PERCEPTION OF SENTENCE STRESS IN

LANGUAGE-IMPAIRED CHILDREN

by

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ABSTRACT

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Two experiments were designed as a preliminary exploration of how stress is used by language-impaired children in the comprehension of spoken language. Response time was measured as subjects decided whether a probe word given immediately after a sentence had been present in the sentence. The results of the first experiment indicated that the probe latency technique was sensitive to the effects of word category (content versus function words) and word position on the response times of children with normal language in the kindergarten, first, third, and sixth grades. In the second experiment, the probe latency task was used to study the effects of stress in relation to word category, word position and sentence meaningfulness in a group of language-impaired children to whom control groups were matched for language ability and chronological age. The response times of the age-matched group were not affected by stress, word category or word position variations. The language-impaired and language matched groups responded to variations in stress and word category, and to sentence meaningfulness in similar ways. Response times to function words were increased significantly by the addition of stress. It was concluded that the absence of sensitivity to stress appears not to be a major causative factor of language impairment.

RESUME

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Deux expérimentations ont été mises sur pied à titre d'exploration préliminaire, sur la façon dont les enfants, ayant des troubles de langage, se servent du stress linguistique pour comprendre le langage parlé. Le temps de réponse a été calculé au moment ou le sujet décidait si un mot cible présenté immédiatement après une phrase, y était effectivement présent ou non. Les résultats de la 1ère expérimentation indiquent que la technique de cible latente est sensible aux effets de catégorisation de mots (mots de contenu versus de fonction), ainsi qu'à l'ordre des mots, et se manifeste dans le temps de réponse des enfants de maternelle, 1ère, 3ème et 6ème année ayant un langage normale. La tâche faisant usage d'une cible latente a été utilisée dans la deuxième expérimentation pour étudier l'effet du stress linguistique par rapport à la catégorie, l'ordre et le sens des mots, chez un groupe d'enfants ayant des troubles de langage. Deux groupes de contrôle rencontrant les mêmes critères que le groupe expérimentale au point de vue d'habileté linguistique et d'âge chronologique ont été utilisés. Le temps de réponse pour le groupe de contrôle ayant le même âge chronologique n'a pas été modifié par le stress linguistique ou les variations de catégorie et d'ordre des mots. Le groupe expérimentale et celui de contrôle ayant les mêmes habiletés linguistiques ont répondu

sensiblement de la même façon aux variations de stress linguistique, de catégorie et de sens des mots. Le temps de réponse pour les mots de fonction était plus long lorsque la variable de stress linguistique était ajoutée. Cette différence était significative. En guise de conclusion, il semble qu'une absence de sensibilité au stress linguistique n'est pas cause majeure de troubles de langage.

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CHAPTER ONE

INTRODUCTION

The perception of accent (sentence stress) by language-impaired children is the topic of this dissertation. Language-impaired children are deviant in their use of linguistic structure. Intonation and accent patterns are one way of structuring linguistic and semantic input. It is important to know if language-impaired children respond to structure of this kind and if they respond similarly or differently than children with normal language. Accent is a prosodic nonsegmental feature and can be defined as the emphasis or prominence given to the stressed syllable of a word to highlight that word as the semantic focus of a sentence. The stressed syllable of a word, i.e., word stress or stress, is the one that has the potential for receiving an accent. Stress and accent are inextricably interwoven with the intonation contour.

The concepts of accent and language impairment are complex and there is a lack of complete agreement regarding the nature of each. In the case of prosody, there is difficulty in assessing the relevant variables by acoustic analysis and perceptual judgement, and there is difficulty in the separate assessment of interactive cues such as pitch, intensity, duration, and linguistic factors. There is also difficulty in comparing research results obtained using different experimental paradigms. As far as language impairment is concerned, the very complexity of language makes its diagnosis and treatment difficult. There is not a general agreement regarding the exact criteria for defining language impairment, and well-standardized comprehensive tests of language ability are not yet available. There is again the difficulty of comparing research results obtained using different experimental paradigms. It is difficult to completely rule out the influence of subtle environmental factors, and also extremely difficult to separate cognitive and linguistic abilities (especially concerning semantics and pragmatics) in establishing "normal intelligence". There is now, however, enough research information accumulated about accent and language impairment to begin studying accent in language-impaired children. This is primarily so, because the focus of linguistic interest has shifted away from sentence grammar to pragmatic considerations of <u>interactive</u> communication situations. The terms accent and sentence stress will be used interchangeably and, similarly, the terms language-delayed, language-impaired and language-disordered will be used interchangeably.

Researchers have concentrated their efforts on investigating how accent aids in the comprehension process; more specifically they have investigated whether accent increases the rate at which sentences are decoded and constrains the possible parsing of a sentence into words and phrases. In studying children, some investigators have explored whether stress is a determining factor in the differential saliency of sentence elements. Others have studied the development of prosodic features in children and how these are used to communicate meaning at various language levels and in varying situational contexts. Language-impaired children are children who do not develop language in a normal way even though they appear to be cognitively, psychologically, auditorally and for the most part neurologically intact, and not deprived culturally. The primary deficit in language-impaired children appears to be one that affects the capacity to develop language. Although there have been several studies concerning the perception and acquisition of accent in normal children, only one previous study has explored accent in language-impaired children.

I will review the (1) relevant literature concerning the processing of accent by adults: (2) the place intonation and accent have had within general language acquisition theories in normal children: (3) the effects of variations in intonation and accent on selective listening, imitation and sentence comprehension in normal children; and (4) the nature of impaired language in children and possible deficits underlying impaired language. I shall begin by clarifying and describing accent and then show how it relates to other prosodic features.

CHAPTER TWO

REVIEW OF THE LITERATURE

The Processing of Accent by Adults

Within the phonological component of language, Crystal (1978) distinguishes between segmental and nonsegmental phonology. Segmental phonology involves the study of the vowel/consonant/syllabic system of sounds. "Nonsegmental phonology consists of any linguistically contrastive sound effect which cannot be described by reference to a single segment (phoneme) but which either (1) continues over a stretch of utterance (minimally a syllable) e.g., extra loudness or (2) requires reference to several segments in different parts of the utterance, e.g., use of breathy voice on vowels." (p. 33) Nonsegmental phonological features consist of both prosodic features and paralinguistic features. Although there is not complete agreement regarding the components of prosody, a straightforward and inclusive definition of prosody was suggested by Crystal (1975). Prosodic features in his view are linguistic (i.e., meaningful) variations in pitch, loudness and duration either singly or in combination (rhythm including pause, accent, timing). Nonsegmental variations other than those caused by pitch, loudness, and duration are referred to as paralinguistic features, e.g., nasality, huskiness, whispering.

Some prosodic features which share a "similar formal basis" and display some common "definition of contrastivity", may be grouped together into prosodic systems. There are four such systems:

(i) stress

(ii) pitch

(iii) timing

(iv) rhythm

Although the four systems are not mutually exclusive, they do provide a framework for separately considering prosodic features, and will be discussed as such below.

Stress

The prosodic feature of stress has been studied by linguists, phoneticians and psychologists, and all have contributed their own definitions of stress. This interdisciplinary study, although certainly beneficial, creates problems as well. There is confusion about the domain of stress, e.g., word stress, sentence stress, inherent or phonetic stress, and about the different terminology used by different groups of researchers who may or may not be referring to the same thing, e.g., stress, emphasis, prominence, accent, and tonic stress.

Stress functions at both the word level and the sentence level (Lehiste, 1970; Kurath, 1964; Bolinger, 1958, 1972). Bolinger clearly differentiates the two functions by giving them different names. The term stress is used to refer to word stress, while accent is used to refer to sentence stress. Word stress (stress, lexical stress, linguistic stress) is the inherent stress pattern possessed by a word of more than one syllable when uttered in isolation, in that one syllable and the same syllable always has stronger stress than any other, e.g., blackbird vs black bird. Monosyllabic words can have no inherent stress pattern. Word stress is predictable stress which belongs to the lexicon.

Accent is stress at the sentence level and belongs to the utterance. Accent falls on the stressed syllable of a word. According to Kurath (1964), some word classes are more likely to be accented (nouns, adjectives, main verbs and adverbs). These word classes are called content words. Others which are more likely to be unaccented (auxiliary verbs, pronouns, prepositions, conjunctions and certain adverbs) are called function words. The function of accent is to signal the importance of a word by giving pitch prominence to one of its syllables (Bolinger, 1958). The assignment of primary stress or accent has the function of highlighting the semantic focus of a sentence (Bolinger, 1972).

The acoustic correlates of stress are changes in fundamental frequency, duration and intensity (Fry, 1958; Lehiste, 1970; McLean and Tiffany, 1973). Variations in fundamental frequency and duration are the more reliable cues (Bolinger, 1958: Fry, 1955, 1958; Niemi, 1979). Changes in intensity and in formant patterns have also been shown to vary systematically with stress but to a much lesser degree (Fry, 1965). Fry (1958) found that as long as a pitch change is easily perceptible to listeners, they tend to judge a higher pitched syllable as more stressed, regardless of the magnitude of change. Bolinger (1958), claimed that pitch prominence, that is, pitch change is the important acoustic cue for accent. It is quite evident from this description that stress cannot be defined in terms of a single acoustic parameter. In addition, it has been found that there is a trading relationship between the acoustic cues which depends on syllable position and position within a phrase (McLean and Tiffany, 1973; Brown and McGlone, 1974).

The nature of stress has been studied by articulatory phoneticians. Ladefoged (1967) claimed that stress is best described in physiological rather than acoustic terms. There is, he stated, no single acoustic event that always occurs in all stressed syllables in English, but every stress is accompanied by an increase of subglottal pressure. Lieberman (1967) agreed that subglottal air pressure is responsible for frequency changes, giving laryngeal activity a secondary role. Collier (1975), on the other hand, gave a primary role to laryngeal activity and a secondary role to subglottal air pressure.

Pitch

Pitch features as prosodic systems can be divided into two systems, (i) tone, which refers to the direction of pitch movement, i.e., rises and falls within a syllable, and (ii) pitch range, i.e., the distance between adjacent syllables or stretches of utterance identified in terms of a scale running from low to high (Crystal, 1975, p. 94). The patterns of pitch movement that occur in a language are referred to as intonation patterns. Connected speech may be analyzed into a series of units of intonation called tone-units or tone-groups. The central nucleus of the tone group is called the tonic. The units of intonation function in sequences to produce melodic contours.

Variation in fundamental frequency over time is considered to be the strongest single acoustic correlate of intonation (Bolinger, 1958; Lehiste, 1970). Other acoustic correlates of intonation are considered to be changes in intensity and duration. Bolinger (1964) presented evidence to show the universal nature of intonation. All languages, he claimed, use pitch in some meaningful linguistic way, be it at the phonemic, syllabic or syntactic levels.

Bolinger criticized researchers who treat intonation as a unitary concept. He greatly emphasized that intonation is not a single system of contours or levels but the production of the interaction of features from different prosodic systems - tone, pitch-range, loudness, rhythmicality and tempo in particular. The various features are given a partly hierarchic organization; the tone unit is seen to consist minimally of a tonic syllable expounded by one of a set of nuclear tones (falling, rising, etc.) and optionally preceded and followed by other syllables involving differing degrees of pitch and loudness prominence. Fry (1958) found that variations in fundamental frequency affect both the intonation and stress patterns perceived by the listener.

