessary part of the matching response, unless one wishes to speculate that variations in search time are not responsible for the inverse relationship of ONL and log frequency. One then would have to speculate, perhaps, that the differences in ONL with word frequency are due to differences in utterance time. There is no evidence at this time that this is the case.

The longer MRLs for six-year-old children than for nine-year-old children and for children than for adults may be due to increased difficulty at the younger ages in making the decision between the "Yes" and "No" responses and/or in commencing to utter the response. While it may be true for adults that very little of the matching response time is spent in selecting and uttering the "Yes" or "No" response, it may not be true for children. Further study of the naming response in children would appear necessary before possible differences in the process in children and adults can be concluded with confidence.

CHAPTER V

SUMMARY

This study explored the effects of speaker age and frequency of occurrence of words on visual duration thresholds and verbal reaction times in children. Fifteen six-year-old and fifteen nine-year-old normal-speaking male children participated in the major experiment. Test stimuli consisting of simple-object line-drawn pictures were presented tachistoscopically to the children. The names of the pictured objects represented a wide range of frequency of occurrence in print in the English language. Different stimuli were used for each of three tasks. The following measurements were obtained for each child: (1) visual duration thresholds (the duration of exposure necessary for the subject to detect enough information to identify the stimulus-object), (2) name-picture-matching response latencies (the time needed to respond "Yes," or "No," if a pictured object were the one named prior to the presentation of the picture), and (3) object-naming latencies (the time needed to name a pictured object). The Visual Duration Threshold and Object-Naming Latency tasks were repeated with slight alterations with a second group of fifteen normal-speaking nine-year-old male children.

The main findings of this study were:

1. Average visual duration thresholds, obtained with post-

stimulus masking, for six-year-old and nine-year-old children, were negatively correlated with the $\log_{10}$ of the frequency of occurrence of the object-names in print. The correlations were not significantly different from zero, however. For the second group of nine-year-old subjects, average visual duration thresholds, obtained with a plain white post-stimulus field, were lower than for the first group but not related to the logarithm frequency of the words.

2. The average visual duration threshold for the six-year-old subjects was significantly greater than for the nine-year-old subjects.

3. The average name-picture-matching response latencies were relatively constant across varying frequencies for both age groups. The mean name-picture-matching latency for "Yes" responses was not significantly different from the mean latency for "No" responses for either age group.

4. Mean name-picture-matching latencies showed a significant decrease with increase in age of subjects.

5. Significant inverse relationships for mean object-naming latency and logarithm frequency of words were obtained.

6. Average object-naming latencies were significantly lower for nine-year-old than for six-year-old children.

7. Average object-naming latencies were considerably smaller in the second of two trials than in the first for both age groups.

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APPENDIX A

A Sample Randomized Schedule for the Stimulus Pictures
Used in All Conditions for Six-Year-Old
Subjects and for Both Groups of
Nine-Year-Old Subjects

A SAMPLE RANDOMIZED SCHEDULE FOR THE STIMULUS PICTURES USED IN ALL CONDITIONS FOR SIX YEAR OLD SUBJECTS AND FOR THE FIRST GROUP OF NINE-YEAR-OLD SUBJECTS

VDT PRACTICE CONDITION

1. saddle	5. frog
2. horse	6. cow
3. zebra	7. bus
4. umbrella	8. house

VDT EXPER. CONDITION

1. snake	7. deer
2. drum	8. clown
3. door	9. comb
4. roller-skate	10. pig
5. chair	11. nail
6. turtle	12. fire engine

MRL PRACTICE CONDITION

WORD	PICTURE
1. napkin	camera
2. bee	bee
3. screw	screw
4. dress	baby
5. crib	crib
6. glove	belt
7. fish	fish
8. motor-cycle	giraffe

MRL EXPERIMENTAL CONDITION

WORD	PICTURE	WORD	PICTURE
1. puppet	razor	7. closet	butter-fly
2. squirrel	squirrel	8. banana	banana
3. finger	finger	9. tiger	spoon
4. wagon	key	10. bird	shoe
5. feather	feather	11. paintbrush	paint-brush
6. toothbrush	toothbrush	12. watermelon	calendar

