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A developmental study of the role of category information in word identification

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A Developmental Study of the Role of Category Information in Word Identification

by

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APPROVAL PAGE

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The studies reported here were generated out of the hypothesis that category information about a word is initially activated prior to identification of the word. Three experiments investigated the role of category information in word identification by 3rd graders, 6th graders, and adults using a serial two-choice classification paradigm. Semantic properties of lists of words and target search instructions were varied to assess the facilitation of the categorical homogeneity of the nontarget words on target word identification. Experiments 1 and 2 required subjects to identify words as exemplars or not of a predefined category as soon as possible. The target words were in lists of categorically homogeneous and categorically heterogeneous nontarget words. Nontarget categories were different from target categories. Experiment 1 had a response stimulus interval (RSI) of 300 msec. A category contrast effect (nonassociative priming) was obtained as the categorically homogeneous nontarget word lists facilitated the identification target words relative to the categorically heterogeneous nontarget lists at all ages. Experiment 2 had a RSI of 2000 msec. A category contrast effect did not occur at any age. The temporal relation between the word trials thus was demonstrated to be important in order for the categorically homogeneous

nontarget words to influence the identification of the target words. Nonassociative priming of category information was assumed to be influential in target word identification during a short processing interval that was not influential during a longer processing interval.

In Experiment 3, subjects identified words as to whether or not they had a predefined perceptual attribute (e.g., wings) as quickly as possible. The purpose was to determine whether perceptual attributes would permit the demonstration of contrast effects at a 300 msec RSI. Contrast effects were demonstrated with perceptual attribute information at all ages. Nonassociative priming, therefore, was assumed to involve imaginal representations, as well as verbal, representations in memory.

Taken together, the present findings indicated that category contrast effects and contrast effects are functions of the priming procedure. Priming, however, does not preclude word identification and cannot be considered as evidence that information about a word (category or perceptual attribute) is activated prior to identification of the word.

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Chapter 1

Introduction

The general goal of this study was to investigate the role of category information in word recognition. More specifically, the investigations reported here attempted to gain understanding of the developmental patterns of and the cognitive activity involved in category contrast effects, a nonassociative priming process. The hypothesis that generated the inquiry was that category information about a word is initially activated from the orthography of the word rather than from the meaning of the word. If that is the case, category information would be involved in the process of coming to recognize a printed word. In order to test this hypothesis, a serial, two-choice task at different response-stimulus intervals, was used to assess the availability of categorical information at various stages of processing the identification of a word.

Category Knowledge in Children

Our current understanding of the development and use of categorical knowledge in young children leaves many questions unanswered. Perhaps the most obvious of these questions concerns the repeated indications that young children have knowledge about categories that is not apparent or demonstrated in many specific tasks. For example, Ragain (1980) investigated the relation between concept usage and the organization of semantic memory in 7-, 11-, 15-, and 18-year-olds. She initially asked subjects how item A was like item B and found that nominal, categorical responses (e.g., animal) increased and idiosyncratic and property responses (e.g., things that have legs) decreased with age. Ragain then asked her subjects to do a picture naming task in which each picture was preceded by one of four types of auditory primes: category, identity, property, or neutral. She found that the category prime reduced picture naming times to the same extent at all ages. Ragain concluded that the nominal category attribute was a salient aspect of concept knowledge across development, even though the use of that knowledge may not be apparent in some tasks devised to demonstrate children's conceptual competence.

McCauley, Weil, and Sperber (1976) investigated the development of knowledge of categories through the use of a semantic priming task. Kindergartners and second graders were shown pairs of pictures, one at a time, and asked to name each picture as quickly as possible. The second picture in the pair was considered the target picture and the first picture in the pair was the prime. The effects on target naming time of (prime-target) category relatedness varied with subjects' ages. The second graders, but not the kindergartners, named the pictures high in category relatedness (e.g., dog-lion) significantly faster than those low in category relatedness (e.g., dog-bone). McCauley et al. (1976) concluded that by age 8, the encoding of categorical knowledge is automatic.

Marschark, Azmitia, and Paivio (1985) investigated associative priming in symbolic comparisons by second and sixth graders. The children were asked to choose the larger or smaller (in real life) of two animals or objects presented to them in equal-sized pictures. In the younger samples, priming effects were larger in homogeneous than heterogeneous category lists. That finding indicated that second grade and sixth grade children spontaneously used their categorical knowledge to affect the activation of associative size information, with the size of the priming effect being larger for the younger children. Marschark et al. (1985), like Ragain (1980) and McCauley et al. (1976), concluded that nominal category attributes seem to be salient aspects of conceptual knowledge in young children by the ages of 7 or 8 years.

Even though there long have been such indications of categorical representations in young children, the functional use of categorical knowledge has been less apparent and more vulnerable to the specific task at hand. Research concerning the organization of children's memory seems, in part, to address that issue. In memory organization research, children typically have been asked to study sets of words or pictures, defined by the experimenter as categorically or taxonomically related, and then asked to recall the sets a short time later. In general, organizational clustering has been found to increase with age, but there have been inconsistent findings. Rossi and Rossi (1965) found that 2- to 5-year-olds could cluster or organize taxonomically at recall. Lange (1973), in contrast, did not find evidence of organization at recall until the late elementary or early high school years. Lange (1978) suggested that the use of taxonomic clustering at recall depends on the nature of the to-be-recalled materials. He found that the stronger the relation between the words, the younger the age at which children showed clustering in free recall. For example, preschoolers were likely to cluster at free recall when the words were strong natural associates (e.g., cat-dog). On the other hand if the words were not associatively related (e.g., lion-canary) children were not likely to cluster (e.g., by category) at free recall until the early adolescent years.

Bjorklund, Ornstein, and Haig (1977) and Liberty and Ornstein (1973) demonstrated that third graders and fourth graders, respectively, did not spontaneously sort pictures of words in a categorically or taxonomically organized manner in a free sort task. Both studies, however, demonstrated that if children were told ahead of time to "put things together that belonged together" they could do so. These findings indicated knowledge of the semantic relations but difficulty in strategically using that knowledge. The use of categorical information in the organization and recall tasks explored by Bjorklund et al. (1977), Lange (1978), and Liberty and Ornstein (1973), thus tends to lag behind the spontaneous arousal of nominal category information in other tasks (McCauley et al., 1976; Ragain, 1980).

The above findings raise questions about the accessibility and availability of categorical representations in young children. Much of the research exploring the accessibility and availability of categorical representations has focused on the strategic use of categorical knowledge (Bjorklund & Zeman, 1984; Lange, 1978), the spontaneous use of nominal categorical information (Marschark et al., 1985), or other developmental aspects of categorical knowledge such as class inclusion (Inhelder & Piaget, 1964) or basic level sorting (Rosch, Mervis, Gay, Boyes-Brame, & Johnson, 1976). Research in each of these areas of study has indicated that at times categorical knowledge is demonstrated to be salient to children but not necessarily used in the task at hand. This repeated finding suggests that categorical knowledge is available in the processing of semantic information but may not be used consciously after arousal. Thus it seems plausible that there are different stages of activation of categorical representations in memory that would account for the demonstration, or lack thereof, of categorical knowledge. Semantic categorical representations that can be accessed early in processing information may not be available at later periods of processing the same information.

Category Contrast Effects in Adults

Fletcher (1983) gave some insight into the above issue in a series of experiments on word identification by adults. He proposed that category information was available to and influential in processing before explicit identification of the word occurs, even though it takes longer to explicitly categorize a word than to identify a word. Fletcher (1983) reasoned that if category information were available to the processing system prior to explicit word identification, one way the category processing could be evidenced was through the demonstration of category contrast effects. Category contrast effects were defined by Fletcher (1983) as the facilitation in target word identification in a list of categorically homogeneous nontarget words relative to a list of categorically heterogeneous nontarget words. Fletcher (1983) assumed that successive presentations of categorically homogeneous words, unrelated to the category of the target word ("contrast" condition) would create the build up of categorical information about the nontarget words. That process would, in turn, make the homogeneous nontarget words contrast highly with the target words and facilitate recognition of the target words relative to the target words in the categorically heterogeneous list. In the heterogeneous list of nontarget words ("random" condition) there would be no consistent categorical information from the nontarget words to increase in strength and contrast with the target word.

In order to investigate category contrast effects, Fletcher (1983) used a serial, two-choice task with different response stimulus intervals (RSI). Fletcher (1983) found that the temporal relation between the response to each stimulus and presentation of the next one to be a significant factor in the demonstration of category contrast effects. Facilitation of target word identification in the contrast condition, relative to the random condition, was demonstrated at a rapid (300 msec) but not a slow (2000 msec) RSI. Fletcher (1983) concluded that categorical information that was available and influential in early periods of processing a target word was not available and influential in later periods of processing a target word. Those findings led Fletcher (1983) to propose that the initial activation of category information in word recognition proceeds from very early perceptual stages (the orthography) of the word rather than the meaning of the word. Thus, category information would be influential in processing a word prior to explicit recognition of the word.

Repetition Effects and Response Stimulus Intervals

Before further consideration of the role of category information in word identification, several related issues must be elucidated. Serial, two-choice task studies historically have been used to investigate the influence of early perceptual processing on visual discrimination in adults. Bertleson (1961) found that if successive stimuli were physically identical, the response latency to the second stimulus was faster than if the two stimuli were different (i.e., repetition effects). Rabbitt (1968) found that repetition effects were demonstrated when prior stimuli had common features (e.g., M,m) with as well as physical likeness (e.g.,M,M) of the current stimulus. (1)

The response-stimulus interval has been found to be a critical factor in repetition effects in visual discrimination tasks (Bertleson, 1961; Rabbitt, Cummings & Vyas, 1977). Rabbitt, Jordon, and Vyas (1978) suggested that the perceptual identification of stimuli in a serial two-choice task could best be understood by assuming that subjects initiate a perceptual analysis of each successive signal by comparing it against some mnemonic representation of its immediate predecessor. The efficiency with which that could be done depends on the RSI: the shorter the RSI, the stronger the memory trace of the preceding stimulus and the greater the chances of its facilitating the processing and responding to the current stimulus.

Serial choice studies have consistently demonstrated that at rapid RSI's (50-300 msec) highly significant repetition effects do occur (Ellis & Gotts, 1977; Hale, 1967; Krueger & Schapiro, 1981; Rabbitt, 1969). RSI's of 2000 msec, however, consistently have lead to no significant repetition effects on visual discrimination tasks (Bertleson, 1961; Fletcher & Rabbitt, 1978; Hale, 1967; Krueger & Schapiro, 1981; Rabbitt, 1969). There have been exceptions to these findings at somewhat shorter time intervals, however, in that repetition effects have been found to occur at a response-stimulus interval as long as 1200 msec in a visual discrimination task. For instance, Fletcher (1981) had subjects respond "same" or "different" to presentations of letters that were superimposed with dot patterns of varying complexity. RSI's ranged from 300 msec to 1200 msec. There were strong repetition effects demonstrated at 300 msec, and even some demonstration of repetition effects at the 1200 msec interval. As will be reported later, however, letters make up a distinctive category, and semantic categories have repeatedly given indication of not having the same time limits as visual discrimination tasks for repetition effects to be demonstrated.

Two different types of stimulus identification have been observed and discussed in relation to the notion of repetition effects. One, called wholistic identification, apparently occurs when the successive stimulus presentations were identical in nature. In that case, subjects are assumed to recognize a match between the mnemonic representation of the physical characteristics of the preceding stimulus and the initial perceptual input from the current stimulus. Stimuli, in that case, are found to be processed without further analysis (Bertleson, 1963; Posner & Mitchell, 1967). The chief characteristic of wholistic processing is the assumed dependency on the persistence of a memory trace from the first stimulus for the duration of the RSI.

Another type of stimulus identification has been called analytic and occurs when the preceding stimulus and the current stimulus are not identical (Fletcher, 1981). In that case, the current stimulus must be analytically processed to identify whether or not there are shared characteristics or features. Once a unifying characteristic is found, response selection is facilitated at short response-stimulus intervals. The analytical process has been considered to be a more selective and dynamic process than the wholistic process (Fletcher, 1981; Fletcher & Rabbitt, 1978).

Bertleson (1965) and Rabbitt (1968) found that after a moderate amount of practice, subjects' perceptual identification strategies began to shift from wholistic to analytical processing. Rabbitt (1968), for example, found that early in a task, a stimulus related to the preceding stimulus that required analytical processing took almost as long a response time as totally unrelated stimuli. Over the course of the task, however, analytical processing became almost as fast as wholistic processing of the information. Fletcher and Rabbitt (1978) found that subjects in a serial choice task learned to respond only to changes or constancy between preceding and current stimulus events. They concluded that by late in practice, each stimulus was not identified as a unitary event but that response selection was increasingly based on analysis of the preceding response. Fletcher (1981) carried the investigation of strategic processing further and found that by late in practice, at short RSI's, successive stimuli were compared only for certain selected features. Stimuli that shared features, however, were consistently responded to faster than stimuli that did not share features.

Few studies have used the serial choice task to examine the repetition effects of semantically based information, which requires analytic stimulus identification rather than wholistic stimulus identification. The literature available, however, consistently indicates that repetition effects occur with semantic information at longer RSI's than with visual discrimination information such as dot patterns.

In one of the earliest serial choice studies based on semantic information (Schaeffer and Wallace, 1970), subjects 1) were presented a category name followed by words to be judged as to whether or not they were exemplars of the category, 2) presented a word followed by category names to be judged as to which was the category to which the word belonged, and 3) presented a word followed by other words to be judged as to whether or not they were synonyms of the original word. Response-stimulus intervals ranged from 100 msec to 3000 msec. The results indicated that the response times to superordinate-to-item judgments were not affected by the response stimulus interval, whereas, item-to-superordinate and item-to-item judgments were affected by the RSI. Repetition effects occurred for the superordinate-to-item task even at the 3000 msec interval. These findings suggested that semantic, categorically-based tasks differ from visual discrimination tasks insofar as the time interval at which a preceding stimulus can affect a current stimulus.