Timing

Timing consists of changes in the durational characteristics of utterances including the duration of syllabic utterance, tempo and pausal patterns. The duration of syllables is affected by proximity to the ends of syntactic units, where syllables adjacent to boundaries are longer (Klatt, 1976); by the length of a phrase, where longer phrases have shorter syllables (Lindblom and Rapp, 1973); by the assignment of lexical stress, where syllables containing unreduced vowels are longer than those containing reduced vowels (Liberman and Streeter, 1978); and by the location of accent, emphasis or focus in a sentence, where syllables in semantically important words are longer (Lindblom and Rapp, 1973). The effects of stress and accent assignment are not necessarily restricted to the emphasized segment. The other unemphasized syllables are shortened relative to their duration in a "neutral emphasis" utterance (Lindblom and Rapp, 1973), the intervals between the syllables are affected (Folkins, Miller and Minifie, 1975), and unemphasized segments will have a longer duration when they are adjacent to the segment receiving emphasis than when they are farther from the location of emphasis (Weismer and Ingrisano, 1979).

Pauses are known to represent critical perceptual features from the level of within morpheme units to rhythmic patterns across entire phrases. Lieberman (1967) found that the duration of the interval between the vowels of 'light' and 'house' served as a cue to distinguish (lighthouse) (keeper) from (light) (housekeeper).

Tempo is the overall rate of utterance, which is primarily controlled by the number and extent of the pauses and secondarily by the durational characteristics of the syllable.

Rhythm

Rhythm refers to the pattern of time intervals between stressed syllables. Allen (1972) found that listeners can easily finger tap in time with the rhythm of an ordinary English sentence. The timing of taps is approximately synchronous with the onsets of the nuclear vowels of the stressed syllables. Not all lexically-stressed vowels receive taps, but vowels to which linguists would ascribe primary phrase-level stress, i.e., accent, and vowels carrying primary lexical stress in open class words, i.e., content words, tend to be accompanied by taps for most listeners. Martin (1972) showed that English is perceived to be rhythmical. He found that musicians can use musical notation to transcribe the perceived rhythm and timing of sentences. He also showed that disturbances to sentence rhythm may influence stress judgements and interfere with sentence decoding (Martin, 1975).

It has been suggested (Abercrombie, 1965; Martin, 1972) that in English there is a tendency for stressed syllables to occur at equal time intervals, i.e., to be isochronous or stress timed. Lehiste (1973, 1978) has shown that isochrony is for the most part a perceptual phenomenon and that listeners will make allowances for large durational differences in the rhythmic units of speech which are not made for non-speech units.

Prosodic Theories

Several theories have been advanced which describe how stress is assigned and what the function of stress might be. Four theories will be described: 1) generative theory of stress (Chomsky and Halle); 2) semantic theory of stress (Bolinger; Halliday); 3) interactional theory of prosody (Crystal); and 4) rhythmical theory of stress (Martin).

Generative Theory of Stress. Within the generative framework there was a reluctance to deal with the issue of prosody. The generative approach (Chomsky and Halle, 1968) relied primarily on a syntactic view of language treating prosody as a "residue". Crystal (1975) offered a good review of this and I shall follow his argument. The only aspect of prosody on which generative theory focussed was stress assignment, for which rules were proposed that would assign stress at various different levels, in a predictable fashion that was determined solely by the syntactic component of grammar. Chomsky and Halle (1968) formulated the nuclear stress rule which assigns primary stress (accent) to the rightmost primary-stressed vowel within a major constituent, thereby weakening all others. It was a rule that applied to surface structures and which operated after all other syntactic rules and lexical stress assignment rules. It resulted in the neutral intonation of English sentences in which the last constituent of the sentence is the one that is stressed. The function of stress was to cue syntactic structure for later semantic processing.

Semantic Theory of Stress (Accent). Bolinger (1972) opposed the generativist view and emphasized the difference between lexical (word) stress and accent (sentence stress). He argued that the location of sentence accents was a function of semantic information and not syntactic structure. According to Bolinger, accent has the definite function of highlighting the semantic focus and the semantic relationships of a sentence. His theory is linked to such notions as predictability and presupposition such that the parts of the sentence that are highly predictable are less likely to be accented, whereas those parts that are less predictable are more likely to receive primary accent. Likewise, the presenting context is important in the assignment of accent. Bolinger stated that accent is more likely to fall on information that is new and not presupposed, whereas the aspects that are presupposed (i.e., not new) will tend not to be accented.

Halliday (1967, 1970) presented a similar theory, stating that intonation and tonic prominence are related to the information structure of an utterance. He distinguished between information that is "given" (recoverable from context) and information that is "new" (unrecoverable from context) and claimed that stress is more likely to be assigned to the portion of the sentence that comprises the "new" information. What the speaker wishes the listener to attend to most particularly is signalled by the tonic - the most salient syllable in the tone group.

An Interaction Theory. Although Crystal (1975) agreed with the semantic approach of Bolinger, he claimed that the semantic explanation may be satisfactory for one aspect of intonation (tonicity or accent), but that other explanations may be required elsewhere. Based on an analysis of the prosodic patterns used in samples of informal spontaneous conversation, he presented a model (Figure 1) of language organization in which he proposed that prosodic phenomena be seen as an independent component which interacts with other components (e.g., accent placement and semantics, tone-unit placement and syntax) in specified ways, but that no one interaction is prior to any other.

He provided a model (production and reception) of nonsegmental phonology in which (1) the placement of tone-unit boundaries is determined by syntactic structure, (2) tonicity (accent placement) is primarily determined by lexical or semantic factors, by contrasts within a closed system, e.g., prepositions 'in' vs 'on', and by lexical presupposition (contrastive accent).

Indirectly tonicity is dependent upon syntax in that tonicity requires the prior establishment of a tone-unit to define its domain and tone units are determined syntactically. The model that Crystal proposed is an interaction model in which syntax, semantics and prosody interact simultaneously to give speech its characteristic intonation.

A Rhythm Theory. Martin (1972) proposed that the rhythmical aspect of prosody serves a perceptual function in sentence processing. He accorded stress an important role in the temporal organization of a sentence. According to Martin, one can from the first few words of a sentence determine the rhythm of the remainder of the sentence and thereby

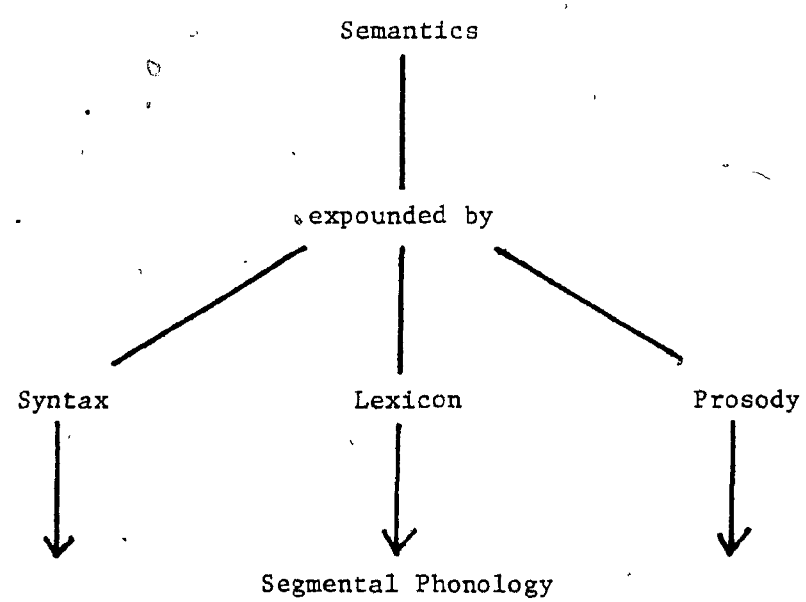


Figure 1. Crystal's Model of Language Organization Taken from The English Tone of Voice, 1975.

predict where upcoming stress locations will be. The ability to determine where stress locations will occur allows the processing mechanisms to direct a greater amount of attention to the potentially most important elements in a sentence.

Relevance of Prosody to Sentence Processing

There are several studies which indicate that prosodic features are relevant to sentence processing. The studies of O'Connell, Turner, and Onuska (1968), Zurif and Mendelsohn (1972), Leonard (1974) and Wingfield (1975) indicated how intonation affects the ability to recall verbal material; the Most and Saltz (1979) study explored the role of stress in indicating new information; and the studies by Dooling (1974) and Nakatani and Schaffer (1978) explored the positive effects of stress and rhythm on sentence processing.

O'Connell, Turner, and Onuska (1968) asked adult subjects to recall nonsense syllables which approximated more or less closely the morphological and/or syntactic structure of English. These levels of structure were defined by systematically varying the placement of function words and meaningful morphological word endings. The stimuli were presented in a monotone or with normal English intonation. It was found that intonation facilitated recall of both the more "grammatically" and less "grammatically" structured stimuli and that structure facilitated recall only if the "grammatically" structured stimuli were intonated.

Leonard (1974) investigated the affects of intonation (monotone vs. normal intonation) on the recall of normal sentences, anomalous (grammatical but unmeaningful) sentences, anagrams (ungrammatical but meaningful) and word lists. It was found that syntactic and/or semantic structure facilitates recall of intonated strings while both semantic and syntactic structure are necessary for recall of unintoned strings. Intonation facilitated recall of material with no meaning beyond the lexical level, i.e., intonation provided some structure which aided in the recall of otherwise unmeaningful stimuli. Leonard suggested that intonation may serve as a signal for grammaticality. "Upon the perceiving of an intonation contour, i.e., a sentence-like rhythm, subjects may search for something else sentence like." (p.334)

The results of a study by Zurif and Mendelsohn (1972) again confirmed that the rhythms of speech can play an important role in the initial determination of structure. Two sets of strings similar to those used in the O'Connell <u>et al.</u>, study, and containing the same nonsense syllables, bound morphemes and function words, were presented in a dichotic listening task. The set presented in a normal intonation achieved a superior right ear advantage, i.e., the same advantage noted for normal language and speech processing, while no advantage was noted for the set presented in a monotone.

Wingfield (1975) presented time-compressed sentences in either normal intonation patterns or in intonation patterns that conflicted with underlying syntactic structure. They found a general decrease in intelligibility with increasing compression. Subjects were, however, able to remember more of the sentences spoken in normal intonation than those spoken with anomalous or conflicting intonation. The same patterns of response were found for sentences spoken in French (Wingfield, Buttet and Sandova, 1979). Both French and English subjects accommodated the syntax to the prosodic curve, leading Wingfield <u>et al.</u>, to conclude that prosody may be the most resistent part of the speech wave form.

Most and Saltz (1979) tested the role of stress in indicating new information. Subjects were given active and passive sentences with stress on either the agent or patient of the sentences, e.g., "The little old lady crossed Cass Ave", or "The little old lady crossed Cass Ave." Subjects decided what questions the sentences would be replies to -- the question-answering element of the sentence is the new information in the sentence. The results support the theory that word stress communicates new information in speech. Stress was more effective for agent stressing than for patient stressing (the agent is more often considered to be the old information, whereas the patient is more likely to be the new information, i.e., where one would normally look for new information). The authors conclude that it is reasonable that stress would be more effective in directing attention to the agent which does not usually get attention.

Dooling (1974) demonstrated the importance of rhythm in sentence perception. A syntactic and rhythmic set was induced and followed by the presentation of a test sentence in which either the rhythm alone or both the rhythm and surface syntactical structure were changed. Changes in rhythm led to major disruptions in performance in which the effect of changes in syntax alone was not significant.

Nakatani and Schaffer (1978) found results to indicate that both stress and rhythm patterns provide cues which help a listener break up a stream of sound into the individual words intended by the speaker. They used the technique of reiterant speech to isolate the extent to which stress, rhythm, pitch and amplitude aid in parsing a tri-syllabic adjective-noun phrase, e.g., "malformed nose" vs "bright campfire" became "mama ma" and "ma mama", reiterated in the context of sentences. They found that the parsing of a phrase was affected when its stress pattern and rhythm pattern were changed, but not when its pitch and amplitude contours were changed. Rhythm served as a cue, through the lengthening of monosyllabic words and the elongation of initial consonants. Stress pattern can be either a direct cue when it constrains the parsing to be unique for listeners who know the rules, or an indirect cue when it gives rise to segmental cues (e.g., aspiration, glottal stops) that are strong markers of word boundaries.