ONL PRACTICE CONDITION

1. lamb	5. cup
2. santa claus	6. dog
3. witch	7. broom
4. cat	8. flashlight

ONL EXPERIMENTAL CONDITION

1. bell	9. leaf	17. toaster
2. camel	10. screwdriver	18. hammer
3. candle	11. scissors	19. hanger
4. fork	12. kite	20. elephant
5. bed	13. ladder	21. carrot
6. sock	14. doll	22. kangaroo
7. rake	15. ring	23. pencil
8. cake	16. shovel	24. sandwich

A SAMPLE RANDOMIZED SCHEDULE FOR THE STIMULUS PICTURES USED IN ALL CONDITIONS FOR THE SECOND GROUP OF NINE-YEAR-OLD SUBJECTS

VDT PRACTICE CONDITION

1. zebra
2. witch
3. lamb
4. house
5. crib
6. comb
7. cow
8. fish

ONL PRACTICE CONDITION

1. dog
2. cat
3. broom
4. baby
5. frog
6. saddle
7. santa claus
8. bus

VDT EXPERIMENTAL CONDITION

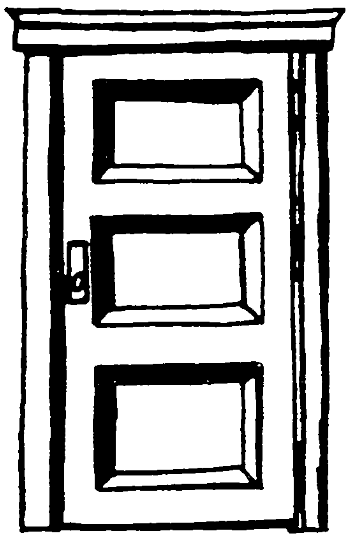
1. fire engine
2. magnet
3. ladder
4. hanger
5. turtle
6. flashlight
7. scissors
8. screwdriver
9. chair
10. shoe
11. nail
12. calendar
13. firecracker
14. pencil
15. hammer
16. shovel
17. cake
18. belt

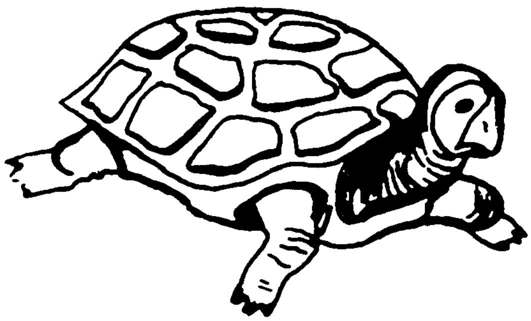
ONL EXPERIMENTAL CONDITION

1. bell
2. roller skate
3. drum
4. butterfly
5. toothbrush
6. bed
7. umbrella
8. toaster
9. paintbrush
10. kangaroo
11. carrot
12. ring
13. key
14. giraffe
15. razor
16. bathtub
17. clothespin
18. pig
19. elephant
20. kite

APPENDIX B

Experimental Picture Stimuli





APPENDIX C

Visual Duration Thresholds (in Milliseconds) for Six-Year-Old Subjects and for Both Groups of Nine-Year-Old Subjects

TABLE 9

VISUAL DURATION THRESHOLDS* FOR TWELVE STIMULUS PICTURES FOR FIFTEEN SIX-YEAR-OLD SUBJECTS

	Stimulus Picture	Subjects 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	chair	30	65	45	60	35	35	50	55	55	45	40	50	35	55	95
2.	door	120	90	130	260	40	40	55	120	170	75	220	150	85	110	410
3.	nail	40	65	45	80	55	50	40	70	45	55	55	50	60	70	130
4.	pig	45	55	40	90	35	35	65	45	60	55	85	50	55	70	150
5.	drum	35	90	30	70	40	35	45	50	45	45	76	60	50	70	80
6.	deer	35	70	35	120	30	40	50	85	45	170	170	60	50	70	170
7.	snake	40	55	40	75	35	60	60	70	45	80	65	50	65	110	95
8.	comb	95	80	35	80	90	60	55	110	60	55	65	85	55	240	120
9.	turtle	45	70	40	130	35	45	85	85	55	40	60	55	45	90	90
10.	clown	35	70	40	110	35	30	130	60	45	45	65	50	45	60	130
11.	fire engine	110	180	150	300	190	300	230	200	90	220	280	180	190	370	150
12.	roller skate	80	130	30	200	40	120	45	140	75	95	65	150	65	75	170

* Obtained with a post-stimulus masking pattern comprised of a nonsystematic array of lines and arcs.