Ellis and Gotts (1973) found that repetition effects based on symbolic information (e.g., categories) were not as bound by the time of the RSI as nonsymbolic information (e.g., dot patterns). They concluded that subjects likely attend more to symbolic information than to nonsymbolic information and thus have a better memory of the preceding stimulus. Ellis and Gotts's (1973) conclusion that attention was important in the rate of decay was consistent with finding of Posner, Boise, Eichelman, and Taylor (1969) that after a 2 sec inter-stimulus interval there was no difference in response times between making decisions about a physical match (A,A) and a name match (A,a) of letters even when the letter to be matched remained exposed. At shorter inter-stimulus intervals the physical match was made faster than the name match. Posner et al. (1969) concluded that the rate of decay depends on the degree to which subjects attend to or focus on the visual experience.

Marcel and Forrin (1974) were the first to directly propose that the repetition effects demonstrated in a serial, two-choice task was an associative priming activity. They turned to the theoretical semantic memory framework of Meyers and Schvaneveldt (1971) to provide a base for their findings. Marcel and Forrin (1974) demonstrated category repetition effects in a task that required the classification of numbers and letters. Their findings with regard to the RSI and category information were consistent with those of Schaeffer and Wallace (1970): for associated category and target items, repetition effects were demonstrated at intervals as long as 3000 msec, but the strength of the effect at the long interval was significantly less than at a short RSI.

In summary, although the serial, two-choice paradigm with a fixed response-stimulus interval has not been used extensively for the study of categorical information, the studies that have been reported consistently have demonstrated that categorical repetition effects occur at long RSI's. The discrepancy between the visual discrimination findings and category findings has not been directly addressed.

Associative Priming and Word Recognition

Existing models of word identification have assumed that categorical information is available only after a word is identified and therefore should not be influential in the identification of the word. Some theorists (e.g., Becker, 1980; Rumelhart & McClelland, 1982; Stanovich, 1980) however, have proposed models of word identification that include semantic mechanisms capable of facilitating the perceptual identification of words. These models require the prior activation of semantic information derived from related context. Becker (1980) and Becker and Killion (1977), for example, proposed that semantic context affects early stages of visual processing or encoding of target information. That proposal was based, in part, on results of a lexical decision task with adults in which the stimulus intensity of visually presented primes and target words was varied (Becker & Killion, 1977). Related semantic context was found to facilitate the lexical decision of target words at low stimulus intensities more than at high intensities.

Lexical decisions by children also have been found to be facilitated by priming with related semantic associates (e.g., doctor-nurse). Schvaneveldt, Ackerman, and Semlear (1977) used a lexical decision task to investigate children's use of semantic context in word recognition. Second and fourth grade children made decisions about letter strings in semantically related and unrelated contexts. The younger readers were found to benefit as much as the older readers from the semantic context in word recognition (see also, Schwantes, Boesl, & Ritz, 1980; West & Stanovich, 1978). Simpson, Lorsbach, and Whitehouse (1983) further investigated the contextual components of word recognition in good and poor readers from the third and sixth grades. Words in clear and degraded form were preceded by related and unrelated words. In general, the contextual benefits were greater with the degraded relative to clearly presented words but especially so for the poor readers.

In a related study, Rosinski, Golinkoff, and Kukish (1975) investigated how beginning readers extract meaning from printed words. A Stroop-type task was used with second graders, sixth graders, and adults, in which subjects either labeled a picture that was superimposed with a word or read a word that was superimposed with a picture. Rosinski et al. (1975) reasoned that if the meaning of the distractor item was automatically picked up, the naming task would take longer if the pictures and words were incongruent than if they were congruent. Rosinski et al. (1975) confirmed that prediction and concluded that by second grade, children were automatically sensitive to the meaning of the printed word.

Consistently, associative priming has facilitated the identification and recognition of words. However, other than Fletcher's (1983) study with adults, no one has explored the idea that nonassociative priming can facilitate word identification. In fact, all information about unrelated primes and targets is to the contrary.

Imaginal Representations

The category-word task used by Fletcher (1983) involved verbal representations in memory. The literature on the development and activation of imaginal representations in memory leads to curiosity as to whether category contrast effects would be demonstrated with the use of imaginal representations in memory. For example, several theorists have proposed that developmentally, imaginal representations in memory occur prior to verbal representations in memory. Bruner, Olver, and Greenfield (1966) assumed that imagery, or "iconic representations" were an essential prerequisite for the establishment of symbolic representations. Werner and Kaplan (1963) similarly assumed that imagery was a more primitive means of representation that verbal representations. Piaget (1962;

Piaget & Inhelder, 1972), in contrast, assumed that images and words were complementary and had distinct symbolic functions throughout the early years.

Paivio (1971) provided the first comprehensive framework for investigating the differential effects of imaginal and verbal representations on memory and learning. According to Paivio (1971), "through exposure to concrete objects and events, the infant develops a storehouse of images that represent his knowledge of the world. Language builds upon this foundation and remains interlocked with it, although it also develops a partly autonomous structure of its own" (p. 437).

Facility in transforming from imaginal to verbal and verbal to imaginal codes converges with age. Increased content and organization of the knowledge base provide richer (Chechile & Richman, 1982) and more automated (Marschark et al., 1985; McCauley et al., 1976) interconnections between linguistic and perceptual information in memory.

Rosinski, Pellegrino, and Siegel (1977) demonstrated that children processed pictures faster than words. Second and fifth graders made "same-different" category decisions to pairs of pictures, pairs of words, or mixed pairs of pictures and words. The picture-picture pairs were responded to significantly faster than the other pairings (see also, Marschark & Carroll, 1984). Other researchers also have found that pictures are processed more rapidly than words by young children. Gibson, Barron, and Garber (1972) found that the judgment of congruence between names of objects is faster when the objects are shown as pictures rather than words.

In learning tasks, researchers repeatedly have found the superiority of visual over verbal learning (the picture superiority effect) in children (e.g., Kee, Bell & Davis, 1981; Pressley & Levin, 1977; Rohwer, Ammon, Suzuki, & Levin, 1971). Rohwer et al. (1971), for example, found in paired associate learning tasks that preschool and early elementary school-aged children learned picture-pairs significantly faster that word pairs. Moreover, the superiority effect of picture-pairs over word-pairs increases with age at least through third grade. The consistent findings of the superiority of imaginal representations over verbal representations suggested that an investigation of category contrast effects in children should extend to stimuli likely to elicit imaginal representations as well as verbal representations.

The Present Research

The notion of categorical information being available before the identification of a word, for children, especially, seems counterintuitive and in need of investigation. Although nominal category information can be automatically accessed in children, there is some question as to whether or not that information would be as central in a word identification task as Fletcher (1983) reported it to be with adults.

The purpose of the current investigation was to examine the developmental changes in category contrast effects in word identification. This was assessed by evaluating the extent to which young readers process a word's semantic category before complete or explicit identification of the word occurs.

Fletcher (1983) introduced the concept of category contrast effects, which he described as nonassociative priming. Yet, he did not specifically delineate the cognitive activity involved in that process. Fletcher also proposed a new model of word recognition, but he did not sufficiently define the model of semantic memory to account for the priming activity. One goal of the present research was to further define nonassociative priming and to account for that priming activity within a tested model of semantic memory.

The review of literature on the serial, two-choice task indicated that categorical judgement tasks differed from visual discrimination tasks in the effects of repetition at varying RSI's. Unlike visual discrimination tasks, category judgement tasks have permitted repetition effects at long response-stimulus intervals. Fletcher (1983), however, did not find any influence of categorical information at the long RSI in his investigation of category contrast effects. Another purpose of the present study, therefore, was to further explore the influence of categorical information at long RSI's.

The literature on language development has reported similarities and differences between the verbal and imaginal representational modes in memory in a variety of areas. The one study that has addressed category contrast effects, however, was based on the use of verbal representations in memory with adults. In that imaginal representations have been assumed to develop prior to verbal representations, a natural question is whether or not category contrast effects would be obtained with the use of imaginal representations in memory. More specifically, would the developmental pattern be similar to that demonstrated in more traditional areas of research in language development?

Three experiments were designed to assess the availability of category information during word identification with children and, in part, to replicate Fletcher's experiment with adults. The experiments involved children of two different ages and adults. Experiment 1 examined the occurrence of category contrast effects at a rapid RSI (300 msec). Experiment 2 examined the occurrence of category contrast effects at a slow RSI (2000 msec). Experiment 3 examined the effects of perceptual information on the presence or absence of contrast effects at a rapid RSI (300 msec).

Chapter 2

Experiment 1

As was noted in Chapter 1, Fletcher (1983) demonstrated the category contrast effect with adults, and introduced the term nonassociative priming as a description of the cognitive process underlying it. There was little, if any, explanation of how that process might work or could be accounted for within an existing model of semantic memory. Experiment 1 investigated the developmental changes in nonassociative priming, using a rapid RSI (300 msec), to further assess the influence of category information on word recognition. The primary objective was to determine the presence or absence of category contrast effects with children and, secondarily, to replicate Fletcher's findings with adults. In the event that category contrast effects were demonstrated, another objective was to explain the underlying priming activity in terms of an existing model of semantic memory.

Although there was no direct information available on category contrast effects in children, past research in several areas of cognitive and language development were used as a base from which to make predictions concerning the developmental nature of category contrast effects. In numerous research studies, children by age 7 or 8 years have demonstrated nominal categorical knowledge (Marschark et al., 1985; Ragain, 1980) as well as priming effects for associative semantic knowledge in word recognition tasks (Schvaneveldt et al., 1977; Simpson et al., 1983).

In order to make the leap from past research pertaining to categorical knowledge and associated priming effects in children to nonassociative priming effects in children, the following assumptions were made: 1) the processing of nonassociative semantic information depends on the same semantic memory structure as the processing of associated semantic information (cf. Morton, 1969, 1970, 1980), 2) the processing of nonassociative semantic information follows a pattern similar to that of associated priming (i.e., words from homogeneous categories are processed faster than words from heterogeneous categories). The above assumptions gave a basis for investigating category contrast effects with children and adults. A replication of Fletcher's (1983) study provided the following predictions: 1) the categorical contrast between the target word and the homogeneous nontarget words would facilitate the processing (i.e., word identification) of the target words in the homogeneous (contrast) condition but not in the heterogeneous (random) condition, 2) the associative priming between nontarget words within the homogeneous condition would facilitate the processing of those nontarget words relative to the nontarget words in the heterogeneous condition. A third prediction based on Fletcher's (1983) assumption that categorical information in the contrast condition would accrue and further reduce response times as the number of semantically related words increased, was that the second target word would be responded to faster than the first target word, but only in the contrast condition.

Of particular interest in this study was the developmental pattern of category contrast effects. Predictions concerning the developmental changes in category contrast effects or nonassociative priming were based on past research concerning associated priming effects and word recognition in children as compared to adults. Simpson et al. (1983), using a lexical decision task, found that contextual benefits were greater for younger and poorer readers than for older and better readers. In general, developmental trends of reaction time in cognitive and language studies have indicated that response times decrease with age (Marschark et al., 1985; Rosinski et al., 1977; Simpson & Lorsbach, 1983). Specifically, adults recognize words faster than children (Schvaneveldt & McDonald, 1981; Schwantes, Bosel, & Ritz, 1980). Based on these findings, the following developmental predictions were made: 1) with increasing age, response times for category judgements would decrease, 2) the category contrast effect (i.e., difference between the mean response times for target words in the contrast and random conditions) would be greatest for the younger children and least for the adults.

In summary, five specific questions were explored. One, would age affect the response times of category judgements? Two, would the response times differ for target and nontarget words? Three, would the nature of the nontarget word list (homogeneous or heterogeneous) affect the response times of category judgements for target and nontarget words? Four, would practice affect the response times of category judgements? Five, would the relative position of a target word affect the response times to the target words?

The paradigm used in the current study was a modification of the paradigm used by Fletcher (1983). Many of the categories were changed to fit the reading level requirements for the youngest subjects. In the current study, there were fewer trial blocks and the lists were shorter than those used by Fletcher.

Method

Subjects. The subjects were 36 native English speakers representing 3 different age groups. Twelve third grade subjects (6 female, 6 male) and 12 sixth grade subjects (6 female, 6 male) from two middle class schools in the Winston-Salem/Forsyth County School System who read on or above grade level and scored average or above on reading achievement were randomly selected by their teachers to participate in the investigation. The California Achievement Test was the measure of reading achievement. The mean reading percentile score for the third graders was 89, and for the sixth graders, 86. The mean ages of the third graders and the sixth graders was 8 years 4 months, and 11 years 4 months respectively. Twelve volunteer undergraduates (7 female, 5 male) enrolled in an introductory psychology course at UNC-Greensboro comprised the adult sample.

Materials. All stimulus words were chosen so as to be within the reading achievement level of the youngest subjects. The words were selected from the word achievement lists in the Houghton-Mifflin Reading Series, which is the reading series used in the Winston-Salem/Forsyth County School System. All words were nouns representing several different categories (see Appendix A). Words were balanced for length across the various categories.

Design and Procedure. The elementary school-aged children were tested in a quiet room provided by their schools. The university students were tested in a laboratory room. Subjects were seated in front of a table that held an IBM portable microcomputer and keyboard. Each subject was asked to look at the computer screen and identify serially presented words as exemplars or not of a predefined category. Subjects were asked to respond to each word as quickly as possible but to try not to make mistakes.

The words were shown in lower case letters drawn from the IBM character set. The words appeared one at a time in the center of the screen. A "READY" signal and tone were given by the computer before the presentation of each word list began to indicate to the subject that he/she should look at the screen and to provide a fixation point. Response to each word was made by pressing one of two buttons on the microcomputer. A "yes" button indicated that the word on the screen was a member of the predefined target category (target word). The "no" button indicated that word on the screen was not a member of the predefined target category (nontarget word). The keyboard was covered except for the "yes" and "no" buttons.

When a response was made, the current word was removed from the screen. The RSI of 300 msec controlled the rate at which the next word appeared on the screen. The computer controlled the RSI and recorded the response times to identify a word as a target or a nontarget word.