The studies just reviewed have shown that variations in prosody affect the ability to recall verbal material, distinguish new from old information for the listener, and may help the listener segment the incoming verbal message.

Role of Stress and Accent in Sentence Processing

There are several recent studies which have dealt more exclusively with the role of stress in adult sentence processing and indicate that indeed stress plays an important role in sentence comprehension.

Foss (1969, 1970) found that reaction times in a phoneme monitoring task were faster when the phoneme to be identified was at the beginning of a content word. To identify a phoneme at the beginning of a function word produces a longer reaction time. Since content words tend to receive higher stress than function words, content words are likely to have more perceptual clarity than function words. It was suggested that the differences observed in the phoneme monitoring task could be explained by the fact that the phonemes in the content words were more perceptually salient than those in function words.

Shields, McHugh, and Martin (1974) conducted a study in which they presented sentences to subjects for a phoneme monitoring task. The phoneme was in the initial position of a ~~two~~-syllable nonsense word in which either one of the syllables was accented. The nonsense word replaced one of the nouns in the sentence. They found that RTs to the target phoneme were faster when the syllable containing the phoneme was accented than when it was unaccented. When a control experiment was carried out in which the acoustically identical nonsense words were spliced among other nonsense words, the differences in RTs to accented and unaccented syllables were no longer obtained. Although it has been suggested that a stressed syllable is more perceptually clear than an unstressed one, the authors claim that a difference in perceptual clarity cannot account for the difference in RTs among the meaningful stimuli, because the target words in both experiments were acoustically identical. They explained their results according to the rhythm theory proposed by Martin (1972), which was cited previously. Cutler and Foss (1977), however, suggested that perhaps a "form class hypothesis" could account for the results, since they claimed that although the target words in the Shields et al. study were nonsense words, they were never the less noun-like in function as they substituted for nouns.

A phoneme monitoring task was conducted by Cutler and Foss but this time the target phonemes were placed in the initial position of content and function words which were varied for stress. The results showed that RTs to stressed content words were no different than RTs to stressed function words, indicating that it was the stress factor and not the form class of the word that determined the effect.

A further study was conducted by Cutler (1975), as reported in Cutler (1976), to determine if one can predict where the stressed portions of an utterance will occur. A set of sentences was recorded in three versions such that the target element in each version received either high, low or neutral stress. The stress was varied by assigning different endings to a sentence so that the target word in one intonational curve naturally received high stress while the same word received low stress in another intonational curve. The high and low stressed targets were then excised and the neutral stress target spliced into the sentence in its place. The two sentence versions presented to the subject were, therefore, the same except that each had a different intonational curve and different endings after the occurrence of the target word. The target items, however, were acoustically identical, having neutral stress. RTs were, nevertheless, faster to the neutral targets substituting for high stressed targets and slower to the neutral targets substituting for low stressed targets. Cutler interpreted these results as indicating that subjects track the intonation contour and thereby conduct an active search for locations of high stress. "Since the RTs were faster, if the item was expected to bear high stress, processing at that point of the sentence was apparently facilitated in some way by the expectation of stress". (p.137)

The Foss, Shields et al., and Cutler studies show that the expectation of stress facilitates the way an item will be processed and that subjects consequently actively seek out where stress locations are more likely to occur so that attention may be focused there, thus reducing some of the uncertainty for the sentence processor.

The Place of Prosody in Language Acquisition Theory

Research in children's language has been almost exclusively concerned with segmental and verbal phenomena. "The nature and development of nonsegmental phenomena in children are generally ignored or referred to haphazardly" (Crystal, 1975, p. 125). Crystal cited many reasons for this lack of attention, including absence of a generally agreed upon classification, difficulty with obtaining data and terminological confusion. More recently, however, there has been more recognition of the importance of intonation and related features in recent language acquisition studies.

I shall briefly review five areas of research concerning language acquisition in order to indicate the role that prosody has within theories pertaining to language acquisition. These five areas are (1) Telegraphic Theory, (2) Semantic Theory, (3) Strategy Theory, (4) Adults Speech to Children, and (5) Pragmatic Theory. A brief description of the development of prosodic features will follow.

Telegraphic Theory

Much of the early research in child language was primarily concerned with characterizing or describing the verbal output of children at different stages of development (Brown and Fraser, 1963; Brown and Bellugi, 1964; Braine, 1963; Miller and Ervin, 1963). The basic technique was to tape record the child's spontaneous speech and then write a grammar that could generate the utterances observed. No account was taken of the context in which the utterances were spoken nor of the prosodic features that accompanied them. It was thought that the written grammar in some way reflected the production rules that children used in generating speech. The independent researchers listed above, observing the natural languages of children from ages one and one half to three in a variety of language communities, reported similar rule systems and similar developmental sequences. The consensus was that from the onset of sentence production, the constructions children use are not random combinations of words, but quite systematically ordered combinations of primitive grammatical categories that they join together. The basic grammatical relations (e.g., noun, verb) are combined into the basic grammatical categories (e.g., subject of a sentence) of phrase-structure grammar.

Brown and Fraser (1963) and Brown and Bellugi (1964) described early speech as being "telegraphic". During this stage of development the sentences the child forms are very similar to the syntax an adult would use in telegram. They found that their children retained nouns, verbs and adjectives, and deleted articles, prepositions, modal auxiliaries and inflections. The retained morphemes were those that were reference-making forms, were relatively unpredictable from the context and received the heavier stresses in ordinary English pronunciation, i.e., content words. The deleted morphemes were those that "were not reference-making, were relatively predictable from context and so carry little information; and receive the weaker stresses in ordinary English pronunciation," i.e., function words.

Brown and his colleagues suggested that the reason for the deletion of function words and the retention of content words may be that function words are not stressed while content words are generally stressed. It was thought that the stress factor might account for the perceptual selection of items from utterances and in turn determines the expressive content of early sentences.

Semantic Theory

Bloom (1970) began to look not only at the actual surface words that were used, but at the context in which the words were spoken and at the prosodic features which accompanied the utterances to determine the functional relations and meanings which the child intended. Bloom's argument centered around the fact that the motivation of children's speech is not in the grammatical structures and relations that children use, but in the semantic intentions or relations that they are trying to communicate. The child may use the same grammatical structure to communicate several semantic intentions and it is only the context and prosodic features which indicate what the child is trying to communicate. It is her feeling that the surface characterization of child speech as telegraphic is an inadequate description of children's real competence as it is a superficial description governed by distributional characteristics and has no way of including or describing the semantic relationships which the words express.

One example cited by Bloom concerned Kathryn, one of Bloom's subjects, who used the construction "Mommy sock" on two separate occasions. The utterance, however, had a different semantic intention on the two occasions that would not be highlighted in a characterization of speech based on distribution characteristics. On one occasion the intention was to show ownership or possession, "This is mommy's sock", on the other occasion the intention was to indicate an agent object relationship, i.e., Mommy is putting on Kathryn's sock. At the two word stage, intonation is used to indicate different sentence types (e.g., imperative vs. question) and stress is used to indicate differentiation of meaning, e.g., possession vs. location) within sentence types.

From the results of Bloom's work, semantic intentions and their syntactic expression became one of the central focuses of child language study. To gain a better understanding of the early semantic-syntactic relations, researchers began studying children's single word utterances. Prosody took on new importance in attempts to describe syntactic knowledge in one word utterances and successive one word utterances, and in differentiating the syntactic knowledge at these periods from that at the two word utterance level.

Prosody, according to Bloom (1973), distinguishes successive single word utterances at 19.3 and 20 months of age (utterances in which the words are separated by pauses and each word has equal stress and a falling terminal contour) from two word utterances at 28 months (which have a falling terminal contour after the last word only with shorter although still variable pause times between words and stress applied more to one word than to the other). She claimed that single word utterances and successive single word utterances are not syntactic, because although children have the availability of the words, e.g., "daddy car", they do not relate the two concepts under one syntactic structure. Branigan (1978) has spectrographically studied the duration and fundamental frequency contour of words in children's single word, successive single word and multi-word utterances. He found that successive single word utterances shared prosodic patterns with multi-word forms and not with single word forms. For Bloom and Branigan, the prosodic integration of utterances, rather than the number of elements expressed, was taken as an indication of underlying structure.

Strategy Theory

Researchers looked at the characterizations of child speech and remarked upon the uniformity and commonness of pattern with which different children learn different languages in different parts of the world. The strategy approach, which places great emphasis on how children learn to process and comprehend speech, was suggested to account for the common orders of language acquisition.

According to the strategy approach, constraints exist on children's capacity to process speech, making it necessary that they use strategies to process linguistic information, e.g., two-year olds search the input for adjacent noun-verb sequences which they interpret as agent-action constructions (Bever, 1970). It is hypothesized that the strategies children use are universal to all children learning language. Slobin (1971, 1973) drew on the results from language acquisition in children learning different languages. He compared the devices which different languages use to express a similar semantic notion and the age at which children using those languages express particular concepts. In this way he isolated some of the features which children seem to select in the utterances they hear. From these he postulated a set of 'operating principles' or strategies that govern the selective listening of children, e.g., pay attention to the ends of words. Chapman and Kohn (1978) found, however, that children who are two and two and one half years old showed consistent individual preferences for applying a strategy, e.g., animate nouns as agent, in some sentences but not in others.

Brown (1973) claimed that the idea of telegraphic speech is still appropriate as a characterization of early speech, providing one realizes that there is not a total absence of function words and that there are various independent variables which can account for the earlier acquisition of some words over others. He suggested that frequency, perceptual saliency and syntactic and semantic factors will all play a role in determining which function words will be mastered first. There have been several studies which have investigated accent as a decoding cue for children. However, these will be reviewed in a later section.

Adults' Speech to Children

Prosody has become an important variable in a new group of studies which focus on the variables present in adults' speech to children. These studies focus on the form of adults'speech in order to describe the model of speech from which children learn language. The results of these studies show that the speech which adults direct to children is very different from the speech which adults use in conversing with other adults (Ervin, 1973; Snow and Ferguson, 1977). Linguistic structure is simplified and sentences tend to be short and grammatically well formed. Speech contains a lot of redundancies, repetitions, imitations, and attentionals and is generally closely related to the immediate context or situation. These features can be seen in the following example from Snow (1972). "Pick up the red one. Find the red one. Not the green one. I want the red one. Can you find the red one?" (p. 563). Adults also tend to speak with exaggerated intonation patterns when speaking to children (Blount and Padgug, 1976; Sachs, 1977). Garnica (1977) found that intonation patterns, as measured by frequency range, were exaggerated to the extent that many adults speaking to children used almost twice the normal adult-to-adult range. She also found that primary stress (accent) placement was different in the speech directed to the child listener with the occurrence of two primary stressed syllables in a sentence which ordinarily in adult-to-adult speech would contain only the primary stress. The duration of certain content words was prolonged in speech to the child listener as compared to the adult listener.

It has been said that the feature modifications of adult speech have an adaptive significance to the child developing language (Sachs, 1977). Like mothers, older children will adapt their speech in appropriate ways when speaking to younger children (Shatz and Gelman, 1973), and to dolls (Sachs and Devin, 1976), and the speech fathers direct to their children displays the same simplification characteristics (Rondal, 1980).

Some studies (Furrow, Nelson and Benedict, 1979) are beginning to explore the relationship between certain aspects of parent language and child language growth. There have not as yet been any which explore how the intonational characteristics of mothers affect language growth. The results of one group of experimenters incidentally shed some light on this matter. Li and Thompson (1977) found that children in their study produced syllables that would ordinarily be unstressed as stressed, i.e., with the full tone accorded to stressed syllables. In an effort to explain this result, they looked at the speech of the caretakers of these children and found that the caretakers were using these "deviant" stress patterns in their speech to the children when trying to teach them words.