TABLE 10

VISUAL DURATION THRESHOLDS FOR TWELVE STIMULUS PICTURES FOR THE FIRST GROUP OF FIFTEEN NINE-YEAR-OLD SUBJECTS

Stimulus Picture		Subjects														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	chair	35	60	55	55	50	45	70	55	40	40	35	45	45	50	55
2.	door	90	110	200	130	440	90	110	180	170	90	95	70	75	85	140
3.	nail	45	45	45	140	60	70	65	65	65	55	50	50	55	50	40
4.	pig	35	35	75	160	320	55	80	80	65	65	60	55	70	55	45
5.	drum	35	30	40	50	40	45	60	55	45	35	30	35	35	45	60
6.	deer	30	45	45	80	40	60	65	50	50	50	40	50	55	55	40
7.	snake	40	35	50	65	45	75	70	60	45	55	65	55	55	60	40
8.	comb	50	40	75	120	110	70	120	75	55	75	75	60	70	60	50
9.	turtle	40	35	40	50	55	50	140	70	50	70	50	65	70	50	55
10.	clown	40	40	55	60	45	45	75	45	55	55	25	40	55	50	35
11.	fire engine	110	210	120	150	240	150	140	190	210	310	85	130	90	80	270
12.	roller skate	40	40	95	160	55	65	150	100	80	80	65	80	70	80	150

* Obtained with a post-stimulus masking pattern comprised of a nonsystematic array of lines and arcs.

TABLE 11

VISUAL DURATION THRESHOLDS* FOR EIGHTEEN STIMULUS PICTURES FOR THE SECOND GROUP OF FIFTEEN NINE-YEAR-OLD SUBJECTS

	Stimulus Picture	Subjects 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	shoe	15	10	7	15	60	6	10	7	6	8	6	5	10	20	5
2.	chair	10	10	7	9	15	8	15	10	7	8	6	7	7	15	5
3.	cake	10	15	8	10	30	10	20	20	8	15	8	8	6	9	5
4.	nail	10	7	7	15	25	10	15	10	10	10	6	8	15	25	6
5.	belt	180	85	130	250	220	250	40	260	45	15	20	270	10	140	250
6.	pencil	10	20	15	20	20	10	15	10	8	15	7	8	15	30	7
7.	hammer	10	10	9	15	10	8	10	8	6	6	6	6	7	7	5
8.	ladder	5	10	5	10	20	5	15	10	8	8	5	6	8	9	7
9.	shovel	5	15	20	10	220	15	15	10	10	10	8	8	10	8	6
10.	turtle	15	10	10	170	210	10	25	20	10	10	6	15	8	20	7
11.	magnet	55	15	75	30	50	65	45	35	15	85	10	55	70	70	35
12.	scissors	10	10	7	10	15	15	15	8	9	6	6	8	6	9	6
13.	flashlight	75	100	10	300	20	10	220	15	15	15	8	20	9	10	50

TABLE 11--Continued.

	Stimulus Picture	Subjects 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
14.	calendar	15	20	9	15	55	10	30	10	25	10	5	8	30	30	9
15.	hanger	5	5	5	15	25	6	15	8	10	7	5	5	5	20	6
16.	fire engine	20	15	15	20	190	15	25	100	35	15	10	10	20	15	25
17.	firecracker	10	10	9	40	140	10	25	35	50	15	15	9	10	30	20
18.	screwdriver	15	10	7	10	35	8	30	10	15	85	10	210	55	30	9

* A plain white card served as the post-stimulus masking field.