An "END OF LIST" signal as given by the computer at the end of each word list. The importance of paying attention and not interrupting the task from "Ready" to "End" was stressed (see Instructions in Appendix A). There was a brief interval at the end of each list with a signal to "PLEASE WAIT".

There were two conditions defined by the nature of the nontarget words in a list. In the "contrast" condition, all of the nontarget words in a list were from the same semantic category, which was a different category from the predefined target category for that list. In the "random" condition, the nontarget words in a list were from several different categories, all of which were different from the predefined target category for that list. The subjects were given no information about the nature of the nontarget words in a list.

Each session consisted of 12 blocks of serially presented word lists. A block consisted of one run (i.e., list) in the contrast condition and one run in the random condition. The target category was held constant within a block.

A run consisted of a serial list of up to 22 words. Twenty of the words in a run were nontargets (10 words, each presented twice) and the other two words were (different) targets. The first target word was not presented before the twelfth word or after the twentieth word. The second target word could be in any position in the run after the fourteenth word as long as there was at least one nontarget word between the first and second target words. A run was terminated after the presentation of the second target word. The length of each run was randomly determined.

The target words for each block were chosen from one of four semantic categories. Each target category was represented once in the first 4 blocks (block set 1), once in the second 4 blocks (block set 2), and once in the third 4 blocks (block set 3). Each target word occurred only once for each subject. The total number of different target words was 48. The order of presentation of the target words was randomized across subjects, and targets within conditions were counterbalanced across subjects.

The nontarget words in each run of the contrast condition were from one of four categories. All four categories were represented 3 times across the 3 block sets (once in each). Each nontarget word was used twice, in 3 different runs, across the 12 blocks. There were 40 different nontarget words used in the contrast condition, 10 words from each of four categories. The computer generated the random orderings of the categories and words across the 12 blocks from a preprogrammed pseudorandom sequence.

The nontarget words in the random condition represented many semantic categories (other than the target and contrast categories). The words were presented randomly across the 12 blocks with the constraint that each word was used twice in 3 different runs. The total number of different words used in the random nontarget condition was 40. The computer generated the random orderings of the words across the 12 blocks from a preprogrammed pseudorandom sequence. The computer controlled the random order of presentation of the two nontarget conditions within each block.

In summary, a 3(grade) x 3(block set - 1st, 2nd, or 3rd block of word lists) x 2(category choice - target word or nontarget word) x 2(condition - contrast or random) design was used. Grade was a between-subjects variable, with all other variables within-subjects. Response time was the dependent measure.

Four practice runs were administered. Reminders about the use of the two response buttons, fixating on the center of the screen, and clarification of the word identification task were given after each practice run. The practice trials contained some of the same categories but none of the same words as the experimental runs (see Appendix A). Each session lasted for 30-40 minutes.

Results

Response times longer than 2 seconds were truncated to that value. The total proportion of truncated responses was 4.3% for third graders, 2.9% for sixth graders, and 1% for university students. Errors were extremely rare. The number of errors was 2 for third graders, 2 for sixth graders, and 1 for university students. All errors were made in the direction of responding "no" to a predefined category target word and were spontaneously recognized and commented on by those who made them. Considering the small number of errors made at all grade levels, the error data were not analyzed further.

Category Choice: Target vs. Nontarget Word. The mean response times to target and nontarget words for the complete design are shown in Table 1. Response times were analyzed using a 3 (grade) x 3 (block sets) x 2 (category choice) x 2 (condition) repeated measures analysis of variance. As predicted, response times decreased with increasing age, $F(2,33) = 4.72$, MSe = 592.32, $p < .01$ (see Table 1), although none of the pair-wise differences were reliable by Newman-Keuls tests. Response times also became faster with practice, $F(2,66) = 3.77$, MSe = 151.38, $p < .02$, yielding a main effect of block set. Newman-Keuls tests revealed no significant differences among the individual means of the block sets.

Response latencies to target words were significantly longer than to nontarget words, $F(1,33) = 45.93$, MSe = 266.37, $p < .01$, and, overall, response times were significantly shorter in the contrast condition than in the random condition, $F(1,33) = 104.29$, MSe = 106.90, $p < .01$. There, also, was a significant interaction of condition and grade, $F(2,33) = 10.92$, $p < .01$, as the difference between response times in the contrast and random conditions decreased with increasing grade. Newman-Keuls tests indicated that the differences between the means in the contrast and random conditions were reliable for each grade, all p's $< .05$, even though the mean differences among the three grades in each condition were not reliable.

There was a significant interaction of condition by category choice, $F(1,33) = 7.79$, $MSe = 45.71$, $p < .01$. Figure 1 shows that the time to recognize a target word as an exemplar of the target category and a nontarget word as not an exemplar of the target category was affected by the semantic homogeneity of the nontarget word lists. Nontarget words within the contrast condition were responded to faster overall than nontarget words in the random condition, $t(33) = 2.44$, $p < .05$. That finding was consistent with the prediction that the associative priming between the nontarget words within the homogeneous condition would facilitate the processing of those words relative to the nontarget words in the heterogeneous condition.

Of greatest interest was the demonstration of a category contrast effect, as the time to recognize a target word as an exemplar of the target category was faster when the nontarget items in a list were drawn from a single semantic category than when drawn from many different categories, $t(33) = 6.28$, $p < .01$ (see Figure 1). That finding replicated Fletcher's (1983) finding and was consistent with the prediction that the categorical contrast between the target word and the nontarget words would facilitate the processing of the target words in the contrast condition but not in the random condition. A significant interaction of grade x category choice x condition also occurred, $F(2,33) = 6.06$, $p < .01$, as the

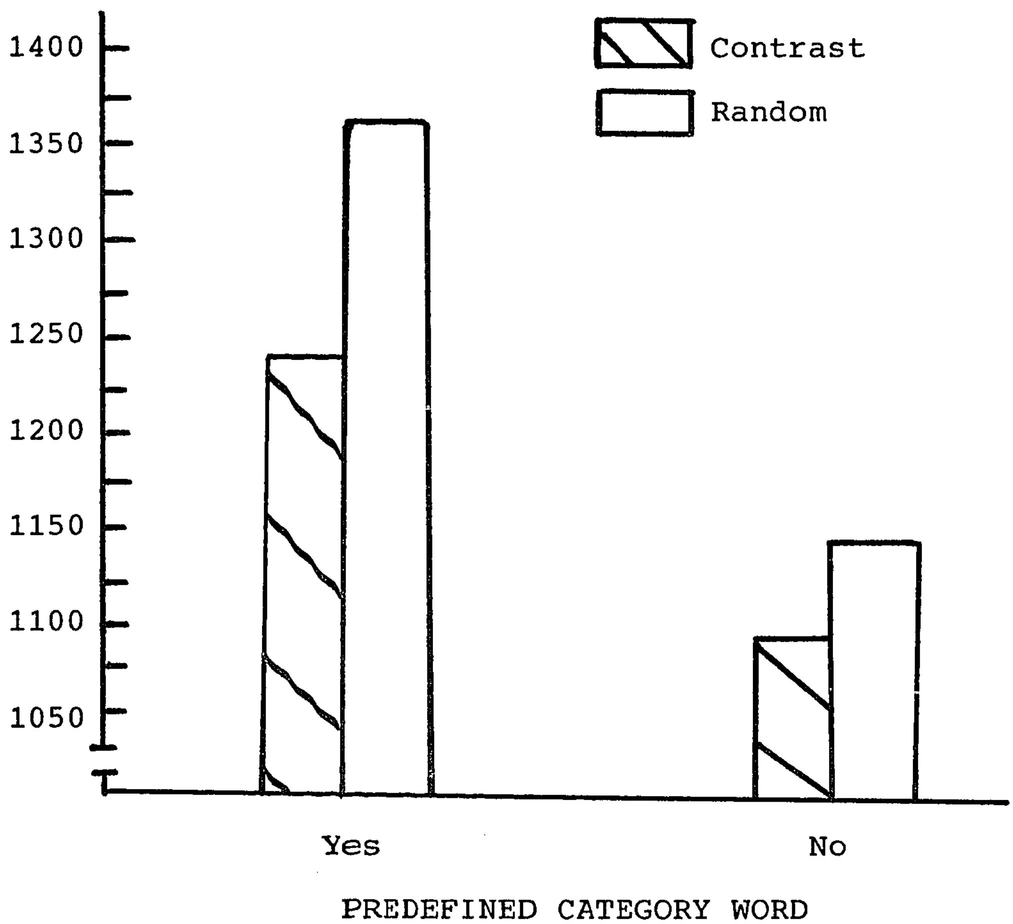

Figure 1. Mean response time (in milliseconds) to target and nontarget words in contrast and random conditions: Experiment 1.

difference between target and nontarget words in the contrast and random conditions decreased with increasing grade (see Figure 2). Newman-Keuls tests indicated that the mean differences between the three grades were reliable, $p < .01$. A priori *t*-tests revealed that the differences between the mean response times to target words in the contrast and random conditions were reliable at each grade with the third graders demonstrating a larger category contrast effect [$t(33) = 10.62$, $p < .01$] than the sixth graders [$t(33) = 4.45$, $p < .01$] or university students [$t(33) = 2.24$, $p < .05$]. That finding was also consistent with the prediction that the extent of priming effects would be greatest for the youngest subjects. A Newman-Keuls analysis indicated that the difference between the response times to the nontarget words in the contrast and random conditions was reliable at each grade, all *p*'s < .01, with the youngest subjects demonstrating the greatest associative priming effects.

Each word list contained many more nontarget words than target words. In order to achieve equal response probabilities of the target and nontarget words, the above analysis representatively used the nontarget word that directly preceded each target word in a list rather than using the average of all of the nontarget words in a list. An additional analysis of variance also was performed using the average response times to all of the nontarget words, which was the method used by Fletcher (1983). There were no

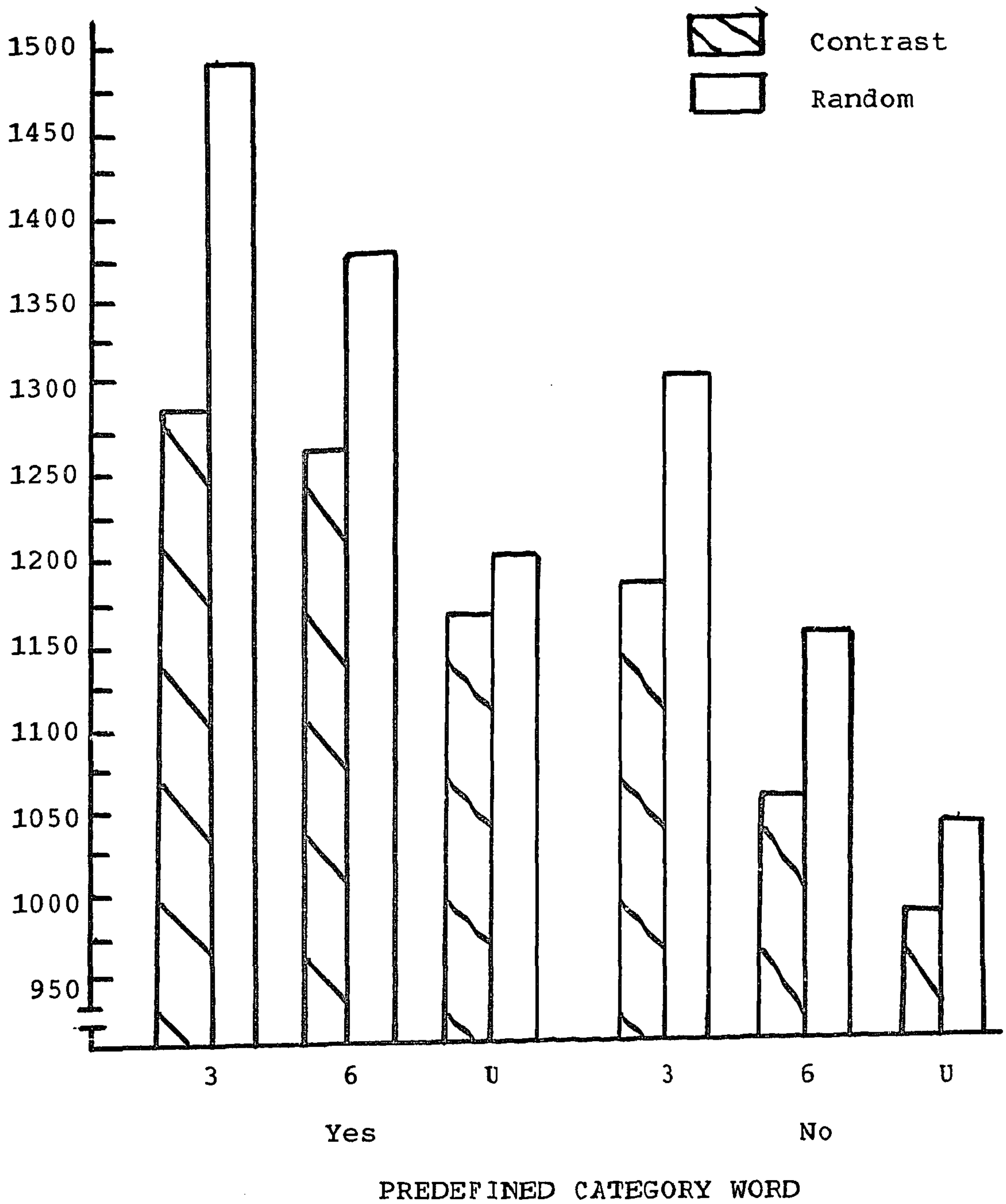

Figure 2. Mean response times (in milliseconds) to target and nontarget words in contrast and random conditions by grade: Experiment 1.

differences in the results obtained using the two methods of analysis in the current study. Fletcher (1983), however, did not obtain a category choice by condition interaction using adult subjects. There was indication that the current result differed from Fletcher's because of the use here of younger subjects. Differences in contextual priming with age accounted for the interaction effect. The differences between the means in each condition of the target words and the nontarget words was as follows for each grade: third graders, 198 msec and 133 msec, respectively; sixth graders, 111 msec and 93 msec, respectively; university students, 54 msec and 52 msec, respectively.