Pragmatic Theory

Prosody has an important communicative function within the pragmatic theories of language acquisition (Bates, 1976; Dore, 1974, 1975; Halliday, 1975). From glosses gained by videotaping children, Dore (1974) described children's single word utterances as "primitive speech acts": A primitive speech act may be a single word (rudimentary referring expression) and/or a single prosodic pattern which functions to convey the child's intention before he acquires sentences. Prosodic patterns convey the 'primitive force' of the primitive speech act, i.e., they indicate how the child intends his utterance to be understood. The prosodic pattern enables the listener to distinguish among the acts of labeling, requesting, and calling even though the child may have only a limited repertoire of words. Dore stated that, "contrasting intonation patterns are the strongest behavioral evidence for inferring contrasting pragmatic intentions" (p. 134).

Dore (1972) found differences in the formal aspects of children's early language. One of the two children that he studied produced far more prosodic features, while the other produced far more words and fewer prosodic features. Dore suggested that there may be predominantly "word-babies" or "intonation-babies" and that "these differences among children may provide them with the basis for different strategies for acquiring the syntax of their language" (p. 349).

Halliday (1975) reported that Nigel, the child he studied, used prosodic features to distinguish between new and old information and to consistently communicate different functions (intentions). Up to the age of two, Nigel would use a declarative structure, i.e., falling intonation to accompany information that was already known to the listener and used an interrogative structure, i.e., rising intonation to indicate information that was new. The falling intonation pattern was also used to communicate the pragmatic function "language as doing", i.e., language which did not require a response on the part of the listener. The rising intonation pattern was used to communicate the mathetic function "language as learning", i.e., language requiring some response on the part of the listener.

The role of adult speech within a pragmatic theory of language acquisition is not so much a matter of how the adult input determines what the child learns. It is more a matter of how adult-child interaction itself is the originating and motivating force for language learning.

The Development of Prosodic Features

Although the research concerning the acquisition of prosodic features is very sparse, one can put together some of the findings to suggest a description of prosodic acquisition. A far more detailed description can be found in Crystal (1975, 1978). There is evidence that early communication is essentially prosodic in nature. Kaplan (1970) demonstrated that a contrast between falling and rising tones can be discriminated by four month old babies. Contrasting tone and intonation contours are produced earlier than segmental contrasts (Von Raffler Engel, 1973; Li and Thompson, 1977). The infant at first varies intonation patterns to express physiological and emotional needs. These patterns emerge at six to seven months (Crystal, 1973) and become distinct at approximately eight months of age (Lenneberg, 1967). Intonation has been cited as the primary means of segmenting the relatively continuous speech signal to permit isolation of relevant syntactic or semantic components (Lieberman, 1967). Tonkova-Yampol'skaya (1973) studied the development of intonation contours and presents evidence to show the appearance of a placid cooing intonation at two months, a happiness intonation at three months and a request intonation at seven months. From nine to 12 months children may use primitive lexical items on single words with appropriate rising and falling prosodic contrasts to communicate labelling, calling, and requesting functions. The prosodic dimension of these units is far more stable and easier to elicit than the segmental dimension (Crystal, 1975). Lewis

(1951) found that children at the end of their first year respond in similar ways to phonetically different adult utterances if the intonation contour is the same.

The single word utterances of children are at first separated from each other, with each word being equally stressed and having its own terminal falling contour (Bloom, 1973). Leopold (1971) suggested that comprehension at the single word utterance stage primarily depends on the child being able to recognize the highly stressed and salient words in an utterance, and that adults speaking to children help them understand by repeating key words and exaggerating stress. Children soon after produce successive single word utterances with prosodic characteristics that resemble those of multiple word utterances, i.e., the words occur with unequal stress and with shorter but variable intervening pauses between them (Branigan, 1978). The prosodic characteristics of successive single word utterances give way to the full prosodic integration of two or more words under one intonation contour.

Within this intonational contour, the placement of accent is governed by the "new information" elements in a sentence or context (Hornby and Hass, 1970; Wieman, 1976). It has been suggested that the communicative value of prosody for the listener decreases with increasing age and that children by age two have mastered all the relevant prosodic contrasts. However, the use of accent patterns to distinguish between grammatic patterns such as nominal compounds (hotdŏg) and adjective-noun phrases (hŏt dog) (Atkinson-King, 1973), learning to associate meaning with certain intonations (Cruttenden, 1974) and learning the rules for pronominal reference (Maratzos, 1973; Solan, 1980) are not learned until much later.

Effects of Variations in Intonation and Accent Upon The Response Patterns of Normal Children

The effects of variations in prosodic input on selective listening preference, sentence imitation, grammatical class selection and sentence comprehension have been investigated in a number of studies.

Selective Listening Preferences

Evidence for the effect of intonation on selective listening preferences first came from a study by Rileigh (1973), who found that first and second grade children chose to listen to a story presented in a lively intonation four times more often than the same story presented in a monotone intonation. Bohannon and Friedlander (1973) found similar results when they asked children in kindergarten through fifth grade to choose between a meaningful, normal syntax story narrated in a flat monotone and a non-meaningful, scrambled syntax story narrated in a lively intonation. The kindergarten and first grade children's choice was again more determined by the livelier intonation despite a sacrifice in meaning. The older children's choices, however, were determined by meaningfulness based on correct syntax.

Effects of Prosodic Variation on Imitation

Bonvillian, Raeburn and Horan (1979) examined, among other variables, the effect of intonation on children's ability to imitate sentences. Twelve nursery school children were asked to imitate active affirmative declarative sentences that were three, six, nine or 12 words long and which were spoken with either a normal or flat intonation. They found that intonation had no effect on the imitation of short sentences, but did allow subjects to perform more accurately on the 12-word sentences. The authors concluded that intonation does facilitate recall when the limits of the child's memory are approached, and went on to suggest that "exaggerated intonation of the sort used by adults when talking to children might be even more helpful than normal intonation" (p.465).

A study by Risley and Reynolds (1970) indicates that stress can determine which aspects of an utterance are more likely to be imitated. They asked four- and five-year-old disadvantaged children to repeat sentences of varying lengths in which the number of words stressed per phrase was varied. For the children who imitated only parts of a sentence, stress was effective in influencing which parts the children would imitate. Stressing a word increased the probability of that word being repeated as an inverse function of the proportion of the words that received stress. When only a small number of words in a sentence were stressed, stress also increased the probability that unstressed words in the same phrase as the stressed words would be imitated.

Blasdell and Jensen (1970) showed that stress and word position act as decoding cues for first language users. In English it is difficult to separate the effects of stress and terminal position, since it is the terminal position which is most likely to receive the stress in unmarked English intonation. They presented strings containing four nonsense syllables to children between the ages of 2:4 and 3:3. Primary stress accent was assigned with equal frequency to each of the four syllables within a string. They found that both primary stress and terminal position favored reproduction of the syllable by the children. In their discussion, the authors suggested that "the role of stress and word position may be to mark the content words of the adult utterance for processing and that the child may learn the content items of the language on the basis of intonation cues" (p.202). One must keep in mind, however, that the stimuli in this experiment consisted of nonsense syllables and that one cannot necessarily generalize these results to meaningful structured speech.

Dupreez (1974) provided further evidence to indicate that stress determines which aspects of an utterance are more likely to be imitated. He collected speech samples from three children at the one word stage of language acquisition while they were conversing with adults. He divided the samples into tone groups and then analyzed the tone groups for imitations of the tonic syllable. He found that the children had a strong tendency to imitate the word on which the major stress (tonic accent) falls. Words occurring in the final position of a tone unit were imitated before similar content words which were not tonic (i.e., occurring earlier in the sentence). When the tonic appeared earlier in the sentence the child imitated not only the tonic word, but also some of the words that followed. Dupreez stated that his results demonstrate the importance of the tonic (which adults greatly exaggerate in their speech to children) in shifting the attention of the child to the different parts of the sentence which occur early, and that the tonic "appears to act as a signal to notice what is to follow"(p. 71).

Effects of Stress on Grammatical Class Selection

The experimenters of the next three studies were not particularly concerned with the effect of stress variations on responses. However, some of their results are relevant to the question of the role of stress in the comprehension of utterances and selection of grammatical classes (content vs. function words) for future use. Shipley, Smith, and Gleitman (1969) investigated how children at the holophrastic and early telegraphic stages of language development obey commands by a touching or looking response. The investigators attempted to ascertain what parts of the utterance these children select or attend to most. The imperatives were well formed, i.e., containing content and function words which were varied naturally in stress (Give me the ball), telegraphic (Give ball), containing only content words in which both words were equally stressed, and holophrastic (Ball), containing a noun which was necessarily stressed. Children at the holophrastic stage of development responded best to holophrastic or telegraphic commands, i.e., commands similar to the kinds they produce. However, the experimenters noted that the presence of a familiar item was the primary factor in obtaining a relevant response. While the experimenters concluded that familiarity rather than stress seems to be the determining factor, it is possible that children are accustomed to hearing well-formed sentences from adults and respond unnaturally to ill-formed sentences. Telegraphic speakers responded best to the well-formed commands which were more complex than their general way of speaking.

Petretic and Tweeney (1977) replicated the Shipley et al. experiment. They required that children act out the meaning of well-formed imperatives and declaratives, i.e., adult forms, telegraphic imperatives and declaratives, i.e., child forms and imperatives and declaratives in which some of the function words were replaced by nonsense words. All of the subjects responded more accurately to adult forms than to child forms, and although the subjects responded to forms containing nonsense words, the adult form was responded to most often, indicating a facilitative effect of the function words. They concluded that although "primary attention is addressed to content words, non-contentives do appear to be evaluated by telegraphic speakers" (p. 208). It was suggested that non-contentives may act as markers for content words (i.e., facilitate their detection).

Homzie, Gravitt and Deese (1978) compared the tendency for children to drop functions (prepositions) and contents (nouns and verbs) when each of these provides a critical element in what children are to reproduce from immediate memory. Children were asked to repeat a story containing two to three sentences with a total of ten to fifteen words. Some of the sentences emphasized nouns, some verbs, some prepositions and some had no special emphasis. Emphasis was not achieved by alterations in prosody but by contrasting two words of the same grammatical class, e.g., Tom is running not swimming, or by making the emphasized word a necessary component for understanding the story, e.g., Tom couldn't see. His hands were over his eyes. Therefore, the emphasis was created by semantic variation. Children had greater difficulty in repeating the content of the story in which prepositions are emphasized than stories in which nouns and verbs are emphasized. However, they found that when prepositions are emphasized, they are produced as often as nouns and verbs.

The experimenters in three of the next four studies were concerned with the effect of stress variations on responses. Since content words are more likely to be stressed than function words in English, it is difficult to separate the effects of stress and grammatical form class. In order to assess the affect of stress on the selection of content and function words in a normal speech situation (where stress tends to be placed on content words, and where function words are generally unstressed), these experimenters used the strategy of "leaving the prosody out". Scholes (1969) asked adults and children (3 yrs. 4 mos. to 5 yrs. 10 mos.) to imitate both well-formed sentences and sentences violating semantic and syntactic constraints. All stimuli were presented in citation form, i.e., unaccompanied by any intonational features. He found that the absence of suprasegmental features and the presence of anomaly had no effect on the adults' imitation ability. The important factor for adults was the grammatical well-formedness of the stimulus. The younger children's reproductions contained the same number of errors for both grammatical and ungrammatical sequences, a finding which, according to Scholes, was due to the absence of suprasegmentals. This finding, however, may have nothing to do with the absence of intonation, and could be just as easily interpreted as a failure of these children to use grammatical organization in recalling the sentences. With increasing age (at approximately four and one half years), the children were able to use the available grammatical cues. The errors made by the children tended to be deletion errors with function words being deleted much more often (31% of attempts) than content words (10% of attempts). This pattern of deletion did not vary with the type of strings, i.e., for grammatical and ungrammatical strings. Since no intonational cues were present to distinguish function and content words, Scholes concluded that something other than stress was accounting for the observed differential deletion.