APPENDIX D

Name-Picture-Matching Response Latencies (in Milliseconds) for Six-Year-Old Subjects and the First Group of Nine-Year-Old Subjects

TABLE 12

NAME-PICTURE-MATCHING RESPONSE LATENCIES FOR TWELVE STIMULUS-PAIRS FOR FIFTEEN SIX-YEAR-OLD SUBJECTS

				Subjects							
	Name	Picture	Res-ponse	1	2	3	4	5	6	7	8
1.	finger	finger	Yes			990	1430		2285		1165
	hat	finger	No	845	900			680		645	
2.	shoe	shoe	Yes	720	625			680		1025	
	bird	shoe	No			890	1165		1625		790
3.	key	key	Yes	870	695			a		1025	
	wagon	key	No			1115	1175		1135		730
4.	feather	feather	Yes			1580	1380		790		1155
	rabbit	feather	No	820	910			740		1105	
5.	spoon	spoon	Yes	580	510			500		870	
	tiger	spoon	No			1160	1040		1275		730
6.	squirrel	squirrel	Yes			830	1015		995		675
	envelope	squirrel	No	665	1360			1550		1665	
7.	butterfly	butterfly	Yes	865	625			560		1420	
	closet	butterfly	No			1115	1040		1290		705
8.	banana	banana	Yes			675	980		a		700
	pumpkin	banana	No	850	850			815		1440	
9.	razor	razor	Yes	730	1235			900		1515	
	puppet	razor	No			1705	a		3050		770
10.	toothbrush	toothbrush	Yes			810	845		745		1005
	bookcase	toothbrush	No	1090	1150			925		1080	
11.	calendar	calendar	Yes	740	650			915		1215	
	watermelon	calendar	No			980	930		1120		1025
12.	paintbrush	paintbrush	Yes			700	1095		2795		655
	sandbox	paintbrush	No	820	1005			845		990	

TABLE 12—Continued.

	Name	Picture	Response	Subjects 9	10	11	12	13	14	15
1.	finger	finger	Yes		1020	410	655		830	
	hat	finger	No	1475				a		1545
2.	shoe	shoe	Yes	1180				1140		a
	bird	shoe	No		780	a	890		885	
3.	key	key	Yes	1385				1080		a
	wagon	key	No		1190	790	800		830	
4.	feather	feather	Yes		1175	430	775		580	
	rabbit	feather	No	2310				1080		2025
5.	spoon	spoon	Yes	1555				1125		a
	tiger	spoon	No		1275	a	800		890	
6.	squirrel	squirrel	Yes		975	1520	1200		670	
	envelope	squirrel	No	1400				850		1720
7.	butterfly	butterfly	Yes	1375				1205		1035
	closet	butterfly	No		1400	970	785		795	
8.	banana	banana	Yes		1175	385	715		885	
	pumpkin	banana	No	1650				955		715
9.	razor	razor	Yes	2195				1085		3090
	puppet	razor	No		1790	1600	765		1025	
10.	toothbrush	toothbrush	Yes		980	715	780		1095	
	bookcase	toothbrush	No	1440				880		1415
11.	calendar	calendar	Yes	1350				1415		a
	watermelon	calendar	No		895	790	950		1020	
12.	paintbrush	paintbrush	Yes		1345	a	1035		860	
	sandbox	paintbrush	No	1360				1256		a

[a] Erroneous responses

TABLE 13

NAME-PICTURE-MATCHING RESPONSE LATENCIES FOR TWELVE STIMULUS-PAIRS FOR FIFTEEN NINE-YEAR-OLD SUBJECTS

				Subjects							
	Name	Picture	Res-ponse	1	2	3	4	5	6	7	8
1.	finger	finger	Yes			880	840	775			695
	hat	finger	No	920	980				450	625	
2.	shoe	shoe	Yes	685	975				365	510	
	bird	shoe	No			740	495	600			650
3.	key	key	Yes	795	795				340	565	
	wagon	key	No			900	990	715			615
4.	feather	feather	Yes			1000	525	760			615
	rabbit	feather	No	840	1190				730	685	
5.	spoon	spoon	Yes	840	770				380	585	
	tiger	spoon	No			790	765	740			410
6.	squirrel	squirrel	Yes			1010	990	800			670
	envelope	squirrel	No	800	790				405	665	
7.	butterfly	butterfly	Yes	810	680				a	895	
	closet	butterfly	No			725	850	920			570
8.	banana	banana	Yes			1220	825	975			600
	pumpkin	banana	No	925	965				495	580	
9.	razor	razor	Yes	710	995				a	880	
	puppet	razor	No			870	740	1490			655
10.	toothbrush	toothbrush	Yes			695	750	970			585
	bookcase	toothbrush	No	940	820				500	685	
11.	calendar	calendar	Yes	850	720				a	550	
	watermelon	calendar	No			940	635	900			715
12.	paintbrush	paintbrush	Yes			1035	770	775			425
	sandbox	paintbrush	No	855	745				595	625	

TABLE 13—Continued.