Target Word Position. The mean response times to the first target word and the second target word for the complete design are shown in Table 2. Response times were assessed using a 3(grade) x 2(target word position) x 2(condition) x 3(block sets) repeated measures analysis of variance. Beyond the reliable main effect of condition and the grade by condition interaction in the previous analysis, the current analysis indicated that when considering only target words, the main effect of grade approached significance, $F(2,33) = 3.04$, $p < .06$, with response times decreasing from the youngest to the oldest subjects.

The main effect of target word position was significant, $F(1,33) = 22.08$, $MSe = 115.19$, $p < .01$, as response times to the second target word were shorter than to the first target word. The target word position by condition interaction was not significant, however, contrary to the prediction that the second target word would be responded to faster than the first in the contrast condition only. There was no trend in the predicted direction. Finally, there was a grade by block set by target word position interaction, $F(4,66) = 3.52$, MSe = 74.64, $p < .01$. The pattern was highly irregular except that younger students consistently responded more slowly than the older students, and the interaction was not considered further.

Discussion

Category Choice: Target vs. Nontarget Words. The overall finding that younger children responded more slowly than older children or adults was consistent with the developmental prediction that with increasing age, response times for word recognition would decrease. The finding was also consistent with various results reported in the literature on semantic processing and reading reaction time studies (Chabot, Petros, & McCord, 1983; Rosinski, Pellegrino, & Siegel, 1977; Simpson & Lorsbach, 1983). Older and younger individuals have been shown to differ in the time they take to access and search semantic memory, in their knowledge of semantic relationships, and in their speed of word recognition.

Practice was found to lower response times across the three block sets at all three age levels involved here.

Fletcher (1983) obtained similar results using only adult subjects. The adult finding can be explained on the basis that in serial choice tasks, increasingly more relevant or selective strategies that facilitate processing (e.g., shift from wholistic to analytic processing, awareness of stimulus repetition and response repetition) are adopted as practice progresses (Fletcher, 1981; Nickerson, 1975). Children's use of selective strategies with the paradigm used here has not been investigated specifically. Children, however, have demonstrated the ability to use selective strategies for processing information in other cognitive tasks (Bjorklund & Zeman, 1984; Lange, 1978). Thus, it seems likely that in the present task, children increased their use of selective strategies as the task progressed.

The finding that primed target words were accepted more slowly than nonprimed nontarget words were rejected seems contrary to some well accepted concepts about the structure of semantic memory and the effect of priming on the accessing of information (e.g., Collins & Loftus, 1975; Morton, 1969, 1970; Smith, Shoben, & Rips, 1974). Collins and Loftus (1975), for example, proposed that semantic memory is organized as an associative network in which the activation of a given concept spreads to related concepts and facilitates the activation of those concepts relative to unrelated concepts.

The influence of the serial choice task on the early categorical processing of information can bring some better understanding to the finding that unrelated, nontarget words were identified faster than the primed target words. For example, Krueger and Schapiro (1981) found that at rapid RSI's stimulus repetition as well as response repetition facilitated response times in making judgments about the current stimulus in relation to preceding stimuli. The facilitation was found to result from information abstracted from the serial presentations that related the nontarget members of a list. Krueger and Schapiro (1981) assumed that the abstracted information from previous presentations functioned as a prime for each successive stimulus. In the current study, nontarget word lists had repetitive stimulus (lists of semantically homogeneous words) and repetitive response (successive "no" decisions and motor movements) information that could have primed the processing of and responding to the nontarget words. Even though there was a category prime for the target words, no benefit would be expected from the repetitive stimulus and response patterns which preceded, preempted, and far out numbered the predefined category-target word pairings. The lack of significant interaction of category choice and grade indicated that the "yes-no" decision process was not influenced differentially by age level even though older subjects responded faster than younger subjects.

Fletcher (1983) dismissed any discussion of his finding that nontarget words were responded to more quickly than target words. He explained that using all of the nontarget words in his analysis gave unequal response probabilities to the target and nontarget words and surmised that little of importance could be interpreted from the finding. As noted above, however, the current study obtained the same results when the representative use of the nontarget words that directly preceded target words was used in order to obtain equal response probabilities. The overall finding that nontarget words were responded to faster than target words was consistent with Krueger and Schapiro's (1981) explanation of the influence of the serial choice task on the response times of targets and nontargets.

Nonassociative Priming - Process and Structure: The significant effect of condition can best be explained in conjunction with the condition by category choice interaction which represented the category contrast effect. With little explanation, Fletcher (1983) described category contrast effects as resulting from nonassociative priming that occurs when highly discriminating or contrasting information between the target and nontarget words facilitates responding to the target word. The "highly discriminating" information occurs only in the contrast condition of the present paradigm. In that case, the repetitive presentation of nontarget words from the same category enables category information about the nontarget words to be abstracted from the serial word presentation. The category information is assumed to build in strength as the list progresses and increasing numbers of nontarget words fit into the nontarget category. The presentation of a target word, which appears no sooner than the thirteenth word in a list, is then in sharp categorical contrast between the abstracted nontarget category and the predefined target category. The abstracted category information from the homogeneous nontarget words is, therefore, considered as a nonassociative prime for the target category word. In the random condition, the nontarget words represented several categories, and therefore, no consistent category information could be abstracted from the nontarget words. The buildup of specific category information from nontarget words would not occur and, hence, would not provide highly discriminating information between the target and nontarget words to facilitate the target word response.

Upon inspection, nonassociative priming involves the input and cognitive processing of <u>relational</u> information as well as <u>distinctive</u> information. The relational information is in part abstracted from the stimulus repetition of all the nontarget words and from the response repetition of many more "no" than "yes" responses. Other relational information is given with the predefined category-target word prime. The distinctive information comes from the categorical distinction between the different categories of the target and nontarget words. The basis for the relational as well as the distinctive information relies to a large extent on the nature of the structure of the serial lists of words (i.e., contrast condition as opposed to random condition).

Explanations and assumptions of nonassociative priming must be consistent with notions about the structure and process of semantic memory. Existing models of semantic memory and word recognition have demonstrated critical vulnerabilities (i.e., Becker's verification model, 1980; McClelland's cascade model, 1979; Sternberg's additive model, 1969) which have not withstood many of the probes of experimental investigation. For example, Sternberg's additive model of reading tended to depict information processing in discrete stages, each performing a specific transformation on its input and passing on the new recoded representation as an input to a subsequent stage. That model cannot account for many important empirical results in the reading literature in that it can not account for higher level processes affecting lower levels (Rumelhart, 1977). Morton's (1969, 1970, 1980) logogen model has not been without criticism (Henderson, 1982), but it has survived over a decade of investigation and seemed to provide an adequate basis of explanation for nonassociative priming.

Morton (1969, 1970) proposed that verbal long-term memory contains memory structures for linguistic information called logogens. Logogens were assumed to automatically interface with perceptual analysis systems (visual and auditory) and context systems (base for knowledge about objects, events, or concepts). Logogens, then, were assumed to be a source of collection and integration of sensory information and semantic information about words. Morton proposed that logogens are activated when the number of features (bits of sensory and semantic information) going to them at input exceeded some criterion. The time to recognize a word thus depends on the rate at which features could be extracted from a stimulus and the number of features required to raise a word detector's feature count from its resting level to its criterion level.

Morton (1970) further assumed that logogens for semantically related words were "nearer" to one another than logogens for semantically unrelated words. Semantic information from the context system of one logogen could, therefore, affect the feature count in related logogens through associative priming. Morton assumed that associative primes raised the feature count of a related word from its resting level by adding previously extracted information toward the criterion level of recognizing a word. Associative priming was assumed to affect the processing of information at an early perceptual stage.

Morton (1970) further assumed that the fewer the categories to be processed, the less time involved in processing feature counts to match the external stimulus with an internal representation. Marschark et al. (1985) obtained findings consistent with that assumption in that the number of categories to be processed was found to directly effect the time to make semantically based decisions.

As previously stated, the knowledge abstracted from the stimulus and response repetitions in the contrast condition (i.e., relational information) is assumed to provide an associative context or prime that facilitates processing and responding to the nontarget words. Also, the predefined category serves as an associative semantic activation for the target word. Both kinds of associative information could be explained within the logogen model.

The distinctive information involved in nonassociative priming results from the contrast between the two different associatively activated processes: the predefined category-target word relation and the abstracted relation between the nontarget words in the contrast condition. The abstracted stimulus information in the contrast condition sets up an "undefined" but quickly operative associative priming within the "defined" priming task. Both kinds of priming information seem to be involved in the processing of each word from early in the task.

Morton's (1970) assumption that word recognition involves the parallel and sequential processing of stimulus information seems to be of critical importance for the notion that category information could facilitate word recognition prior to explicit recognition of the word. For example, the accumulation of sensory input into the logogens was assumed not to occur in only a step-by-step manner but also through the integration of information that developed over the process of the activation of a logogen and its semantic link. Specifically, once a logogen has been activated, context or related semantic information affects the amount of firing needed to subsequently activate that logogen or a related logogen within a short period of time.

The significant interaction of grade by condition, in which the contrast condition was faster for all subjects, indicated that the developmental patterns of contextual priming in the present task were similar to those demonstrated in more traditional cognitive measures. Contextual effects of related information have been shown consistently to be greater for younger than for older individuals in word recognition studies (Simpson, Lorsbach, & Whitehouse, 1983; West & Stanovich, 1978).

The significant interaction of grade by category choice by condition supported two of the initial predictions. The findings indicated that not only did nonassociative priming occur in children, but also that the contextual effects were greater for younger children than for older children or adults. Chechile and Richman (1982) proposed that the decrease in contextual effects with increasing age was related to the knowledge base: with increasing age stronger interconnections are made resulting in increased semantic activation from input information. The developmental pattern for nonassociative priming in the current study was thus demonstrated to be similar to the pattern reported in the literature for associative priming.

The lack of significant interactions of block set by category choice, and block set by condition indicates that practice did not have a differential role in category choice decisions or in the influence of the structure of the word lists on responses (the associated priming sources). These nonsignificant interactions suggests that nonassociative and associative priming are stable cognitive activities that are not differentially affected by unfamiliarity or familiarity of the task. Nonassociative and associative priming are primarily dependent upon conceptual development, and the memory organization for those concepts. Age did not differentially affect the stability of the stimulus repetition patterns in category choice and condition across block sets.

Target Word Position

There is no obvious explanation as to why the effect of grade only approached significance in the analysis of target word position. The finding that the second target word was responded to more quickly than the first target word seemed likely given the importance of strategy in a serial, choice reaction time task. An influential strategic rule likely abstracted from the organization of all of the word lists was that the presentation of the first target word functioned as a cue that the second target word would appear shortly. The "readiness" would facilitate response time to the second target word in both conditions. The "readiness" strategy would also be one explanation for the lack of an interaction of target word position and condition. However, the lack of a target word position by condition interaction was not consistent with the prediction or with Fletcher's (1983) findings that the second target word would be faster than the first in the contrast condition only. Fletcher (1983) proposed that the more nontarget words in a homogeneous list that preceded a target word, the greater the facilitation in responding to it. The additional contrasting information of the nontarget words between the first and the second target word in the contrast condition was assumed by Fletcher (1983) to be stronger as a result of the additional stimulus repetition. The difference in the findings in the present study and Fletcher's (1983) seems important to explore in order to clarify the influence of the paradigm on the processing of target words.

Response times to target words did not decrease significantly across block sets. Selective analytical strategies (e.g., awareness most of the words are nontargets), which evolve with practice, have been considered important in reducing response times over the course of serial choice tasks. Selective strategies, however, are assumed to involve the information abstracted from the repetition of nontarget words (e.g., category information, most words are "no" responses). The limited number of target words, all of which are different, would presumably not be affected by those strategies across block sets. The effect of condition on target words was discussed in the previous analysis.

In summary, the results of Experiment 1 replicated Fletcher's (1983) finding of category contrast effects in adults and further demonstrated that category contrast effects also occur in children as young as eight years of age. The demonstration of nonassociative priming at the 300 msec RSI indicated that preceding category information is influential in the identification of the current word. The difference between the finding in the current study and that of Fletcher (1983) on the target word position by condition interaction raised a question about how the paradigm influences response times to the second target word (i.e., stronger category contrast or knowledge that the second target word was presented shortly after the first). The two different findings could not be explained the same way.

Chapter 3

Experiment 2

The bulk of the literature on serial, two-choice, response time tasks has involved visual discrimination tasks. This literature has indicated that RSI's of 2000 msec or slower tend not to give significant stimulus repetition effects (Bertleson, 1961; Fletcher & Rabbitt, 1978; Hale, 1967). Stimulus repetition effects, therefore, have been assumed to occur when the mnemonic representation of the preceding trial affects the early perception of the current trial.

There have been reports, however, of significant effects of stimulus repetition at 2000 msec RSI's or greater. Consistently, those findings have involved category information. As previously noted, Schaeffer and Wallace (1970) found in the serial comparison of word-categories (same or different), that RSI's as long as 3000 msec did not slow the facilitation of the "same" category response. Krueger and Schapiro (1981) determined that the reason letters showed repetition effects at a long RSI in traditional visual discrimination studies was because letters were a "natural category" that permitted alternative ways to identify the stimulus information other than just matching physical stimulus identities (e.g., alphabet).

Their results showed repetition effects for letters at a 2900 msec RSI.

As was noted in Chapter 1, Fletcher (1983) demonstrated that category contrast effects, which are based on stimulus repetition effects, did not occur at a 2000 msec RSI. The assumption was that no mnemonic representation of the previous word was active to facilitate the processing of each successive homogeneous nontarget word, and subsequently, no build up of abstracted information about the nontarget word occurred to serve as a contextual background against which the target words could be contrasted.