In a second study, Scholes (1970) tried to further explore the factors responsible for retaining contentives and deleting functions. Young children (mean age 3 years, 11 months) were asked to repeat a set of word strings which varied in length (3, 4, and 5 words) and syntactic and semantic well-formedness, and then the same set with the function or content words replaced by nonsense words. The data indicated that deletion of content words was not affected by deviations from well-formedness. Subjects could recognize and retain those words whether the strings they were embedded in were sentences or not. The deletion of function words was strongly affected by well-formedness. A greater number of function words were deleted when the stimulus was well formed or syntactically deviant than if the stimulus was semantically anomalous. Imitation of the strings containing nonsense words indicated that children deleted nonsense items accompanied by real content words far more than they deleted nonsense items accompanied by real function words. Scholes again claimed that stress is not a factor since all the stimuli were citation readings. However, this conclusion is unwarranted, as the stress factor was never assessed as a variable in the experiment. Syntactic factors do not account for the data, as the differential retention was observed in the syntactically deviant strings. Scholes asked, "Could the child be equating importance with some semantic notion such as propositional nucleus? Perhaps he could. If the semantic cohesion of the string is destroyed, the differential retention also disappears" (p. 169). Scholes concluded that if the child can assign a reading to the string, he deletes functions. However, if no reading can be assigned, all words are then treated alike and the amount of deletion is governed by capacity and not linguistic strategy.

Freedle, Keeney and Smith (1970) found that while sentence grammaticality had no effect on the retention or deletion of nouns, it did have a strong effect on the imitation of function words (articles in this case), in that a significantly greater number of articles were deleted in ungrammatical strings. These findings are contrary to those of Scholes, who found ~~higher~~ deletion rates for well-formed sentences than for ungrammatical ones. The fact that the sentences were read with normal intonation, as opposed to the citation form used by Scholes, may account for the difference. Sentence grammaticality was claimed to be the predominant factor accounting for article deletion rather than low information value and lack of stress (again these researchers did not investigate the stress aspect). However, a general tendency to delete functions was noted for the grammatical sentences as well. The authors state that, "It is still possible that the tendency to delete articles and inflections may be due to differential stress and low information value within the grammatical sentence" (p.153).

Eilers (1975) compared the effects of suprasegmental (prosodic) cues, semanticity and word order changes on the imitation of content and function words in an imitation task. She varied the suprasegmental, grammatic and semantic features of ten simple declarative sentences (four to six morphemes long) and presented them to children between 18 and 37 months of age. The sentences were presented under three suprasegmental conditions:

(i) normal unmarked intonation pattern

(ii) as citation readings

(iii) with only one suprasegmental variable, i.e., duration.

As only the semantic and word order (grammatical) changes produced statistically different performance, Eilers concurred with Scholes and Freedle _et al._ that suprasegmental features cannot account for the predominance of content words in children whose speech is telegraphic. When suprasegmental cues are removed, children still distinguish content from function words and, in fact, delete functions words even more. However, a closer examination of the data reveals that the sentences lacking suprasegmental cues were imitated more poorly than those in the control condition and that when only one suprasegmental feature--duration--was added, there was no decrement in performance from the control condition. Eilers said that these suprasegmental trends were reflected by the difficulty the experimenter had in obtaining imitations when all suprasegmental features were held constant and the relative ease of persuading children to imitate the sentences in which one suprasegmental feature duration was allowed to vary. She stated that "suprasegmental salience predominates sometime during the first 18 months of life and helps to determine the order (hierarchy) of linguistic processing in the young child" (p. 237). Eilers felt that "for children aged 18 to 36 months ... such suprasegmental information may already be redundant since grammatical processing is fairly well developed" (p. 237). However, the results of this study do not necessarily mean that stress has no function, but only that it does not affect the imitation of certain sentences, i.e., the sentences of her study. In addition, one must keep in mind the results of the Cutler (1976) study, which indicated that stress plays an important role in adults' processing of sentences, even though their grammatical processing is well developed.

As a final note on this topic, Crystal (1978) was critical of the strategy of investigating prosodic effects by "leaving the prosody out", i.e.,presenting a series of stimuli in identical tones of voice. He said that they involve assumptions which themselves need investigation. Sequences lacking prosody are abnormal in parent-child interactions, and there is a question as to how much the strangeness of the stimuli would affect responses. To really examine the effects of stress, one would have to use stimuli that are deviantly stressed.

Effects of Prosodic Variation on Sentence Comprehension

Wheldall (1978) investigated the influence of intonational style on sentence comprehension in children between the ages of 3:9 and 4:9. Some of the children heard sentences presented in a highly-intonated, lively form (similar to the way adults talk to young children), while the other children heard the sentences presented in a flat, monotonic form. Although they found that overall sentence comprehension scores did not vary as a function of intonational style, they did find a statistically significant effect on the comprehension of passive sentences, favoring the heavily-intonated condition.

Lahey (1974) investigated the relative importance of word order, syntactic markers (morphemic inflections and function words) and prosody (intonation, stress and durational aspects) in signalling the relationships among the grammatical units of sentences. Children were asked to act out the semantic-syntactic relationships of sentences (co-ordinate sentences, sentences with center-embedded relative clauses, and sentences with a right branching relative clause) presented with prosody and/or markers eliminated, or with both intact. She found that for most sentence presentations, the presence of prosody and/or markers did not increase the performance over that obtained when only word order was the primary linguistic cue used for the determination of relationships within sentences. She attributed the difference in the use of prosody in her study and in studies of imitation (where the prosody has been shown to have a positive effect) to the nature of different response modes. An imitation task, she explained, may not require interpretation of semantic relationships as does a task requiring the manipulation of objects. Furthermore, the time between the stimulus presentation and imitation of response is different for the two tasks, perhaps requiring different memory processes. However, for centre-embedded sentences containing markers, the presence of prosody did significantly improve performance. Lahey explained that when centre-embedded sentences are presented with prosody there is a reduction in the interference of the markers. With sentence prosody, substantive (content) words are stressed more than function words causing a decrease in the duration of function words relative to substantive words. Without prosody the duration of all words was equal. Lahey suggested that the children may have had a search strategy that ignored unstressed elements without a referent and held only stressed words in memory when a stress difference is present. Differential stress may aid sentence processing by reducing the time or space in storage for elements not considered essential in the search for subject-verb-object, i.e., basic syntactic-semantic relations. Lahey concluded that "if so, prosody may play a role in language learning by pointing out the major lexical items upon which to apply an order strategy and not as a device signalling relationships" (p. 664).

The above studies of the effects of variations in intonation and accent upon the responses of normal children, suggest that children attend differentially to different grammatical word classes and that accent may play a role in determining this differential attention. The results obtained with these experimental paradigms cannot necessarily be generalized to the communicative function of prosody in actual communication interactions but have provided some important information about the role accent plays in psycholinguistic experimentation.

The Language Deficits of Language-Impaired Children

Language disorders may be associated with many different conditions, e.g., mental retardation and deafness, in which the cause for the disorder is known. However, there are other children who fail to develop language, and although neurological abnormality is suspected, the cause for the language problem is not known. In some of these cases, it is suspected that the absence of language is part of a more encompassing psychopathological disorder, e.g., autism, schizophrenia, while in other cases the absence of language seems to be a more specific phenomenon and somewhat less related to other factors. The children in this last category are generally labelled "language-impaired", "language-disordered", and "language-delayed".

The literature to be reviewed concerns language-impaired children. However, the concept of language impairment is complex and there is a lack of complete agreement regarding its nature. While most investigators try to control for the known causes of language delay, i.e., hearing, neurological, physical, cultural, and personality abnormalities, a variety of these may occur either singly or in combination, to a small degree, in language-impaired children. It is difficult to completely rule out the influence of environmental factors and extremely difficult to separate cognitive and linguistic abilities (especially semantics and pragmatics) in establishing "normal intelligence". It is often difficult to compare research results obtained using different experimental paradigms, and in comparing the performances of language-impaired children to that of matched normals, different researchers use different matching procedures. Some investigators match according to language ability;

while others match according to chronological age. In matching according to language ability, some use standardized tests, which differ; while others use length of utterance, calculated from spontaneous speech samples, which vary according to the number of utterances collected and the contextual situation, in which the utterances are obtained. It is important, therefore, to keep in mind all this variation when generalizing about the results of studies concerning language impaired-children.

There have been two approaches to the study of language functioning in language-impaired children. The first involves obtaining descriptions and classifications of the language patterns produced so that comparisons may be made with language patterns produced by normal children of the same age or younger. The descriptions have been obtained primarily from data collected from spontaneous speech samples. Syntactic, cognitive-semantic, and pragmatic comparisons have been made in order to determine where the impaired linguistic functioning is deviant and whether it is qualitatively deviant, quantitatively deviant, or whether it is simply delayed.

The second approach is concerned with identifying the underlying processes which may account for the observed language patterns. The main theories put forward to account for the deviant language of language-impaired children postulate 1) a deficit in auditory abilities (temporal perception, auditory memory, or rate of processing), or 2) a specific linguistic deficit. Research dealing with both approaches will now be reviewed.

<u>The Syntactic, Semantic and Pragmatic Nature of Dysphasic Language</u>

<u>Syntactic</u>. Menyuk (1964) used a generative model of grammar to

compare the grammar of ten children diagnosed as using "infantile" speech with the grammar of ten children using normal speech. She elicited language samples from the two groups of children who were matched for age (age range from 3 years to 5 years, 2 months) and asked the children to repeat sentences which contained varying phrase structures, transformations, and ungrammatical forms (approximations to well-formed sentences). An analysis of the language samples revealed that the grammatical usage of the two groups differed. The children with normal speech used more transformations than the "infantile" children, who used more ungrammatical forms (approximations) and used them significantly more frequently. The approximations of the children using "infantile" speech contained many omissions (noun phrase, verb phrase, preposition, marker of tense). Those of the children using normal speech contained a greater number of substitutions and redundancies. Menyuk concluded that "infantile" seemed to be a misnomer since at no age did the grammatical production of a child with "infantile" speech match that of a normally developing child. "Infantile speech", she concluded, was not merely delayed but different.

Lee (1966, 1974) confirmed the qualitative difference observed by Menyuk (1964). In analyzing language samples of "language-delayed" and normal children, she found that the language-delayed children did not produce some of the syntactic structures (articles, verb tense markers, auxiliary be, modal can, copula) produced by the normal children. She concluded that many of the children who are called "language-delayed" are not merely following a normal pattern of development at a slower rate.

Leonard (1972) found only a quantitative difference between the language samples of "defective" and normal speaking children matched for age (mean 5 years 3 months). He found significant differences between the two groups only in the frequency with which they used certain transformations (normals used more conjunctions, embedding auxiliary be, adjectives, negation, pronoun forms) and deviant forms, and not in the developmental level of the structure used. Leonard concluded that there were no apparent qualitative differences between the normal and deviant speakers.

Morehead and Ingram (1973) substantiated this quantitative difference. They compared the grammatical structures produced by 15 normal and 15 "aphasic" children matched for M.M.U. (Mean morphemes per utterance). They found that the linguistically deviant children do not develop bizarre linguistic systems that are qualitatively different from normal children, but develop quite similar linguistic systems with a marked delay in onset and acquisition time. However, they did find significant differences between the groups in the number of major lexical categories (noun, verb) used per utterance length, i.e., fewer semantic relations per utterance. Morehead and Ingram concluded that "aphasics" may have a "representational" (semantic-cognitive) deficit rather than a syntactic one.