	Name	Picture	Response	9	10	11	12	13	14	15
				Subjects						
1.	finger	finger	Yes		725	790	410			455
	hat	finger	No	995				895	910	
2.	shoe	shoe	Yes	520				915	865	
	bird	shoe	No		695	620	495			650
3.	key	key	Yes	535				1280	945	
	wagon	key	No		755	705	605			860
4.	feather	feather	Yes		670	565	455			605
	rabbit	feather	No	515				935	865	
5.	spoon	spoon	Yes	375				720	910	
	tiger	spoon	No		675	475	655			675
6.	squirrel	squirrel	Yes		740	725	680			570
	envelope	squirrel	No	675				780	825	
7.	butterfly	butterfly	Yes	700				1260	905	
	closet	butterfly	No		775	610	595			900
8.	banana	banana	Yes		650	690	815			470
	pumpkin	banana	No	540				725	850	
9.	razor	razor	Yes	745				1115	880	
	puppet	razor	No		835	1175	870			810
10.	toothbrush	toothbrush	Yes		535	725	585			500
	bookcase	toothbrush	No	620				1335	855	
11.	calendar	calendar	Yes	440				2540	845	
	watermelon	calendar	No		900	610	705			730
12.	paintbrush	paintbrush	Yes		1095	555	475			500
	sandbox	paintbrush	No	1080				725	855	

[a] Erroneous responses

APPENDIX E

Object-Naming Latencies (in Milliseconds) for Six-Year-Old Subjects and Both Groups of Nine-Year-Old Subjects

TABLE 14

OBJECT-NAMING LATENCIES FOR TWENTY-FOUR ITEMS IN TRIALS I AND II FOR FIFTEEN SIX-YEAR-OLD SUBJECTS

	Stimulus Picture	Trial	Subjects 1	2	3	4	5	6	7	8
1.	bed	I	970	785	740	845	790	740	995	390
		II	775	670	755	2350	665	740	1160	720
2.	ring	I	700	880	690	865	750	715	840	715
		II	695	755	645	715	695	685	870	710
3.	bell	I	775	915	1070	790	680	1280	1280	740
		II	740	750	1065	1180	735	805	1205	855
4.	cake	I	745	860	680	730	a	935	1130	840
		II	795	720	700	635	710	1080	1510	775
5.	doll	I	1355	1330	905	1075	a	755	1170	1155
		II	930	a	900	1370	a	580	885	690
6.	candle	I	730	2240	915	1905	935	740	1205	1370
		II	870	1050	1000	1020	790	865	1570	690
7.	pencil	I	1220	720	825	b	700	700	770	a
		II	905	1110	1120	985	715	700	1000	765
8.	elephant	I	815	865	775	915	725	710	1025	905
		II	690	800	750	870	690	710	940	735
9.	hammer	I	720	620	650	1045	1155	715	840	1225
		II	690	915	790	1055	690	660	870	940
10.	fork	I	875	935	720	885	820	875	790	975
		II	950	1075	700	790	845	740	1300	735
11.	leaf	I	775	710	725	850	660	730	900	570
		II	615	b	735	950	660	835	980	720
12.	sandwich	I	795	705	1710	2215	820	680	1100	1180
		II	750	900	860	b	945	680	925	735
13.	ladder	I	770	1100	740	785	1380	675	1130	585
		II	720	1360	a	1300	765	790	1180	740
14.	camel	I	745	950	1555	6090	1560	735	830	a
		II	700	685	1170	2215	3290	1035	950	825

TABLE 14--Continued.