Experiment 2 investigated the developmental nature of nonassociative priming at a long RSI (2000 msec) to further assess the influence of category information in word identification. The primary objective was to determine the presence or absence of category contrast effects in children at the long RSI, and secondarily, to replicate the process with adults.

In the serial two-choice task the assumption has been made that the boundary for which a preceding trial would not influence the perception of the current trial is 2000 msec (Rabbitt & Fletcher, 1978; Rabbitt & Vyas, 1981). Fletcher (1983) reported results consistent with that assumption. In that the current study replicated Fletcher (1983), the prediction was made that the categorical organization of the nontarget word lists (homogeneous condition and heterogeneous condition) would not differentially affect response times to the target words at the 2000 msec RSI at any age. Thus, there would be no demonstration of category contrast effect at the 2000 msec RSI. Given the developmental trends discussed in Chapters 1 and 2, wherein younger subjects demonstrate longer response times than older subjects in word recognition tasks (e.g., Schwantes, Boesl, & Ritz, 1980), it was predicted that with increasing grade, response times for word identification would decrease.

Method

Subjects. Subjects were obtained in the same manner as for Experiment 1. Twelve third graders (6 female, 6 males), twelve sixth graders (6 female, 6 male), and twelve university students (8 female, 4 male) participated in the investigation. The mean ages for the third graders and the sixth graders was 8 years 2 months, and 11 years 1 month, respectively. The mean reading percentile score for the third graders was 88, and for the sixth graders, 87.

Materials. The same stimulus materials were used in Experiment 2 as were used in Experiment 1 (see Appendix A).

Design and Procedure. The design and procedure for Experiment 2 was identical to that of Experiment 1 except for the response-stimulus interval. The RSI for Experiment 2 was 2000 msec. Grade was a between-subjects variable, with block set, category choice, and condition being within-subjects variables. Response time was the dependent measure.

Results

Response times longer than 2 seconds were truncated to that value. The total proportion of truncated responses was 5.7% for third graders and 3.3% for sixth graders; and no responses by university students were truncated. Errors were rare: 7 for third graders, 3 for sixth graders, and 3 for university students. All errors were made in the direction of responding "no" to a predefined category word, and all were spontaneously recognized by those who made them. Considering the small number of errors made at all grade levels, the error data were not analyzed further.

The mean response times to target and nontarget words in the random and contrast conditions for the complete design are shown in Table 3. Response times were analyzed using a 3(grade) x 3(block set) x 2(category choice) x 2(condition) repeated measures analysis of variance. As predicted, overall, response times decreased with increasing grade, yielding a reliable effect of grade, $F(2,33) = 9.27$, $MSe = 543.32$, $p < .01$. Newman-Keuls analyses indicated no significant differences among mean response times of the three age groups. Response times also became faster with practice, yielding a main effect of block set, $F(2,66) = 9.16$, $MSe = 236.15$, $p < .01$. The Newman-Keuls test revealed no significant differences among the individual means of the block sets.

Response latencies to target words were slower than to nontarget words, $F(1,33) = 37.96$, MSe = 285.86, $p < .01$, yielding a significant main effect of category choice. Overall, response times were shorter in the contrast condition than in the random condition, $F(1,33) = 10.86$, MSe = 90.53, $p < .01$, yielding a significant main effect of condition.

There was a significant interaction of condition and category choice, $F(1,33) = 18.70$, MSe = 61.56, $p < .01$. The time to recognize a target word as an exemplar of the target category was not affected by the homogeneity of the nontarget word list even though the time to recognize a nontarget word as not an exemplar of the target category was affected by the semantic homogeneity of the nontarget word list. A Newman-Keuls analysis indicated that nontarget words within the contrast condition were responded to significantly faster than the nontarget words in the random condition, $p < .05$ (see Figure 3). Newman-Keuls tests also indicated that the difference between response times to the nontarget words in the contrast and the random conditions was reliable at each grade, all p's $< .05$, even though the mean differences among the three grades in each condition were not reliable. Of greatest interest, was the lack of a category contrast effect. That is, no significant

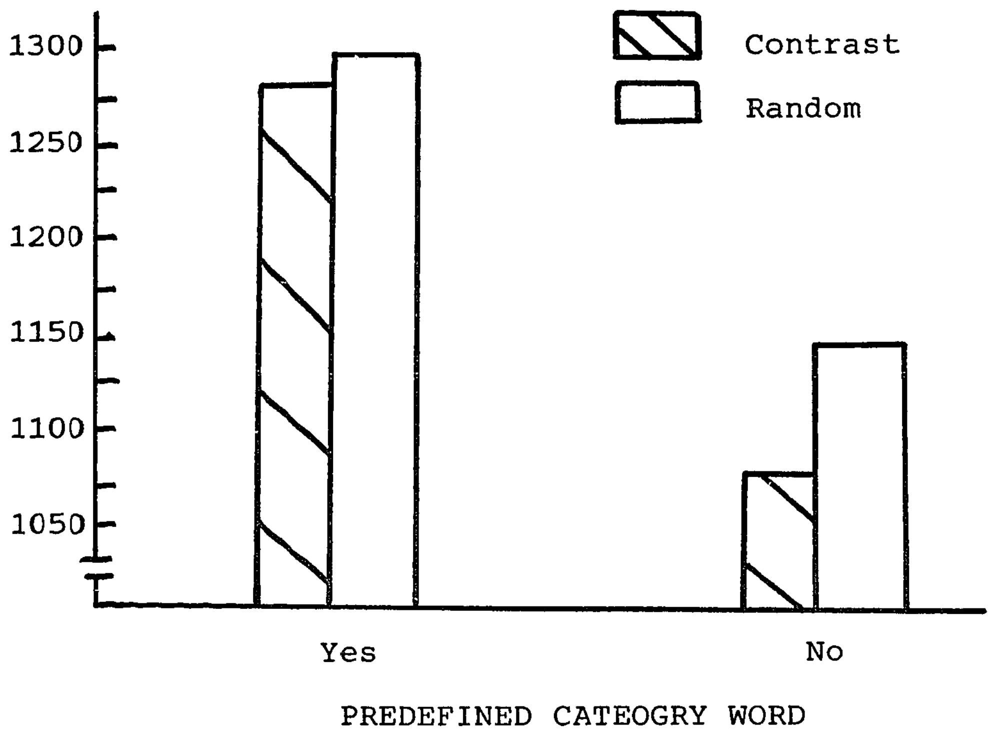

Figure 3. Mean response times (in milliseconds) to target and nontarget words in contrast and random conditions: Experiment 2.

difference was obtained between the time to recognize a target word as an exemplar of the target category when the nontarget items were drawn from a single semantic category and when drawn from several different categories, $t(33) = .12$, $p > .2$ (see Figure 3). This result extended Fletcher's (1983) finding to children: there was no demonstration of category contrast effects at the 2000 msec RSI at any age.

In order to achieve equal response probabilities of the target and nontarget words, the preceding analysis of variance involved the nontarget word that directly preceded each target word in a list rather than the average of all of the nontarget words in a list. An analysis of variance was also run using the average of the nontarget words, replicating the method used by Fletcher (1983). No differences were revealed between the two methods of analysis. Given the similar results of the two methods, the second analysis will not be discussed further.

Discussion

The overall finding that younger children had slower response times than older children or adults supported the developmental prediction that with increasing age, response times would decrease. The finding was also consistent with studies in the literature discussed in Chapters 1 and 2.

Practice was found to lower response times across the three block sets at all three ages in this study. That finding suggested that increasingly more relevant or selective processing strategies are adopted here even at long RSI's. Fletcher (1983) did not examine the effect of practice at the long RSI on the word identification task. However, Fletcher (1981) and Krueger and Schapiro (1981) reported practice effects with dot discrimination tasks at a 2000 msec RSI.

In terms of pre-experimental predictions, the finding of greatest interest was the lack of a category contrast effect: at the long RSI, nonassociative priming did not occur. The current finding was similar to that of Fletcher (1983) and seemed in agreement with the assumption that an RSI of 2000 msec would provide a boundary condition in which the processing of any word trial should be unaffected by the processing of the previous word trial (Bertleson, 1961; Fletcher & Rabbitt, 1978). Given that assumption, the buildup of information that related the nontarget words in the contrast condition would not occur. The contrasting information of the abstracted associative priming information and the defined associatively activating information (predefined category-target word relation) also would not occur. Each of these activities rely on the perception of the current word stimulus being affected by previous word stimuli and facilitating the response to the current word.

In the current study, however, there was indication that associative priming information related the nontarget words in the contrast condition. Unlike Fletcher's findings (1983), main effects were demonstrated for condition (contrast over random) and category choice (nontarget over target). Most importantly, a category choice by condition interaction was obtained as nontarget, but not target, words were affected by the categorical homogeneity of the nontarget word lists at all grade levels. The abstracted stimulus information from previous word trials, acting as an associative prime, did influence the processing of the current word at the long RSI even though nonassociative priming was not demonstrated.

Unlike Fletcher's (1983) findings, the demonstration of associative priming in the current study was consistent with previously reviewed literature in which repetition effects have been shown to occur with categorized material at longer RSI's than with dot or line patterns on visual discrimination tasks (Ellis & Gotts, 1973; Krueger & Schapiro, 1981). One explanation for those findings is that the associative categorical information is apparently quite salient and stable in word identification tasks and thus that information is available even after considerable time lapse.

Fletcher (1983) extended the serial two-choice paradigm to a word task involving categorical information. He continued to assume that, as in visual discrimination tasks, at 2000 msec the mnemonic representation of a preceding trial would not be strong enough to influence the perception of a current word. Fletcher's findings on the word identification task were consistent with that assumption.

The current findings of associative priming at the 2000 msec RSI were not consistent with that assumption. It seems reasonable that associative priming could occur and there still not be demonstration of nonassociative priming because the two processes involve different cognitive activity. As discussed in Chapter 2, nonassociative priming involves not only relational information, but also distinctive information that results from the contrast of two different sources of associatively activated information: the predefined category-target word relation and the abstracted relation among the nontarget words in the contrast condition. Further investigation is needed to more clearly understand why the nonassociative priming does not occur but the associated priming does occur at the long RSI.

The lack of demonstrated grade differences in associative priming (nontarget words in the contrast condition) at the long RSI departed from the developmental findings reported in the literature on context effects obtained from more traditional priming tasks. All subjects similarly relied on contextual information with the 2000 msec delay between responses and succeeding stimuli. Simpson, Lorsbach, and Whitehead (1983) reported no age differences in the size of contextual effects in a word recognition task with a 1500 msec prime-target interval. They surmised that the long prime-target interval atteunated the context effects and the age differecnes in those effects.

In summary, the results of Experiment 2 replicated Fletcher's (1983) finding of no category contrast effects at a 2000 msec RSI in adults, and demonstrated the same pattern in children as young as eight years of age. The lack of demonstration of nonassociative priming at the 2000 msec RSI indicated that preceding category information does not influence current word identification. Unlike Fletcher's (1983) findings, however, there was indication here that associative priming did occur at the 2000 msec RSI at all grade levels. Subjects in the current study demonstrated shorter response times to the nontarget words in the contrast condition than in the random condition. The repetitive abstracted stimulus information sufficiently remained active in memory to facilitate identification of the nontarget words in the contrast condition. Further exploration of categorical information in serial two-choice task seems important for a more complete understanding of the paradigm as used to assess nonassociative and associative priming activity.

Chapter 4

Experiment 3

To date, the demonstration of category contrast effects has involved tasks which used verbal representations in memory. Experiment 3 was designed to allow inferences about the presence or absence of category contrast effects in tasks which use imaginal representations in memory.

Some researchers have assumed that perceptual attributes, presented as pictures or words, are processed through an imaginal representational system (Paivio, 1975; te Linde, 1983). That well tested assumption was used as the basis for inferring that imaginal representations were used, at least in part, in the processing of information in the current study. Perceptual attributes rather than categories were given as primes for the target words (i.e., things that have wings, things that have arms) and were presented as line drawings as well as words.

Previous research findings have indicated that imaginal representations might easily, or naturally, allow the conditions for nonassociative priming to occur. For example, Potter and Falcouner (1975) found that category information was spontaneously accessed with line drawings and was a salient part of pictorial information in adults. Specifically, line drawings of an object could be categorized more quickly than the written word representing the object could be categorized. McCauley et al., (1976) also found with children that category information was a salient part of pictorial information and that the information was spontaneously accessed. With specific focus on word recognition tasks, words presented simultaneously with corresponding pictures brought faster response times in children's recognition of the words than when the words and pictures did not correspond (Golinkoff & Rosinski, 1976). Picture primes have been assumed to provide information that decrease the time to recognize the word.

The primary objective of this study was to determine whether or not perceptual attribute information contrasted with the buildup of homogeneous category information, would permit the demonstration of a contrast effect at a rapid RSI. Another objective was to determine whether or not the perceptual attribute information would allow a developmental pattern of contrast effects similar to the one demonstrated in Experiment 1.

The assumption was made that the perceptual attribute information about a word was processed in the logogen for that word (cf. Morton, 1970, 1980). The assumption also was made that imaginal as well as verbal representations were used in the processing of the words in the task (cf. Paivio, 1971). Based on Fletcher's (1983) findings of category contrast effects, the following predictions were made about the occurrence of contrast effects in this study: 1) the contrast between the perceptually activated target word and the categorically homogeneous nontarget words would facilitate the processing of the target words in the homogeneous (contrast) condition but not in the heterogeneous (random) condition, 2) the associative priming of the nontarget words within the homogeneous condition would facilitate the processing of those nontarget words relative to the nontarget words in the heterogeneous condition. Fletcher's (1983) assumption that the categorical information in the contrast condition would build in strength as the number of semantically related words increased and further facilitate identification of the target words gave basis for the third prediction: the second target word would be responded to faster than the first target word in the contrast condition only. The findings of target word position in Experiment 1 were not consistent with that assumption.