Steckol and Leonard (1979) found that language-impaired children show less usage of specific grammatical morphemes (present progressive, articles, copula and auxiliaries) than normal children with the same M.L.U. The language-impaired subjects did not use a greater number of substantive words (words of semantic importance) to compensate for the absence of grammatical morphemes. The language-impaired subjects were, therefore, not expanding their utterance length by adding features of substantial semantic importance. The results are explained by the hypothesis "that language impaired children fail to view grammatical morphemes as significant features of communication", p. 299. When the communicative significance of certain morphemes is made salient (i.e., by its meaning), language impaired children make greater use of them.

Johnston and Schery (1976) investigated the acquisition and use of 14 grammatical morphemes in 287 language-disordered children aged 3.0 to 16.2. They found that the language-disordered children learned the same morphemes in much the same order as normal children and with the same general relationship to overall language development level as measured by sentence length (M.M.U). The language-disordered children, however, did differ in the rate of acquisition time, i.e., the time between their first use of a morphological form to full control of its usage in obligatory contexts. The authors suggest that semantic, conceptual and cognitive processing variables may be responsible for the different acquisition rates.

Semantic. From the results of the above studies, one can see that the quantitative/qualitative debate concerning the syntactic capacities of language-impaired children has not been resolved. To this date, studies concerning the semantic performances of dysphasic children indicate that they do not differ qualitatively from normals. Leonard, Bolders, and Miller (1976) obtained language samples from 40 children and examined semantic relations as a function of chronological age (3 and 5 years) and linguistic status (normal and language-disordered). They found no difference in semantic relation utterance types (case relations similar to those suggested by Fillmore, 1968) nor in the frequency of their use when the normal and language-disordered children were matched on M.L.U. (Mean length of utterance). The semantic relations expressed by the disordered group reflected those used by normals at an earlier level of development.

Freedman and Carpenter (1976) compared the two-word utterances of four language-impaired children with the two-word utterances of four normal children at the same linguistic level and also found no differences between the two groups in the use of a set of ten basic semantic relations.

Pragmatic. The equivocal results of the syntactic studies, the lack of demonstrated deficiencies in the semantic studies and the influence of pragmatic studies in normal children have prompted investigators to apply pragmatic approaches to study the communicative effectiveness of impaired language. It was thought that the frequency differences reported in earlier studies may be a consequence of a more fundamental issue, i.e., a consequence of qualitative differences in the conversational strategies of dysphasic children. The three studies which will be reviewed all indicate that language-disordered children are deficient in their effective use of language for communication.

Snyder (1975), compared presuppositional and performative (declarative and imperative) pragmatic performance of language-disordered and normal children at the one-word stage of language development. On the verbal presuppositional measures, language-disordered children, unlike the normals, tended to encode the less informative elements in the conversational context almost as frequently as the more informative ones. The language-disordered children performed more poorly than the normal children, on both of the performative measures as well.

Gallagher and Darnton (1978) studied how language-disordered children at three stages of language development (MLU = 1.6, MLU = 2.4, MLU = 3.1) revised their responses when asked "What?" by an adult pretending not to understand. The responses of the language-disordered children were compared to those of normal children at the same stages of language development. They found that although the language-disordered children modified their responses to meet the demands of the conversational situation, they did so in a qualitatively different manner than the normal child. The revision strategies of the language-disordered children did not vary significantly with language level and their unchanging profile of revision strategies did not correspond to the profiles of strategies used by normal children at any language stage.

Musselwhite, St. Louis, and Penick (1980) studied nine language disordered children between the ages of 7 years 1 month and 10 years 6 months (the children were divided into three groups) according to their language ability. The investigators videotaped the children in a play situation and analyzed their verbal and nonverbal communicative interactions. They found that the percentage of successful communicative interactions correlated with other conventional measures of receptive and expressive language (MLU, number of verbs or verb complexity, standardized language age score on parts of Peabody and ITPA) while the total number of successful and unsuccessful interactions did not.

Underlying Process Which May Account for Impaired Language

Many of the clinical descriptions of children with language disorders include reports of auditory perceptual deficits. Benton (1964) stated that the basis for the developmental aphasic's telegraphic speech may be a high level auditory perceptual deficit comprising deficits in the orientational, discriminative and integrative aspects of auditory cognition. Hardy (1965) described the aphasic child's difficulty as "auding" (i.e., perceiving, storing and recalling the serial order of information received through auditory channels) which results in a poorer ability to discriminate between similar sounding words. Eisenson's (1972) concept of childhood aphasia was based on the assumption that a child's receptive and expressive language difficulties are the products of auditory perceptual dysfunction. According to Eisenson, aphasic children do not have the capacity to listen as rapidly as is required to perceive and process what is physically received. These clinical observations have been the impetus for the experimental investigation of the auditory perceptual abilities of language-disordered children. The areas which have received the most attention are deficits in temporal ordering, auditory memory, and speed of processing.

<u>Temporal Order</u>. Rosenthal (1970, 1972) presents evidence to support a temporal ordering deficit in language-impaired children. He presented short speech and nonspeech sounds either in isolation or in pairs to language-impaired and normal children. The child was asked to temporally order the sounds presented in pairs. He found that although the language-impaired children learned to identify sounds presented in isolation as well as the normal group, they had great difficulty when they had to report the order in which the sounds occurred. Rosenthal claimed that the auditory trace is long enough for the identification of a single sound but not long enough for language-impaired children to determine temporal order. He concluded that the children's inability to temporally and sequentially order

stimuli may be the result of a primary auditory storage deficit.

Memory. Evidence for memory deficits in language-impaired children comes from studies by Menyuk (1964, 1969, 1972). She asked normal and language-disordered children to repeat sentences which varied in length as well as syntactic structure. The repetitions of the language-disordered children contained many omissions while the repetitions of the normal children contained substitutions and redundancies. The language-disordered children were not able to repeat certain syntactic structures which they were able to produce spontaneously while the repetitions of the normal children were more advanced than their spontaneous speech. Menyuk hypothesized that a cognitive limitation on the short-term memory of language-impaired children might be responsible for their deficit. However, an increase in length of the sentences presented for repetition (in Menyuk's study) also entailed an increase in sentence complexity. As a result, Menyuk and Looney (1972) compared the effects of sentence length versus sentence structure on the sentence repetition ability of 13 language-disordered children and 13 normal children. Two sets of 24 sentences were presented for repetition. One set consisted of sentences containing varying syntactic structures that were three to five words in length and the second set of sentences consisted of words and nonsense syllables containing the phonological sequences contained in the first set of sentences. They found that the language-disordered children had greater difficulty in repeating all the sentences (longer sentences as well as more complex sentences) than did the normal children, but that the degree of difficulty they encountered was a function of sentence structure rather than sentence length. Many of the errors that were produced consisted of modals "can" or "will" or auxiliary markers ("be" or past tense) being omitted. Menyuk and Looney ruled out stress accounting for the omissions, because while some of the items omitted received no stress (i.e., "is" in "that boy is named Tommy") others omitted did receive some stress (i.e., "does" in "does the boy like milk"). They also ruled out semantic factors accounting for the results because the language-impaired children retained and expressed the elements (i.e., content words) which preserve meaning.

They concluded that there are limits on the structural decoding capacities of these children as a result of limits on their immediate memory. These limits do not allow time for the storage of the complete phrase to enable a deeper analysis. As a result, the parts of the utterance that are retained are those necessary for deriving meaning and it is these same meaning bearing elements which the disordered child produces in his repetitions. It was, therefore, the view of these researchers that the expressive language problems of the language-impaired are a result of memory factors which do not allow syntax to be adequately processed to promote learning.

Rate of Processing. Tallal and Piercy (1973) presented evidence for a deficit in the rate at which language-impaired children can process auditory material. They investigated the perceptual deficits of language disordered children by using visual stimuli, non-linguistic stimuli (tones) and non-linguistic speech like stimuli, i.e., stimuli which acoustically resemble speech sounds, but which do not match the acoustic spectrum of any specific phoneme. The durations of the stimuli and interstimulus intervals were varied. Subjects responded by pressing panels corresponding to the order in which the stimuli had been presented, or corresponding to same different judgements. They found that language-impaired children (matched for age and sex and nonverbal I.Q.) were unable to sequence or discriminate auditory stimuli when the rate of presentation is too fast. They found that it was the total duration of the two stimuli and the interval between them , i.e., the total time between the onset of tone 1 and the offset of tone 2, that was critical for the performance of the language-impaired children. This difficulty in the rate of processing was not found when visual stimuli were presented. Tallal and Piercy concluded that this constraint on the speed of processing auditory information might underlie the dysphasic's language impairment. In further experiments (Tallal, 1974, 1975; Tallal and Stark, 1981) the "aphasics" discriminated between vowels as well as matched normal children. These have steady state frequencies in the first three formants which remain constant over the entire length of the stimulus. However, the language-impaired children could only discriminate between speech sounds mediated by transitions if they were sufficiently long in duration.

The work of Tallal and her colleagues indicate that stimulus duration is an important variable in the auditory processing of language-disordered and that increased exposure to acoustic information is necessary whether the nature of the information is linguistic or non-linguistic.

<u>Linguistic Hypothesis</u>. Cromer (1976) advocated only a weak form of cognitive hypothesis to account for the language-impaired children's failure to develop language. He claimed (1976) that "the cognitive

structures and operations and the cognitions to which they give rise are of central importance in understanding the language acquisition process, but that these cognitive entities by themselves are not sufficient to explain that process. We must also possess certain specifically linguistic capabilities in order to express these meanings in language. Such linguistic capacity may be lacking in certain pathological conditions" (p. 326). Cromer (1980) claimed that the difficulty language-disordered children have in acquiring language is due to an inability to deal with hierarchically-ordered relationships of the type inherent in the structure of language. Cromer was critical of the research which has investigated the temporal and sequential ordering of abilities of language-impaired children as being based on the erroneous view of language being sequential. He linguistically analyzed the written productions of language-disordered and deaf children (children who both suffer from auditory perceptual problems) and found differences between the two groups. Although both groups of children showed grammatic disorganization in their writing, the deaf children tried a variety of structures (many of which rely on complex transformations), while the language-disordered children wrote simpler sentences and failed to use the kinds of structure that would involve a true hierarchical organization of the overall sentence. He cited Martin's rhythmical theory (i.e., that rhythmic sequences possess hierarchical organization) and experimental evidence (Kracke, 1975) indicating that "aphasic" children have difficulty in reproducing nonverbal rhythmic sequences to support his theory of a hierarchical ordering disability.

Studies of Prosody in Language Disordered Children

The literature reveals only one study directly related to this topic, and a second study which is relevant, even though it deals with a mentally-retarded language-delayed population.

Stark, Poppen, and May (1967) investigated the effect of altering prosodic features in the language-impaired. The chronological ages of the language-impaired children ranged from 7 years 5 months to 9 years 5 months with a mean age of 8 years 3 months. The normal control group was not specifically matched with the impaired group on language ability or age, but consisted of a younger group of children ranging in age from 4 years 2 months to 7 years 11 months with a mean chronological age of 5 years 3 months. The researchers investigated whether alterations in prosodic features of three-word auditory sequences would enhance sequencing ability, i.e., would affect the attention directed to different aspects of the sequence and thereby enhance reproduction of the sequence. When stress was applied to the initial word of the sequences, recall of the entire sequence was enhanced for the language-impaired children. Stress had no effect on the performance of normals. However, this result may reflect a ceiling effect in which the three-word sequences were too easy for normals. When the other items in the sequence were stressed the recall ability of the language-impaired children tended to be disrupted. The authors concluded that the difficulty that language-impaired children have in decoding and encoding language may be related to an impaired auditory memory for sequences.