	Stimulus Picture	Trial	Subjects 1	2	3	4	5	6	7	8
15.	shovel	I	755	895	910	1340	870	920	820	910
		II	655	1550	925	1130	925	700	1015	660
16.	rake	I	725	1200	795	1125	730	680	750	1265
		II	745	1245	815	1335	770	850	975	400
17.	sock	I	835	585	710	865	940	680	800	870
		II	765	830	755	800	645	755	1105	710
18.	kite	I	740	610	665	1260	4865	730	1000	705
		II	650	785	695	865	895	660	975	655
19.	carrot	I	775	775	755	5045	790	815	815	850
		II	675	955	820	1910	825	840	850	665
20.	scissors	I	800	605	675	710	750	655	780	635
		II	795	710	665	1100	715	765	840	760
21.	kangaroo	I	1145	1730	1635	1230	1785	1040	1130	c
		II	735	850	815	a	c	770	745	1760
22.	hanger	I	830	1540	720	840	720	760	1680	910
		II	a	755	845	875	695	575	875	640
23.	toaster	I	1010	1460	1060	1205	980	840	1185	1520
		II	1040	1110	850	1360	745	825	1210	790
24.	screwdriver	I	1245	2455	3227	a	a	a	5235	a
		II	1410	1565	1050	1620	a	a	775	a

TABLE 14—Continued.

Stimulus Picture		Trial	Subjects 9	10	11	12	13	14	15
1.	bed	I	990	870	2075	840	675	765	1905
		II	815	850	805	640	595	650	1220
2.	ring	I	1020	915	965	890	715	775	1150
		II	805	660	790	740	745	680	1135
3.	bell	I	885	815	915	840	615	730	a
		II	970	1665	1415	685	580	700	a
4.	cake	I	740	830	795	675	470	1345	1390
		II	715	a	1180	625	665	750	1500
5.	doll	I	825	1630	875	1240	675	765	a
		II	1015	865	a	745	735	750	a
6.	candle	I	1200	825	1100	800	860	3465	1700
		II	730	960	1215	690	620	720	1380
7.	pencil	I	1225	a	970	810	690	660	2085
		II	1090	770	1580	1055	650	1085	2700
8.	elephant	I	785	3150	875	650	765	750	1625
		II	655	1610	890	665	710	915	1605
9.	hammer	I	945	1130	1020	1060	535	730	1555
		II	895	675	880	665	585	580	1040
10.	fork	I	1260	1195	660	1005	695	535	1735
		II	1440	1020	b	700	715	675	2020
11.	leaf	I	910	855	1335	625	425	770	a
		II	845	1230	975	740	660	735	1270
12.	sandwich	I	1660	860	1100	685	b	910	a
		II	950	990	945	685	715	745	2930
13.	ladder	I	905	950	655	1125	910	875	1165
		II	1015	1090	1300	795	770	735	a
14.	camel	I	765	1430	1030	855	690	705	3525
		II	1265	c	3705	715	635	705	1540
15.	shovel	I	845	970	1385	855	1760	1100	1045
		II	920	1700	930	640	745	785	3330

TABLE 14--Continued.

	Stimulus Picture	Trial	Subjects 9	10	11	12	13	14	15
16.	rake	I	780	2720	1420	715	650	795	1525
		II	1390	1470	1830	665	725	640	1515
17.	sock	I	730	760	675	775	775	580	1010
		II	1055	690	675	755	670	525	1455
18.	kite	I	680	785	1260	a	700	760	1200
		II	695	1040	1655	670	695	790	1890
19.	carrot	I	1125	915	6270	780	610	925	1375
		II	970	755	2430	520	680	650	1010
20.	scissors	I	655	2650	740	610	535	630	1420
		II	780	925	b	685	610	480	910
21.	kangaroo	I	1095	3235	1275	505	680	870	a
		II	1415	1400	1610	1020	700	725	a
22.	hanger	I	1175	c	1585	915	690	750	5685
		II	1395	1510	860	820	740	785	985
23.	toaster	I	1145	1445	1860	2120	720	810	c
		II	875	1115	2005	a	775	695	a
24.	screwdriver	I	a	2550	a	1465	1705	1450	1640
		II	1730	1250	a	1080	1380	1190	1550

[a] Erroneous response

[b] Response discounted because the location of the onset of response was not distinguishable