Adults have been found to identify pictures and words in shorter periods of time than children (Marschark & Carroll, 1984; Pellegrino et al., 1977; Rosinski et al., 1977). These findings gave basis for the following developmental predictions: 1) with increasing age, response times would decrease for judgements of the presence or absence of perceptual attributes, 2) the contrast effect (difference between the contrast and random conditions for target words and nontarget words) would be greatest for the youngest children and smallest for the adults.

In summary, five specific questions were explored. One, would age affect the response times of judgements of attribute presence with the use of perceptual information? Two, would a perceptual attribute decision (did the current word have the predefined perceptual attribute or not) affect response times of word identification on target and nontarget words? Three, would the nature (homogeneous or heterogeneous) of the nontarget word list affect the response times of judgements of attribute presence in nontarget and perceptually activated target words? Four, would practice affect the response times of judgements of attribute presence with the use of perceptual information? Five, would the relative position of the target word affect the time to make judgements of perceptual attribute presence in the perceptually activated target word?

Method

Subjects. Subjects were obtained in the same manner as for Experiments 1 and 2. Twelve third graders (6 female, 6 male), twelve sixth graders (7 female, 5 male) and twelve university students (8 female, 4 male) participated in the investigation. The mean age for the third graders was 8 years 2 months, and 11 years 2 months for the sixth graders. The mean reading percentile score for the third graders was 89, and for the sixth graders, 88.

Materials. Stimulus materials were selected in the same manner as for Experiment 1. The words were for the most part the same words as in Experiment 1. Substitutions were made so that all target words, and no nontarget words, had the predefined perceptual characteristics. Some categories that were designated target or nontarget in Experiment 1 were reversed in the current experiment. That change was made so that all target categories represented distinctly different perceptual attributes (see Appendix A.)

Design and Procedure. The design and procedure for Experiment 3 was the same as for Experiment 1 with one exception. The prime for the target word was a perceptual attribute of the target word rather than the category of the target word (i. e., thing that has wheels - car). The instructions were "look for things that have wheels" and a line drawing of a wheel was shown to the subject. Each perceptual attribute was characterized by a line drawing (see Appendix A). The decision for each word was based on the perceptual attribute prime. That decision is referred to as the perceptual attribute choice. The RSI was 300 msec.

A 3(grade) x 3(block set - 1st, 2nd, or 3rd block of word lists) x 2(perceptual attribute choice - target word or nontarget word) x 2 (condition - contrast or random) design was used. Grade was a between-subjects variable, with all other variables within-subjects. Response time was the dependent measure.

Results

Response times longer than 2 seconds were truncated to that value. The total proportion of truncated responses was 7.4% for third graders, 5.1% for sixth graders, and 2.6% for university students. The number of errors was 2 at each grade level. All errors were made in the direction of responding "no" to a predefined perceptual attribute and were spontaneously recognized and commented on by those who made them. Considering the small number of errors made at all grade levels, the error data were not analyzed further.

Category Choice: Target vs. Nontarget Words. The mean response times to target and nontarget words in the random and contrast conditions for the complete design are shown in Table 4. Response times were analyzed using a 3(grade) x 3(block set) x 2(perceptual attribute choice) x 2(condition) repeated measures analysis of variance. As predicted, overall, response times varied with grade, $F(2,33) = 12.77$, $MSe = 71.13$, $p < .01$. As can be seen in Table 4, response times decreased with increasing grade, yielding a reliable effect of grade. Newman-Keuls tests indicated that the differences in mean response times among the three grade levels were reliable, p's $< .01$.

There was a significant main effect of block set, $F(2,66) = 22.32$, $MSe = 144.02$, $p < .01$, indicating that response times became faster with practice (see Table 4).

Newman-Keuls tests, however, did not yield significant differences among the individual means of the block sets.

Response latencies to target words were longer than to nontarget words, $F(1,33) = 23.64$, MSe = 192.96, $p < .01$, and, overall, response times were shorter in the contrast condition than in the random condition, $F(1,33) = 81.68$, MSe = 64.77, $p < .01$, yielding a significant main effect of condition.

The interaction of condition and perceptual attribute choice was significant, $F(1,33) = 21.46$, MSe = 56.68, $p < .01$. Figure 4 shows that the time to identify a target word as having the perceptual attribute and the time to identify a nontarget word as not having the perceptual attribute was affected by the semantic homogeneity of the nontarget words. Further, nontarget words in the contrast condition were responded to faster than to nontarget words in the random condition, $t(33) = 2.81$, $p < .05$ (see Figure 4). That finding was consistent with the pre-experimental prediction that the associative priming of the nontarget words in the contrast condition would facilitate the processing of those nontarget words relative to the nontarget words in the heterogeneous condition.

Of greatest interest, was the demonstration of contrast effects as the time to recognize a target word as an exemplar of the target perceptual attribute was faster when the nontarget items in a list were drawn from a single

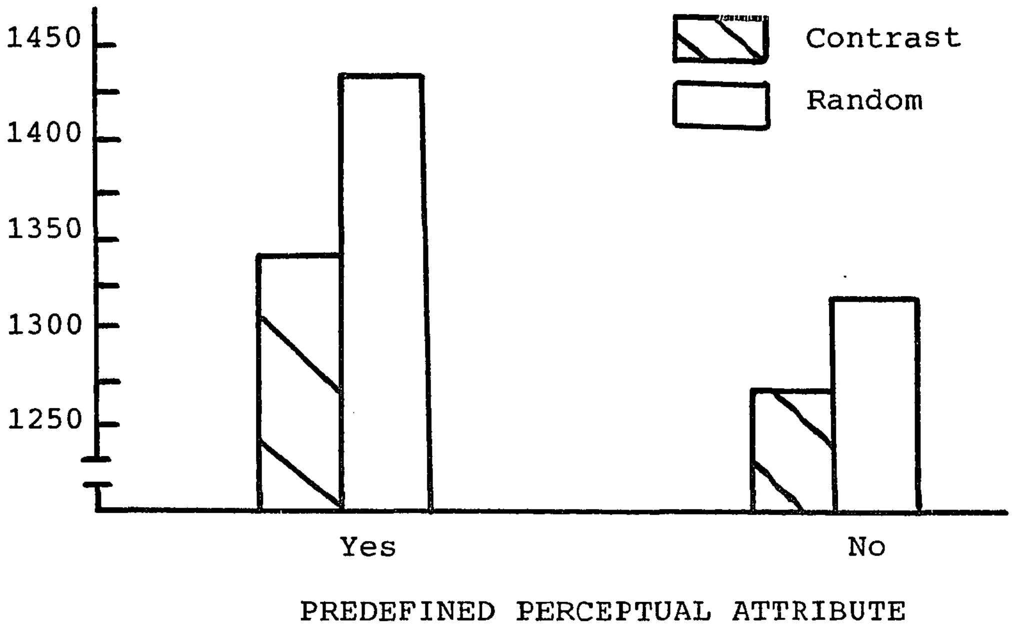

Figure 4. Mean response times (in milliseconds) to target and nontarget words in contrast and random conditions: Experiment 3.

semantic category than when drawn from many different categories of nouns, $\underline{t}(33) = 4.99$, $\underline{p} < .01$ (see Figure 4). That finding was consistent with the prediction that the contrast between the perceptual attribute of the target word and the categorically homogeneous nontarget words would facilitate the processing of the target words in the contrast condition relative to the random condition. The interaction here resulted from greater differences between the means of the contrast and random conditions for the target than the nontarget words at all three grade levels (see Table 4). There was not a significant interaction of perceptual attribute choice by condition by grade. That finding was not consistent with the prediction that the younger subjects would demonstrate greater contextual effects than the older subjects.

Target Word Position. The mean response times to the first target word and the second target word for the complete design are shown in Table 5. Response times were assessed using a 3(grade) x 3(block set) x 2(target word position) x 2(condition) repeated measures analysis of variance. Beyond the reliable effects of grade and condition reported in the previous analysis, the current analysis indicated response times to the second target word were faster than to the first target word, $\underline{F}(1,33) = 33.51$, $MSe = 113.58$, $\underline{p} < .01$, yielding a significant main effect of target word position. The target word position by condition interaction was not significant, however, a finding inconsistent with the prediction that the second target word would be faster than the first target word in the contrast condition only. Nevertheless, a slight trend was observed in the predicted direction.

Discussion

Category Choice: Target vs. Nontarget Words. The overall finding that younger children responded more slowly than older children or adults was consistent with the developmental prediction that with increasing age, response times would decrease. The current finding was similar to various results reported in the literature pertaining to picture-word studies. For example, Rosinski et al., (1977) found that older children recognized words that were primed with corresponding or semantically associated pictures faster than younger children (i. e., an imaginal to verbal decoding deficit of young children). Marschark and Carroll (1984) found similar results not only with younger and older children but also with adults, as response times in a picture-word recognition task decreased with increasing age. Again, older and younger individuals have been shown to differ in the time they take to access and search semantic memory, differ in their knowledge of semantic relations, and differ in their speed of word recognition in tasks involving primarily verbal stimuli, as well as primarily pictorial stimuli, and combinations of both verbal and pictorial stimuli. The reliable differences among the individual means of the response times at the three grades indicated a pronounced decrease, from younger to older subjects, in the speed of processing the material.

Practice was found to lower response times across the three block sets. The use of perceptual information gave similar results to those of Fletcher (1983) with the use of all category information. The current finding was consistent with the basic assumption that increasingly more relevant or selective processing strategies (e.g., most responses are "no") are adopted as practice progresses in tasks of the sort used here (Fletcher, 1981; Nickerson, 1975). These strategies, in turn, lead to faster responses over time.

Traditionally, serial two-choice studies have been used in visual discrimination tasks (e.g., same-different dot patterns or letters) which involve the use of imaginal-spatial or imaginal representations in processing the information (Bertleson, 1963; Rabbitt, et al., 1977, 1979; Rabbitt, et al., 1980). Practice has been found to lower response times in those tasks. As noted in Chapter 2, however, other studies have indicated that practice effects are demonstrated in tasks that involve primarily verbal representations (e.g., the category information tasks of Fletcher, 1983, and Schaeffer & Wallace, 1970). Even though the serial two-choice paradigm previously has not been used to assess processing strategies with children, children have demonstrated selective processing strategies of pictorial information and verbal information in more traditional processing tasks (e.g., Bjorklund & Zemar, 1984). Children presumably used selective strategies to facilitate responses over the course of the task. In the current study, the main effect of practice indicated that the use of both imaginal and verbal representations followed the same practice effect pattern as the use of only verbal representations (e.g., Experiment 1) for children and adults. Age did not differentially affect the practice effect pattern.

The finding that perceptually activated target words were accepted more slowly than nontarget words were rejected was consistent with the findings reported in the literature that the repetitive stimulus and response patterns for the nontarget words in a serial choice task facilitates the decision of the nontarget stimulus relative to the decision of the target stimulus (Fletcher, 1981; Krueger & Schapiro, 1981). Even though the target stimuli were perceptually activated, the target words had no benefit of the repetitive stimulus and repetitive response patterns created by nontarget words, which preceded and substantially outnumbered the prime-target word pairings. That assumption has been borne out in studies that have required the use of imaginal representations as well as verbal representations in memory (Bundesen & Larsen, 1975; Ellis & Gotts, 1977).

The current finding, which was based on perceptual as well as verbal stimuli, gave results similar to the studies that used only one stimulus mode. The use of both representational modes in a single task here did not appear to differentially change the influence of the stimulus repetition and response repetition pattern in target and nontarget word identification.

The significantly faster responses to words in the contrast relative to the random condition can best be explained in conjunction with the condition by perceptual attribute choice interaction, which represented the contrast effect. In the current study, the highly discriminating information came from the contrast between the abstracted category information and the perceptual attribute information. Nonassociative priming was discussed at length in Chapter 2.

In that processing of perceptual attributes has been assumed to involve imaginal representations in memory (Paivio, 1975; Pellegrino et al., 1977; Rosinski et al., 1977; te Linde, 1977), imaginal representations were assumed to be used in the nonassociative priming elicited by the present task. For example, the perceptual attribute knowledge served as a prime for the target words, and as the basis of the "yes-no" decisions as to whether the nontarget words had the predefined perceptual attribute. The associative priming (i.e., abstracted category information) among the nontarget words in the contrast condition occurred even though the decisions for the nontarget words were based on perceptual attribute information. The abstracted category information did make for a distinctive contrast with the perceptually activated target words in the contrast condition and, thereby, nonassociative priming occurred involving the use of imaginal as well as verbal representations in memory.

The lack of a significant interaction of response choice by condition by grade was inconsistent with the prediction that the younger subjects would demonstrate greater contextual benefits from nonassociative priming than the older subjects. Even though the university students responded faster than sixth graders or third graders, across all conditions, there were no reliable grade differences in the benefits from the contextual information in the nonassociative and associative priming of the target and nontarget words.

The finding that contextual information did not benefit younger children more than the older children and adults was contrary to reports from related areas of study. Many researchers have demonstrated developmental differences in contextual effects in various cognitive tasks using both pictures and words as stimuli (e.g., Rosinski et al, 1977; Schvaneveldt et al, 1977; Simpson et al., 1983). One explanation for these age related contextual differences is that with increasing age, the interconnections among concepts in memory are richer and broader, thus allowing the processing of current stimuli to be less dependent on contextual information (Chechile & Richman, 1982). Clear explanations of the current finding, that all subjects seemed to rely equally on contextual information in word identification, are not obvious.

The lack of significant interactions of block set by perceptual attribute choice, and block set by condition suggested that practice over the course of the task did not have a differential role in the perceptual attribute decision or in the influence of the structure of the word lists on responses. Those findings were consistent with Fletcher's (1983) and with Experiment 1 in the current investigation. Fletcher (1981) proposed that strategies abstracted from practice did not influence the stimulus repetition effects beyond the early blocks in the task. The use of imaginal as well as verbal representations with nonassociative and associative priming did not change that pattern.