Another study (Wheldall and Swann, 1976) investigated whether stressing a critical element of a syntactic structure would facilitate the comprehension of that structure in mentally-retarded language-delayed children. The results indicated that stress did not produce any significant positive effect in comprehension in either normal or sub-normal children. Only a few examples of the items used to test comprehension were included in the article. From these examples, however, it seems that the items were relatively simple, and, therefore, possibly already comprehensible by the subjects. The effect of stressing may have increased the speed of comprehension but this factor was not measured in the study.

CHAPTER THREE

RATIONALE OF THE PRESENT RESEARCH

As indicated in the preceding review of the literature, little or nothing is known about sentence processing in children with language disorders. We do not know what elements in the speech stream these children attend to. They may be using strategies different from those used by normal children, and therefore, fail to attend appropriately to the parts of the sentence necessary to promote normal language learning.

Language-impaired children are for the most part more adept at producing the meaning-bearing items of a sentence than they are at producing the grammatical morphemes. At the same time, there is evidence which shows that language-impaired children have difficulty processing auditory stimuli of short duration and that an increased exposure improves perception. The grammatical forms which language-impaired children acquire easily are those that are stressed and of longer duration, while the forms which they have difficulty acquiring are those that are not stressed and of shorter duration.

Brown (1973), indicated that perceptual saliency, frequency, grammatical complexity, and semantic complexity may all play a role in determining why some forms are acquired earlier than others. Studies on adult processing of sentences have shown that the expectation of stress modifies how adults disperse their attention among the words of a sentence. Some attention has been directed toward understanding the relationships between syntactic-semantic learning and stress in normal children. However, only one study explored the effects of stress variations among the language-impaired.

A perceptual reason may possibly explain why language deviant children have difficulty in acquiring grammatical morphemes. Furthermore, the general use of stress to increase the likelihood of imitation of therapeutic situations recommends an investigation of its actual function. The purpose of the present research was to investigate those aspects of an utterance to which language-impaired children attend and to examine the affects of stress upon the focus of their attention. More specifically, this research investigated stress and its function as a decoding cue in normal and delayed language learners, while keeping grammatical and syntactic complexity constant.

A probe latency technique was chosen as it involves a minimal amount of speech production on the part of the subject. This technique, developed by Suci, Ammon and Gamlin (1967); Walker, Gough, and Wall (1968); and Caplan (1971), involves presenting subjects with a series of sentences, each of which is immediately followed by a word (the probe). The subjects must decide whether the probe occurred in the sentence just presented. The experimenter measures reaction time (RT) as the interval between the presentation of the probe and the subject's response. The RT differences are a measure of how initial attention affects the search of the immediate memory representation of the sentences for the various probes. The probes in the study consisted of stressed, unstressed and neutral, content and function words.

Two studies were conducted. The first study was done to investigate whether the content-function phenomenon observed in children's speech production might have a counterpart in perception, when normal children listened to neutrally accented sentences. This first study was also undertaken to investigate the feasibility of using a probe latency task, the effects of age, the difference between positive and negative probe words and whether subjects process the sentences in a probe task for meaning.

The second study was performed to investigate whether variation in the placement of accent effects the perceptual saliency of content and function words, whether the syntactic-semantic structure of a sentence effects the way in which content and function words are processed, and whether the patterns of response to accent variations and syntactic-semantic sentence structure by language-impaired children differ from those of normal children of the same language ability and normal children of the same chronological age.

CHAPTER FOUR

EXPERIMENT 1

Hypotheses

1. The response times of older normal children would be faster than the response times of younger normal children.

2. Response times to content words would be faster than response times to function words, although this difference in response times may disappear with increasing age.

3. Response times to positive probes may be different from the response times to negative probes.

4. Response times to probes occurring later in the sentence would be faster than response times to probes occurring earlier in the sentence.

5. Response times to probes from meaningful material would be different than the response times to probes from semantically deviant material.

Method

Subjects

The subjects consisted of 40 children, eight randomly selected from each of the prekindergarten, kindergarten, first, third, and sixth grade levels. These levels were chosen to provide a broad spectrum for studying age trends in sentence-processing strategies. At each age level there were four males and four females. The subjects were from middle class homes, and of average intelligence, as judged by their teachers. All the children were from the same school except for the prekindergarten group, which was obtained from a nearby nursery school. None of the subjects had any known hearing or speech difficulties and all had learned English as their first language.

Stimuli

Two sets of stimuli were constructed. The first set consisted of 48 meaningful, simple, active declarative sentences nine words in length. Each sentence contained an adjacent function and content word in the 5th and 6th word positions of the sentence. These positions will henceforth be referred to as the 1st and 2nd probe positions. The words in the sentences were one syllable in length except for one two-syllable word which could occur in any word position prior to the 1st probe word position. All the words were controlled for frequency of use and were among the 1,000 words most frequently used (Thorndike and Lorge, 1944; Ling and Ling, 1978).

The second set of stimuli consisted of 24 syntactically intact but semantically anomalous sentences. These sentences were like the meaningful sentences in length and structure and the words used were the same words that had been used in constructing the meaningful sentences.

Each meaningful and anomalous sentence was followed by both positive and negative probe words. The positive probes were the function and content words occurring in the 1st and 2nd probe positions. The negative probes were a function and content word which had not occurred in the sentence. These probes were syntactically similar to the positive probes but were, for the most part, semantically anomalous with the sentence. For the following sentence, "The big fat monkey jumped through the small hole", the 1st and 2nd positive probes are "jumped" and "through" respectively, and the negative probes are "asked" and "down". Nouns and verbs were chosen to represent the content category, and adverbs, pronouns, auxiliaries, and prepositions were chosen to represent the function category. It was decided that adverbs would be included, as adverbs had been classified somewhat tentatively with respect to content and function words. Figure 2 shows the number and type of meaningful stimuli probed. The meaningful sentences and their respective probes are given in Table 1, and the anomalous sentences and their probes are presented in Table 2.

Materials

Each sentence was recorded on a Sony 350 Tape recorder by a female speaker using a normal falling intonation, at a rate slightly slower than normal speech. A 50 millisecond tone was placed at the end of the sentence to denote the sentence end. The probe words were recorded 150 milliseconds after the sentence by a male speaker, and a click was recorded on a second tape channel at the onset of the probe word. The purpose of recording the probe word in a male voice was to make the probe word as distinguishable as possible from the sentence. Figure 3 shows the timing of these events as they occurred on the tape for a single sentence.

Each recorded stimulus sentence and probe word were then randomly dubbed as a unit to one of four different tapes. For example, "The big fat monkey jumped through the small hole" occurred on each of the four tapes. On Tape 1, the probe word following it was "jumped", on Tape 2, the probe word was "through", on Tape 3, the probe word was "asked" and on Tape 4, the probe word was "down". The probe words were assigned such that there were an equal number of positive and negative probes, 1st and 2nd position probes, and content and function probes on each tape. The order of the sentences was such that these probe characteristics were randomly sequenced.

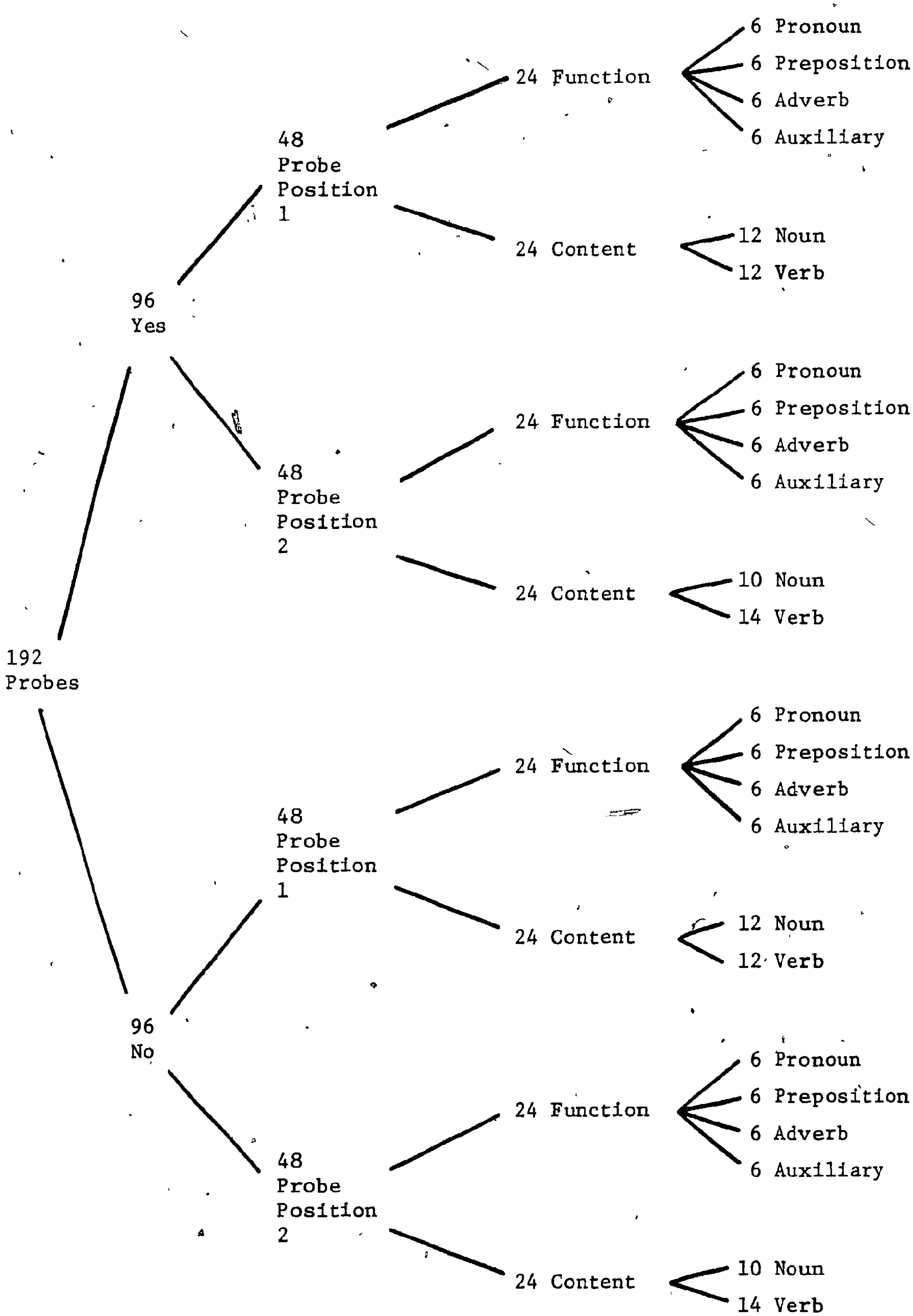


Figure 2. Number and Type of Meaningful Probes

TABLE 1

48 Meaningful Stimuli with Positive, Negative Content and Function Probes.

	SENTENCES	POSITIVE PROBES	NEGATIVE PROBES
1.	The man was showing me bears in the woods.	me, bears	her, fence
2.	At the school party we played a nice game.	we, played	her, sat
3.	My father comes home from work in a train.	from, work	by, arm
4.	In five minutes the boys had cleaned the room.	boys, had	fish, would
5.	We placed 2 pieces of bread in the bag.	of, bread	up, truck
6.	The tiny white mouse ate some of the cheese.	ate, some	put, us
7.	The boy is cutting us cake in the house.	us, cake	we, pen
8.	My wet red sweater soon dried in the sun.	soon, dried	first, climbed
9.	The tall mailman could give that to the boy.	give, that	make, none
10.	The big fat monkey jumped through the small hole.	jumped, through	asked, down
11.	My big strong brother put them on the truck.	put, them	ask, you
12.	The young pretty girls stayed there in the rain.	stayed, there	called, near
13.	The girl is feeding him food from the dish.	him, food	that, card
14.	All the people ride to town in the bus.	to, town	out, seen
15.	The squirrels must look near trees for good nuts.	near, trees	from, milk
16.	At night the doctor could help the old man.	could, help	were, dig