[c] Subject failed to respond

TABLE 15

OBJECT-NAMING LATENCIES FOR TWENTY-FOUR ITEMS IN
TRIALS I AND II FOR THE FIRST GROUP OF
FIFTEEN NINE-YEAR-OLD SUBJECTS

Stimulus Picture	Trial	Subjects 1	2	3	4	5	6	7	8
1. bed	I	1010	855	865	1540	565	745	685	715
	II	730	845	880	855	625	730	725	830
2. ring	I	825	900	825	725	750	580	775	630
	II	730	940	690	850	735	645	725	585
3. bell	I	715	750	860	710	800	735	715	730
	II	720	755	755	595	780	530	860	715
4. cake	I	710	780	930	810	705	390	705	1045
	II	735	755	640	880	755	580	675	525
5. doll	I	920	1445	1270	a	1080	885	1100	1360
	II	785	1015	640	a	1080	620	1050	925
6. candle	I	1130	1100	1260	1635	930	1120	910	1085
	II	895	1160	660	1425	1230	510	685	725
7. pencil	I	735	770	970	730	985	645	1180	905
	II	870	880	790	765	1020	540	725	675
8. elephant	I	630	990	1365	965	975	570	780	1385
	II	785	750	845	1170	830	840	930	1250
9. hammer	I	675	635	660	570	805	b	635	715
	II	710	650	595	700	b	680	610	760
10. fork	I	935	740	750	1540	800	720	780	800
	II	935	715	635	900	875	970	1190	665
11. leaf	I	830	685	665	565	770	325	750	675
	II	920	765	660	375	785	730	675	545
12. sandwich	I	a	940	1280	a	500	605	1160	1360
	II	620	825	685	690	750	600	960	685
13. ladder	I	930	890	1015	910	b	795	1350	930
	II	810	985	1070	725	740	530	845	645
14. camel	I	2510	920	1020	1980	2585	825	c	3205
	II	b	1350	790	3655	1020	575	990	a

TABLE 15--Continued.

	Stimulus Picture	Trial	Subjects 1	2	3	4	5	6	7	8
15.	shovel	I	700	790	1155	1080	2075	885	850	1450
		II	800	775	1060	910	1360	545	875	810
16.	rake	I	810	1190	1955	1240	1860	825	1090	1105
		II	795	780	790	850	1570	720	1065	690
17.	sock	I	1095	635	710	765	720	745	710	645
		II	680	650	615	900	830	990	650	640
18.	kite	I	810	885	795	680	970	795	695	635
		II	590	680	825	760	740	550	670	630
19.	carrot	I	750	850	840	890	970	720	470	1205
		II	710	900	755	770	900	720	805	925
20.	scissors	I	610	700	770	670	b	565	760	595
		II	660	795	660	650	795	625	625	550
21.	kangaroo	I	890	3175	1320	1185	1140	2600	950	1610
		II	710	900	700	c	b	2440	1110	850
22.	hanger	I	710	940	1650	a	660	640	1040	935
		II	650	1025	750	a	975	700	a	975
23.	toaster	I	960	1525	2450	1110	2025	795	1050	960
		II	780	825	840	980	4650	1010	990	760
24.	screwdriver	I	990	990	1355	a	1410	a	1315	1140
		II	880	b	975	a	1180	1035	935	865

TABLE 15—Continued.

	Stimulus Picture	Trial	Subjects 9	10	11	12	13	14	15
1.	bed	I	995	695	765	860	640	895	905
		II	670	650	780	560	680	840	570
2.	ring	I	695	670	850	810	750	845	820
		II	610	780	1060	705	735	775	635
3.	bell	I	785	645	650	685	910	765	620
		II	595	605	640	605	735	745	620
4.	cake	I	640	670	680	660	750	1080	450
		II	545	650	700	715	780	800	575
5.	doll	I	a	1205	a	1085	825	1080	845
		II	a	930	1330	670	680	3435	1090
6.	candle	I	915	690	870	935	720	960	780
		II	575	690	785	630	740	1075	675
7.	pencil	I	1070	785	690	725	660	780	780
		II	725	655	675	705	775	800	715
8.	elephant	I	1520	755	350	640	535	720	645
		II	695	1680	815	695	510	735	615
9.	hammer	I	570	490	a	700	445	520	700
		II	600	760	770	615	610	810	645
10.	fork	I	580	940	1070	610	690	830	1100
		II	740	695	875	820	715	965	820
11.	leaf	I	590	650	800	670	690	765	660
		II	610	795	a	655	790	840	590
12.	sandwich	I	635	a	760	1130	725	1090	325
		II	540	820	655	895	520	810	985
13.	ladder	I	755	840	735	730	730	1125	840
		II	565	980	825	730	825	1105	725
14.	camel	I	840	970	2465	1185	720	1310	300
		II	780	875	840	640	475	990	725
15.	shovel	I	820	790	600	710	890	1370	1140
		II	595	695	465	650	1320	1060	655

TABLE 15--Continued.