Target Word Position. The finding that the second target word was responded to more quickly in both the contrast and random conditions was not consistent with the hypothesis that the second target word would be responded to faster than the first target word in the contrast condition only. Fletcher (1983) proposed, and found with adults, that the more nontarget words in a homogeneous list that preceded a target word, the greater the facilitation of the target word. Fletcher suggested that each additional nontarget word gave additional stimulus information in the contrast condition. The additional stimulus repetition of the nontarget word was assumed to strengthen the contrasting information between the first target word and the second target word in the contrast condition. An explanation that would be more in keeping with the current finding would concern the importance of strategy in the serial choice task. For example, in that all lists were constructed so that the presentation of the second target word came shortly after the presentation of the first target word, the occurrence of the first target word likely became a cue to be "ready" for the second target word in both conditions. Again, the difference in the findings in the present study and Fletcher's (1983) seems important to investigate further in an effort to gain clarity of the influence of the serial choice paradigm on target word position when using categorical information.

Response times to target words did not decrease significantly across block sets. Selective strategies, which evolve with practice, have been considered important in reducing response times over the course of the task in a serial choice task. Selective strategies, however, are assumed to apply to the information abstracted from the stimulus repetition of nontarget words, which provides the contrast for the response to the target words, and to the approach to the task itself (e.g., most words are "no" responses). The limited number of target words would presumably not be affected by processing strategies across block sets. The lack of a main effect of block set on target word identification with the use of imaginal as well as verbal representations would, therefore, be consistent with assumptions of the serial choice paradigm. Grade and condition effects were discussed in the previous analysis.

In summary, the demonstration of contrast effects permits the assumption that imaginal representations as well as verbal representations in memory can be involved in the processing of nonassociative priming information. Children as young as age eight, as well as adults, demonstrated contrast effects between perceptual attribute information with preceding homogeneous category information at the 300 msec RSI. In this study, there was no demonstration of developmental contextual effects in nonassociative and associative priming. There was no difference in the extent of benefit from contextual information in word identification between the oldest and the youngest subjects. That finding is inconsistent with the nonassociative priming and associative priming patterns demonstrated in Experiment 1. Further investigation of perceptual and categorical information in nonassociative priming is needed to more clearly understand the developmental patterns.

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Chapter 5

General Discussion

The preceding studies demonstrated effects of nonassociated priming by children as young as eight years of age as well as by adults. Specifically, contrasting categorical information was demonstrated to be as central in a category decision task with children as with adults. Also, contrasting perceptual attribute and categorical information was demonstrated to be as central in a perceptual attribute decision task with children as with adults.

In view of the relatively new and untested concept of nonassociative priming, the need to link that cognitive activity to an existing model of semantic memory that could accommodate the process seemed fundamental to further exploration and interpretation. The semantic memory model of Morton (1969, 1970, 1979, 1980) and his subsequent assumptions about word recognition proved to be a satisfactory, though not complete, framework for the explanation of nonassociative priming in word identification.

Henderson (1982) strongly criticized the logogen model of word recognition because of the lack of specificity of sensory analysis and lack of parsimony and specificity in the notion of different memory structures for different kinds of stimulus information (e.g., pictures and words). Existing models, in general, however, do not specify assumptions about the integration of the "visual process" and the "lexical process" in word recognition. Morton's (1969, 1970, 1980) model does seem to imply a direct visual access to the lexicon from the sensory input. The weakness of the logogen model most relevant to the current study, however, pertains to the lack of specificity of how information from structures for printed words and/or auditory words, and pictures are integrated to make for a common output mode. For example, a word presented orally was assumed to function as a prime for a semantically related printed word in a study by Morton and Patterson (1980). Pictures, however, were assumed to be processed in a structure similar to but different from logogens for words. There was no specific accounting by Morton (1969, 1970, 1979, 1980) for how a picture would in turn facilitate the processing of a word, or, in other words, how the memory structure for pictures and words are integrated.

The abstracting of categorical information from the nontarget words in a serial, two-choice paradigm was assumed by Fletcher (1983) to be fundamental and vital to nonassociative priming. Schaeffer and Wallace (1970) found that the association made between the elements of a serial choice task (i.e., stimulus repetition effects) depended on the defined basis for comparison. In Experiment 1, category membership was the defined basis for comparison which, in turn, gave the "undefined" basis for comparison of the nontarget words. In Experiment 3, the bases for comparison were predefined perceptual attributes. The nontarget words, however, were not organized by perceptual attributes in either the contrast or the random condition. There was categorical homogeneity in the contrast condition but not the random condition. The finding of contrast effects in Experiment 3 suggested that the abstracted unifying feature (e.g., category information) among the homogeneous nontarget words facilitated the processing of the nontarget words even though the response decision was focused on another feature (e.g., perceptual attribute) of the word.

Lawrence (1971) stated that the main condition for rapid detection of a target out of a background was that the target and background be clearly different and distinguishable from each other. In Experiments 1 and 3 target words could be clearly distinguished from nontarget words in the contrast condition because of the strong contrast between the defined category or perceptual attribute information and the abstracted homogeneous category information. The random condition did not provide that strong contrast in either experiment. In Experiment 2, the mnemonic representation of the preceding nontarget word presumably did not remain sufficiently active to make for a clear distinction between the succeeding target word, and thus, did not differentially affect target word identification.

Nonassociative priming involves the encoding of relational (e.g., associative) as well as distinctive (e.g., contrasting) information about each word. Much of the research on the encoding of relational and distinctive information has focused on memory for words. Both children and adults have been found to encode distinctive and relational information. Age, however, has been influential in the kinds of information most often encoded (Ackerman, 1983; Ackerman & Rust-Kail, 1982). In comparison to adults, children typically perform more relational encoding than distinctive contrasting encoding of item specific information and memory varies as a result. The explanation for these findings has been that conceptual development limits the amount of contrastive encoding children can do (Ackerman, 1983; Ackerman & Rust-Kail, 1982).

The apparent role of processing of relational and distinctive information in the current study was more in keeping with findings pertaining to the spontaneous accessing of categorical information (i.e., McCauley et al., 1976; Potter & Falcouner, 1975). In the present investigation, the occurrence of category contrast effects and contrast effects indicated that children as well as adults successfully encoded relational as well as distinctive information. All ages sufficiently encoded distinctive and relational information for the contrast between the target word and the nontarget word to occur and permit category contrast effects as well as contrast effects.

The pattern of increased contextual benefits with decreasing age was demonstrated in Experiment 1 in nonassociative and associative priming activity. No developmental differences in contextual benefits were demonstrated in Experiment 2 or Experiment 3. Even though the experiments cannot be compared directly, the lack of demonstrated differences in contextual benefits with age either in Experiment 2 (e.g., associative priming) or Experiment 3 (e.g., nonassociative or associative priming) raised question about why those tasks gave different results from Experiment 1. Simpson, Lorsbach, and Whitehead (1983) did not obtain differences in the size of context effects at different grades at a 1500 msec prime-target interval using a standard priming paradigm. The long interval was thought to attenuate the context effects and particularly the age differences in those effects. Further investigation is needed, however, to understand the effect of time and stimulus differences on the size of contextual benefits with age.

When Fletcher (1983) extended the use of the serial two-choice paradigm to categorical information, he seemed to ignore the studies available that used the paradigm with semantic category information (i.e., Marcel & Forrin, 1974; Schaeffer & Wallace, 1970). For example, Fletcher (1983) made the assumption that there would be no stimulus repetition effects at the long RSI based on the findings from visual discrimination tasks (e.g., dot patterns). Even prior to the 1983 study, Fletcher (1981) obtained repetition effects with letters at a 1200 msec RSI and did not link his finding with earlier works which used categories as the defined unit for comparison. Marcel and Forrin (1974), however, found that repetition effects were demonstrated with letters at a 2900 msec RSI. They surmised that letters were linked by category information which served as an associated prime for the letters. When Ellis and Gotts (1973) found that repetition effects based on symbolic information were not as bound by the RSI as nonsymbolic information, they reasoned that symbolic information is attended to more than nonsymbolic information, and thus, memory for symbolic information would be stronger. In other words, symbolic information activates more associations in semantic memory than dot patterns activate, thereby enhancing the likelihood of increased attention and greater influence over succeeding trials.

The finding of associative priming at the long RSI in the current study was in keeping with the (limited) majority of studies that have used categories as the defined basis of comparison in the serial two-choice task. That is, stimulus repetition effects did occur at the 2000 msec RSI, as nontarget words in the contrast condition were responded to faster than the nontarget words in the random condition. Fletcher's (1983) assumption of the lack of repetition effects with category information at a long RSI was not fully in agreement with the current or previous findings that were available to but not discussed by him. The compiled findings have suggested that category information is more salient than some other kinds of information and influences stimulus repetition effects at longer RSI's than less salient information. The conclusion can be made that associative category stimulus information does influence the perception of succeeding nontarget (i.e., associative priming) words at a RSI at least as long as 2000 msec.

Fletcher's (1983) assumption that nonassociative priming would not occur at the long RSI was borne out by the current findings. However, the above discussion indicates that Fletcher's reason for that assumption (no stimulus repetition effects) was not wholly consistent with the findings in the present study. Associative priming of the nontarget words, a vital part of nonassociative priming, did occur. Different assumptions, therefore, must be made about the strength of mnemonic representations of nonassociative and associative priming in a serial two-choice task. The mnemonic representations of nonassociative category primes and targets appear to be less stable than associative category primes. Hence, a close temporal relation between word trials is necessary in order for the representations in memory to allow the highly discriminating categorical information of previous nontarget words to influence the processing of a succeeding target word. Some researchers (Ellis & Gotts, 1973; Posner et al., 1969) have proposed that attention is a significant factor in the strength of mnemonic representations or in the rate of decay. Nonassociative priming requires that attention to the associatively activated target word as well as the abstracted categorically primed nontarget words. In comparison, associative priming requires attention only to the abstracted categorically primed nontarget words. The differences in the amount of information to be focused on in nonassociative and associative priming could make for differences in the presumed rate of decay of mnemonic representations.

Another point of departure between the assumptions of Fletcher (1983) and the current findings pertained to the response time to the second target word. Fletcher assumed that the more stimulus repetitions in a list, the faster the response to the next target word. He obtained results consistent with that assumption. The second target word was responded to faster than the first target word in the contrast condition, but not the random condition. In the current study, Experiment 1 and Experiment 3 indicated that the second target word was responded to faster than the first target word in both conditions. The explanation of these findings was that the first target word served as a cue for the presentation of the second target word in both conditions. In another study, Henderson and Chard (1978) found no effect of target word position using a paradigm similar to that used in the current study. Further exploration of target word position seems indicated to clarify the effect of target word position in the paradigm used here.

The semantic activation of target words consistently has been shown to facilitate the time to recognize or identify that word (Schvaneveldt et al., 1977; Schwantes et al., 1980; Stanovich & West, 1979). Fletcher (1983) concluded that the demonstration of category contrast effects at a short but not long RSI indicated that category information was influential in the early stages of the process of word identification. Fletcher (1983) further concluded that nonassociative priming indicated that category information was initially activated prior to and was not dependent upon explicit identification of a word.

When a stored representation of the meaning of a word is accessed through the processing of a sensory input, it has been assumed to remain activated for a period of time and allow for further processing. Holender (1986), however, concluded that semantic activation generally is accompanied by identification of the word as indicated by the ability of a subject to perform discriminations on the basis of the meaning of the word (e.g., lexical decision task). The possibility that sensory input elicits semantic activation without accompanying identification has been suggested in various areas of study (e.g., visual pattern masking, dichotic listening). To that end, Fletcher (1983) proposed that category information is initially activated from the very early perception of the word (orthography) prior to recognition or identification of the word.

Holender (1986) proposed that the single criterion for making the assumption that semantic activation is not accompanied by identification of the word is "positive indirect evidence" of semantic activation (i.e., semantic priming effect) together with "negative direct evidence" (stimulus unavailable for report) of stimulus identification at the time of presentation. In the current study, semantic activation of the nontarget words (e.g., associative priming) in the contrast condition was indirectly evidenced by the faster response times to those words relative to the nontarget words in the random condition. As for nonassociative priming, again, there was indirect evidence of contrasting semantic and perceptual information facilitating word identification because responses to the target words in the contrast condition were responded to faster than target words in the random condition. The criterion of negative direct evidence of stimulus identification at the time of presentation was not met, however. The task was to make a decision about the categorical identity of a word. As an additional indication that categorical identification was being made, most of the youngest subjects made spontaneous comments about the categorical homogeneity of the nontarget words in the contrast list (e.g., "these are all people").

Fletcher (1983) proposed that his findings of category contrast effects were an indication that category information is a part of the processing of a word prior to recognition of the word. With that hypothesis in mind, the current findings were consistent with Fletcher's (1983) conclusion that category information was influential in the nonassociative priming activity in word identification. The findings also were consistent with Fletcher's (1983) conclusion that the temporal relation between primes and targets was significant in the demonstration of nonassociative priming in word identification. The nonassociative priming effect occurred at rapid but not long RSI's. The method set forth by Fletcher (1983) to obtain these findings, however, did not meet the criteria specified by Holender (1986) to ensure that category information about a word was elicited prior to the identification of the word.

The results of Experiment 3 (e.g., contrast effects with perceptual attributes) tend to raise further question about Fletcher's (1983) conclusion that category contrast effects were a measure of category information involved in the processing of a word prior to its explicit recognition. For example, Paivio (1971) reported that imagery and verbal associative processes were not influential in tachistoscopic perceptual recognition tasks (e.g., are successive words the same or different). He concluded that higher-order meaning (e.g., referential and associative) had no effect on perceptual recognition thresholds.

In a related area, studies that have used pictorial stimuli have obtained identification of the pictures after very short exposure. For example, Rayner and Posnansky (1978) used an illuminated tachistoscope and reported identification of pictures presented for the mean duration of 18 msec. Similar findings were reported by Purcell, Stewart, and Stanovich (1983). In other words, identification of stimuli that involve imaginal representations can be a very rapid process and permit early assess of associative and perceptual information in priming tasks.