	Stimulus Picture	Trial	Subjects 9	10	11	12	13	14	15
16.	rake	I	725	895	840	1000	745	980	845
		II	605	775	a	685	415	2385	815
17.	sock	I	580	765	705	755	650	650	660
		II	600	730	630	555	620	630	635
18.	kite	I	675	740	880	725	825	765	735
		II	775	615	745	625	825	765	680
19.	carrot	I	1100	775	1100	720	850	860	725
		II	745	730	840	570	665	905	675
20.	scissors	I	685	630	685	620	650	695	370
		II	505	620	510	615	460	1095	545
21.	kangaroo	I	1220	720	b	770	745	810	695
		II	1380	1570	755	690	465	875	665
22.	hanger	I	1455	1375	840	690	710	1135	955
		II	860	790	885	645	495	710	705
23.	toaster	I	910	950	815	830	710	1160	840
		II	610	785	790	650	855	850	835
24.	screwdriver	I	995	1125	1160	860	2235	1100	675
		II	920	780	1445	925	1335	1275	665

[a] Erroneous response

[b] Response discounted because the location of the onset of response was not distinguishable

[c] Subject failed to respond

TABLE 16

OBJECT-NAMING LATENCIES FOR TWENTY ITEMS FOR THE SECOND GROUP OF FIFTEEN NINE-YEAR-OLD SUBJECTS

	Stimulus Picture	Subjects 1	2	3	4	5	6	7	8
1.	bed	750	805	720	755	695	670	680	795
2.	ring	925	845	745	805	1140	1125	830	850
3.	key	760	730	785	615	1085	1140	845	1165
4.	bell	730	685	700	1075	880	745	770	825
5.	pig	690	960	680	1230	1055	715	785	830
6.	drum	675	1900	1965	880	965	775	840	1035
7.	elephant	550	1000	1215	650	970	1245	740	800
8.	butterfly	755	625	995	820	1135	685	735	810
9.	umbrella	975	1060	920	850	1550	775	920	960
10.	kite	980	1185	870	900	700	740	860	825
11.	carrot	820	1705	910	725	1195	805	795	960
12.	razor*	a	b	1750	a	a	a	b	1645
13.	toothbrush	805	1205	710	1045	1330	1250	1370	975
14.	giraffe	800	a	1120	a	1795	700	800	645
15.	kangaroo	720	730	b	1120	1165	1180	865	895
16.	toaster	1520	b	1035	930	1240	b	1150	955
17.	bathtub	400	940	965	1590	800	485	1320	1465
18.	clothespin*	1415	b	b	1270	1380	2880	2710	2075
19.	roller skate*	a	945	785	1025	935	1525	1105	a
20.	paintbrush	1115	b	1095	895	a	1015	1300	1505

TABLE 16--Continued.

	Stimulus Picture	Subjects 9	10	11	12	13	14	15
1.	bed	735	725	850	790	805	890	1435
2.	ring	1005	1000	790	1015	945	950	1075
3.	key	740	765	1040	820	960	710	830
4.	bell	800	985	770	740	830	740	790
5.	pig	700	680	730	980	760	1050	1030
6.	drum	845	790	775	695	780	655	850
7.	elephant	870	835	660	885	840	740	765
8.	butterfly	775	920	710	785	795	965	840
9.	umbrella	820	830	1395	945	770	1780	810
10.	kite	700	680	560	860	1005	1020	660
11.	carrot	935	1915	805	950	710	1015	980
12.	razor*	b	a	2100	a	1260	1550	a
13.	toothbrush	795	a	950	945	1050	1120	1015
14.	giraffe	765	1235	a	830	2825	a	1085
15.	kangaroo	1125	770	1095	885	800	890	810
16.	toaster	960	a	870	2860	1085	1015	1150
17.	bathtub	1165	a	925	865	895	990	1390
18.	clothespin*	2035	a	1745	b	2250	1935	a
19.	roller skate*	930	a	a	a	665	a	a
20.	paintbrush	1085	1545	a	1300	a	1185	960

* Not included in the analyses of the data

[a] Misnamed words

[b] Subject failed to respond