Overall, there is indication that Fletcher's (1983) paradigm was not a valid measure for critically assessing the very early activation of categorical information in word recognition. The paradigm does not ensure that the activation of category information occurred from the orthography of the word prior to recognition of the word. The findings of the current study do indicate that category contrast effects are reflective of the temporal sensitivity of nonassociative priming. The time period over which the memorial representation of the abstracted category prime remains sufficiently active to influence the perception of the categorically unrelated target is short. The finding of the short temporal relation suggests that nonassociative priming does influence target word perception early in the process of making the categorical judgement about the word. These findings further indicate that even though categorically unrelated primes and targets require longer response times than categorically related primes and targets, under certain conditions (i.e., stimulus repetition effects), category primes unrelated to the target category do facilitate category judgements about the target word. That suggests that category information is a salient aspect of the concept of a word. However, there currently is not a critical measure of when in the "process" of word recognition category knowledge is accessed.

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Footnote

1. Repetition effects can involve the repetition of physically identical stimuli (e.g., A,A), repetition of stimuli with common features (e.g., A,a), repetition of semantic information about the stimuli that is defined by the experimenter or abstracted by the subjects (e.g., semantic category), or repetition of response pattern (Krueger & Schapiro, 1981). In the current study, "repetition effects" pertain to the use of abstracted stimulus information and repetitive response patterns.

APPENDIX A

TESTING MATERIALS

Instructions

I want you to play a word game on the computer. We will call it "War of the Words". I will tell you the name of a category, like "animals", "food", "vehicles" or "clothes". You will then see a word printed in the center of the computer screen. As soon as you know the word, you push the "yes" button (I will point to that button) if the word belongs to the category I told you, or the "no" button (I will point to that button) if the word does not belong to the category I told you. For example, if the name of the category I tell you is "animal" and the first word you see on the screen is "book", you will push the "no" button to say "no" a book is not an animal. If the next word you see on the screen is "cat" you will push the "yes" button to say "yes" a cat is an animal. Push ONLY one button for each word. Work as fast as you can but do not rush.

Place your hands beside the keyboard like this (demonstrate). After you push a button, it is very important that you return your hands to the sides of the keyboard. When you push a button, do not hold it down or jab it.

I want you to practice a few times before the real game of "War of the Words" begins. When you are ready to begin, push the middle bar (I will point to it). Look at the center of the screen. You will see the word "READY" and hear a beep. I will then tell you a category name. In a very short time, a word will come on the screen. As soon as you recognize it, push the "yes" button if the word belongs to the category I told you or the "no" button if the word is belong to the category I told you. There will be more "no" words than "yes" words. Work quickly but carefully. If you make a mistake do not try to correct it. Push only one button for each word. The category is ______.

(I said the category 3 times before the words began.)

Practice Words for Experiments 1 and 2

Targets

Clothes:	vest	belt	gown	shorts
People:	man	woman	artist	dentist

Nontargets: Contrast

Animals:	seal	giraffe	sheep	wolf
	swan	cub	zebra	ox
	rooster	boar		
Food:	rice	grapes	spinach	soup
	pretzel	butter	turkey	rolls
	ham	jelly		

Nontargets: Random

bank	cane	van	jeep
mountain	rug	barrel	highway
cage	shell	tooth	badge
plow	whistle	basket	home
bench	cradle	towel	bottle

WORDS for EXPERIMENTS 1 and 2

TARGETS

Food:	bread	cake	pie	beans
	carrot	peanut	cabbage	apple
	potato	corn	pears	banana
Animals:	dog	duck	cow	pig
	turtle	bear	bird	cat
	horse	monkey	snake	chicken
Vehicles:	tricycle	bus	boat	wagon
	airplane	car	bicycle	truck
	ship	skates	train	carriage
Clothes:	dress	sweater	skirt	shirt
	pants	mitten	tie	shoe
	coat	socks	jacket	hat

NONTARGETS: CONTRAST

Furniture:	lamp	bed	stove	table
	chest	desk	couch	stool
	chair	bathtub		
Body Parts:	arm	hand	leg	foot
	head	ear	nose	heart
	eye	mouth		
People:	boy	girl	pilot	nurse
	doctor	teacher	shepherd	lawyer
	baby	fireman		

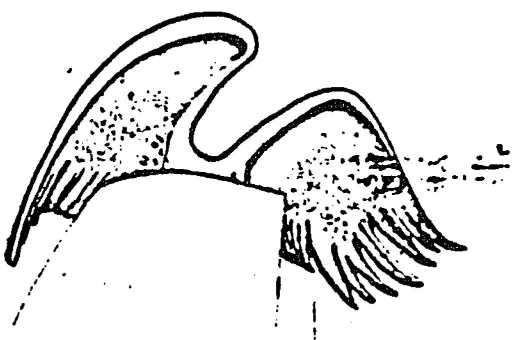
<u>Musical Instruments:</u>

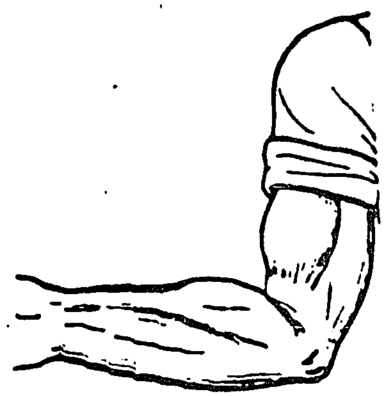
piano	violin	drum
guitar	bugle	flute
trombone	clarinet	organ
trumpet		

<u>NONTARGETS: RANDOM</u>

rose	tulip	leaf	hammer
school	house	bridge	fork
circle	chain	spoon	knife
candle	rope	crayon	camera
balloon	ball	kite	phone
scissors	lock	brick	pipe
torch	stream	penny	nickel
fountain	book	knife	brush
blanket	snow	rain	bucket
puzzle	star	moon	tree

PERCEPTUAL ATTRIBUTES for EXPERIMENT 3 - PRACTICE





PRACTICE WORDS for EXPERIMENT 3

Targets

Wings:	duck	robin	eagle	swan
Arms:	man	woman	dad	dentist

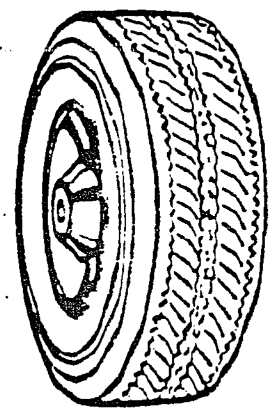
Nontargets: Contrast

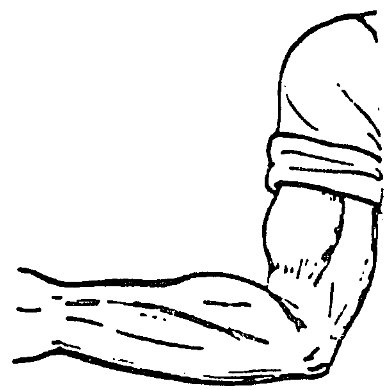
Animals:	burro	giraffe	turtle	worm
	hog	gerbil	zebra	mouse
	ox	boar		
Food:	pretzel	rice	ham	grapes
	butter	jelly	spinach	turkey
	soup	rolls		

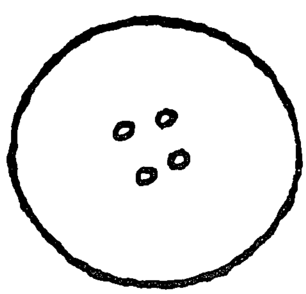
Nontargets: Random

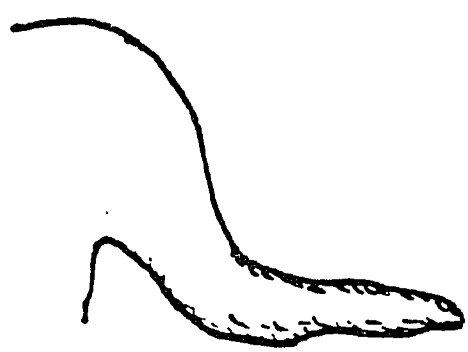
boat	barrel	tooth	basket
towel	ship	rug	badge
home	bottle	bank	mountain
cane	cage	plow	bench
highway	shell	whistle	cradle

PERCEPTUAL ATTRIBUTES for EXPERIMENT 3









WORDS for EXPERIMENT 3

Targets

Arms:	boy	girl	pilot	nurse
	baby	doctor	teacher	artist
	lawyer	fireman	father	mother
Wheels:	tricycle	bus	van	airplane
	car	bicycle	jeep	skates
	train	wagon	truck	carriage
Tails:	dog	duck	cow	sheep
	wolf	bird	horse	monkey
	snake	pig	cat	chicken
Buttons:	dress	sweater	skirt	pants
	suit	jeans	coat	pajamas
	jacket	vest	shirt	uniform

Nontargets: Contrast

Food:	bread	cake	pie	carrot
	peanut	potato	corn	pears
	apple	banana		
Furniture:	lamp	bed	stove	table
	sink	chest	desk	bench
	stool	bathtub		
Body Parts:	leg	foot	eye	head
	ear	nose	heart	mouth
	knee	toe		

Musical Instruments:

piano	violin	drum	flute
trombone	clarinet	trumpet	organ
guitar	bugle		

Nontargets: Random

rose	leaf	hammer	school
house	bridge	fork	circle
chain	spoon	tulip	candle
rope	crayon	soil	balloon
ball	cave	knife	phone
scissors	lock	brick	pipe
torch	stream	penny	nickel
fountain	book	sand	brush
blanket	snow	rain	bucket
puzzle	star	moon	dime

APPENDIX B

TABLES

TABLE 1

Mean Response Times (in milliseconds) to Target and Nontarget Words in Random and Contrast Conditions in Grades 3, 6, and U: Experiment 1

	Random		Contrast	
	Block Set 1			
Grade	Mean	SD	Mean	SD
Targets				
3	1484	236	1303	204
6	1405	203	1303	202
U	1239	256	1142	206
Nontargets				
3	1375	202	1244	161
6	1185	118	1084	111
U	1072	183	1027	115
	Block Set 2			
Targets				
3	1527	206	1314	153
6	1380	226	1274	197
U	1189	226	1165	182
Nontargets				
3	1298	207	1192	129
6	1168	147	1082	134
U	1032	144	960	139
	Block Set 3			
Targets				
3	1470	193	1270	131
6	1351	214	1228	152
U	1194	217	1183	194
Nontargets				
3	1258	207	1095	207
6	1131	141	1039	196
U	1047	147	1007	169

TABLE 2

Mean Response Times (in milliseconds) to Target Word Position in Random and Contrast Conditions in Grades 3, 6, and U: Experiment 1

	Random		Contrast	
	Block Set 1			
Grade	Mean	SD	Mean	SD
Target Word One				
3	1479	260	1301	206
6	1401	231	1340	228
U	1269	319	1179	264
Target Word Two				
3	1489	225	1303	209
6	1408	196	1266	183
U	1207	255	1105	278
	Block Set 2			
Target Word One				
3	1542	231	1341	131
6	1448	283	1316	217
U	1190	276	1185	219
Target Word Two				
3	1512	202	1288	183
6	1313	194	1232	188
U	1188	251	1145	281
	Block Set 3			
Target Word One				
3	1490	227	1296	127
6	1360	259	1267	270
U	1262	237	1222	220
Target Word Two				
3	1451	182	1245	152
6	1341	195	1188	240
U	1125	220	1144	271

TABLE 3

Mean Response Times (in milliseconds) to Target and Nontarget Words in Random and Contrast Conditions in Grades 3, 6, and U: Experiment 2

Grade	Random Mean	Random SD	Contrast Mean	Contrast SD
Block Set 1				
Targets				
3	1529	249	1484	285
6	1432	145	1446	136
U	1101	177	1086	209
Nontargets				
3	1357	296	1276	256
6	1208	163	1167	152
U	1037	193	1010	196
Block Set 2				
Targets				
3	1357	230	1404	201
6	1329	173	1283	166
U	1074	212	1080	204
Nontargets				
3	1170	233	1133	254
6	1181	114	1089	146
U	1030	119	952	107
Block Set 3				
Targets				
3	1328	229	1319	231
6	1290	167	1316	122
U	1080	196	1076	221
Nontargets				
3	1118	297	1112	240
6	1130	203	1068	177
U	997	169	931	182

TABLE 4

Mean Response Times (in milliseconds) to Target and Nontarget Words in Random and Contrast Conditions in Grades 3, 6, and U: Experiment 3

	Random		Contrast	
	Block Set 1			
Grade	Mean	SD	Mean	SD
Targets				
3	1666	248	1589	244
6	1539	193	1468	202
U	1257	262	1155	264
Nontargets				
3	1611	225	1555	245
6	1419	158	1364	173
U	1105	271	1083	309
	Block Set 2			
Targets				
3	1613	254	1530	264
6	1482	211	1391	154
U	1162	240	1092	225
Nontargets				
3	1426	220	1413	251
6	1391	185	1360	122
U	1052	250	1048	253
	Block Set 3			
Targets				
3	1534	253	1456	202
6	1429	169	1351	140
U	1151	256	1066	238
Nontargets				
3	1396	268	1331	260
6	1344	139	1250	154
U	1050	267	1010	256

TABLE 5

Mean Response Times (in milliseconds) to Target Word Position in Random and Contrast Conditions in Grades 3, 6, and U: Experiment 3

	Random		Contrast	
	Block Set 1			
Grade	Mean	SD	Mean	SD
	Target Word One			
3	1682	267	1649	264
6	1551	222	1507	199
U	1287	281	1210	294
	Target Word Two			
3	1651	241	1530	251
6	1527	189	1429	229
U	1227	270	1101	251
	Block Set 2			
	Target Word One			
3	1642	265	1572	291
6	1507	237	1401	197
U	1178	278	1124	229
	Target Word Two			
3	1584	256	1487	245
6	1457	201	1381	135
U	1146	223	1061	230
	Block Set 3			
	Target Word One			
3	1675	279	1617	221
6	1530	193	1499	149
U	1304	288	1177	246
	Target Word Two			
3	1617	221	1592	237
6	1489	149	1428	194
U	1177	246	1098	241