17. He threw the rubber ball high in the sky.	ball, high	saw, out
18. At the circus my friend did watch the bear.	friend, did	dogs, could
19. The driver drives the car on the wet road.	car, on	tree, for
20. Early in the day I comb my long hair.	I, comb	him, build
21. The fat old lady walked down the long road.	walked, down	pushed, next
22. Many tall plants will soon grow in the yard.	soon, grow	here, pull
23. Each day the farmer does milk the brown cow.	does, milk	are, dish
24. Only the pretty nurse can get you this pill.	can, get	do, meet
25. Soon the funny old clown will eat the bread.	clown, will	queen, have
26. The good teacher should see mine in the box.	see, mine	fall, us
27. The nice little girl has found the red bike.	has, found	are, sang
28. All the young children went up the wrong street.	went, up	fly, in
29. The small baby birds first lived in this tree.	first, lived	there, cooked
30. Our soft white kitten fights with the new dog.	fights, with	swim, to
31. In the kitchen the girls have baked a cake.	girls, have	men, should
32. The nice old lady broke this in the room.	broke, this	read, they
33. In the morning the child must brush her teeth.	child, must	frog, does
34. Father will see you at home in 2 days.	at, home	with, car
35. The two new horses ran fast in the race.	ran, fast	smell, now

36.	The girl is leaving for school in a week.	for, school	on, cup
37.	My small happy friend now has a new toy.	now, has	soon, cry
38.	She put the yellow block next to the cup.	block, next	mat, slow
39.	By morning the birds were gone from their nest.	were, gone	did, stood
40.	Her nice dad always reads her books in bed.	reads, her	shut, them
41.	For my birthday I would like a new doll.	would, like	had, grow
42.	The tired old man then sat in the chair.	then, sat	far, hopped
43.	My grandma could bring you juice in the yard.	you, juice	none, foot
44.	My sister pushed the glass off the blue chair.	glass, off	mat, at
45.	The good children can now swim in the pool.	now, swim	than, bake
46.	The farmer threw the fish back in the lake.	fish, back	toy, now
47.	Some of the dirty pigs should take a bath.	pigs, should	men, is
48.	My brother kicks the ball far in the park.	ball, far	ship, here

TABLE 2

24 Anomalous Stimuli with Positive and Negative Content and Function Probes.

	SENTENCES	POSITIVE PROBES	NEGATIVE PROBES
1.	At night the kitchen can help the new cow.	can, help	were, eat
2.	The wrong white squirrels see through the soft ear.	see, through	bring, next
3.	He dried the rubber man fast in the rain.	man, fast	cake, out
4.	Then the dirty milk must get you this room.	must, get	could, run
5.	Only the old red bath would clean the bread.	bath, would	nut, did
6.	Monkeys must place you from home at 2 schools.	from, home	in, yard
7.	My good pretty park first threw a tall yard.	first, threw	here, broke
8.	In the circus the teeth could help their friend.	teeth, could	bears, are
9.	The tired small trees now kick in the cup.	now, kick	then, play
10.	We ride young drivers with bread in the trees.	with, bread	on, cow
11.	The box is showing us woods in the bread.	us, woods	him, truck
12.	The old yellow lake sat there in the plant.	sat, there	got, fast
13.	The tall old mouse broke her in the man.	broke, her	ate, I
14.	The lady will jump for dogs in good holes.	four, dogs	with, cups
15.	The small pretty bike had baked the brown girl.	had, baked	was, stayed
16.	My party could feed him hair in the game.	him, hair	us, block

17.	My good white mailman ate you in the dish.	ate, you	swim, we
18.	Our pieces pushed the road near the wet bags.	road, near	food, at
19.	The tiny nice house reads that in the cheese.	reads, that	give, it
20.	All the blue people look down the fat nuts.	look, down	pull, to
21.	Many new pools will soon live in the chair.	soon, live	now, cry
22.	Some of the funny days should brush the cake.	days, should	woods, would
23.	She walked the happy toy next to the sky.	toy, next	mouth, there
24.	In the old lady I played a long truck.	I, played	her, jumped

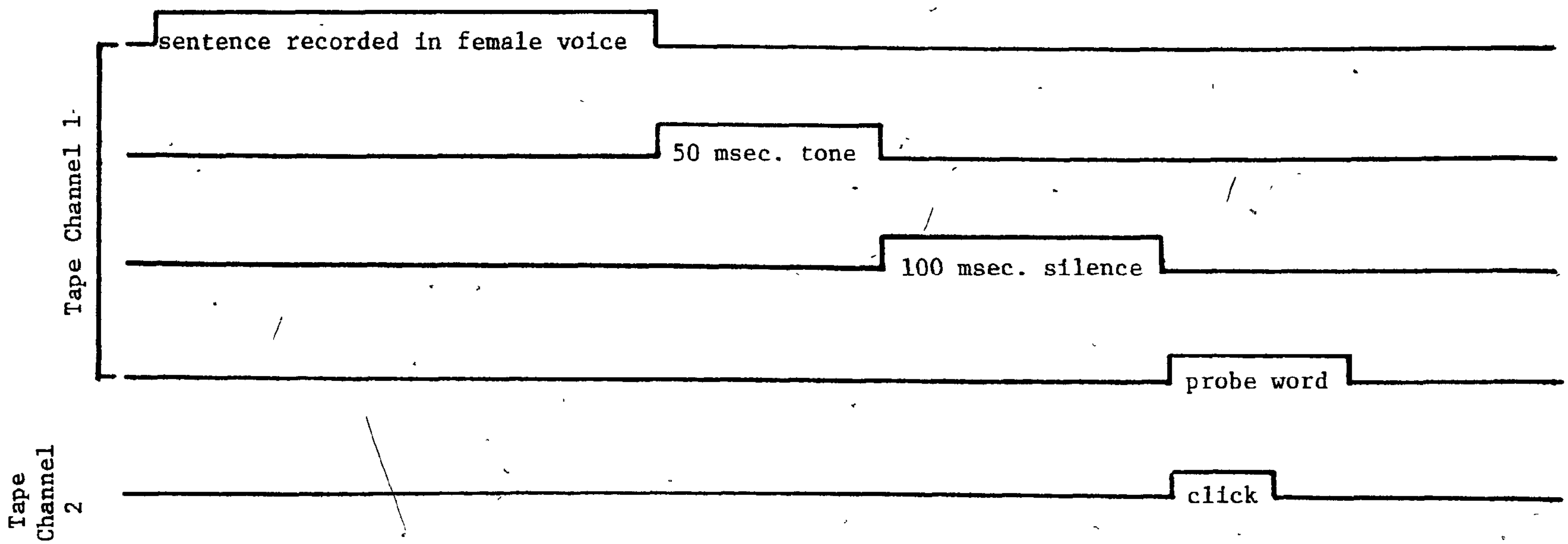


Figure 3. Time Course of Events on the Tape for a Single Sentence.

The materials, therefore, consisted of four tapes, each containing the 48 meaningful sentences followed by the 24 anomalous sentences. The only difference amongst the tapes was in the probe words that followed the sentences.

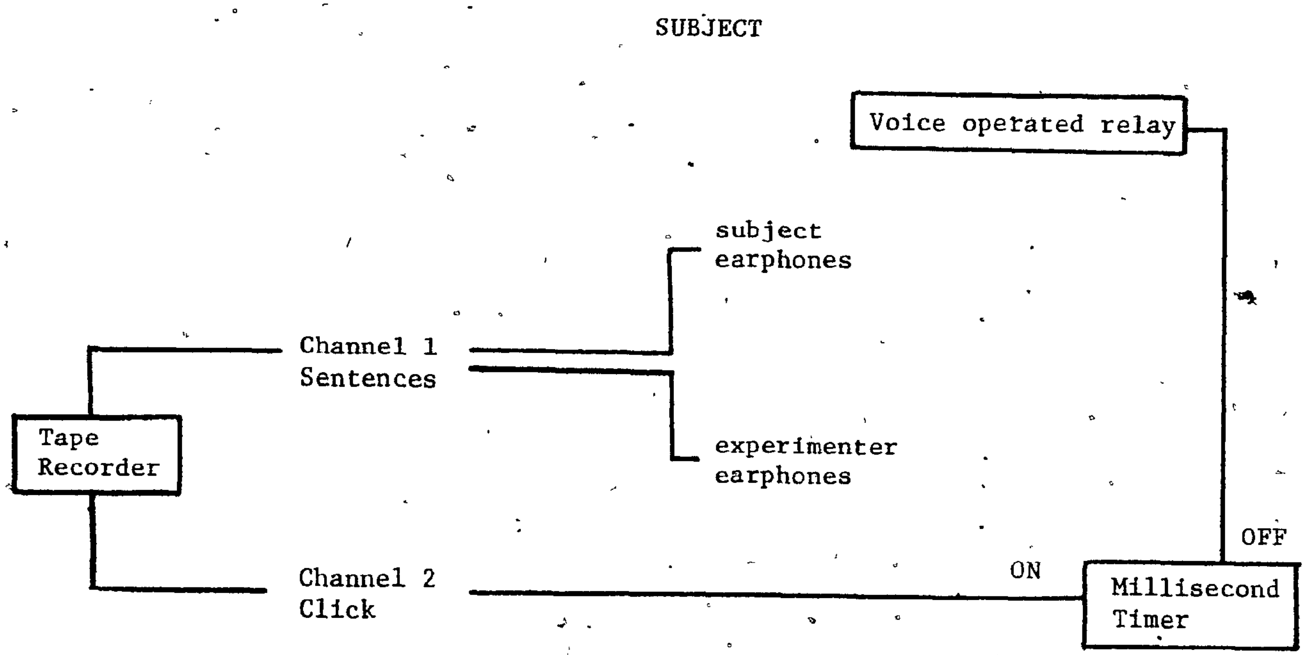
Apparatus

The equipment used in this study included a Sony 350 reel-to-reel tape recorder, a Hewlett Packard millisecond timer and a standing microphone. Figure 4 shows a schematic diagram of the apparatus. The experimenter started the tape recorder and the subject and experimenter listened through separate headphones to a sentence and probe word. The inaudible click recorded on the 2nd tape channel activated the millisecond timer, which was stopped when the subject's spoken response activated the voice operated relay.

Procedure

One male and one female subject from each grade level were assigned to each of the four tapes. One subject received the anomalous sentence set first and the other subject received the meaningful set first. For the prekindergarten and kindergarten subjects, the meaningful sentences were presented in two groups of twenty-four. Each subject was escorted to the testing room and was seated at a table on which there was a tape recorder and a microphone. The subject was told:

> "First you are going to hear a lady say something and then you will hear a man say something. If the man says something that was the same as something the lady said, then you say 'same'. If the man says something that is not the same as something the lady said, then you say 'not the same'."



<u>Figure 4</u>. Schematic Diagram of Apparatus for Probe Verification Task.

They were told to make sure they got the correct answer and to say the answer as quickly as possible into the microphone.

A set of earphones was then fitted to the child's head and each child was given six training sentences before beginning the test sentences. The training sentences were the same length and format as the test sentences. Any child who did not give correct answers for the final four training sentences was not used as a subject in the experiment. Six first grade children had to be excluded because they were unable to perform the task and seven kindergarten children could not be used because of not wanting to participate, not wanting the earphones on, or not being able to do the task. Other subjects were chosen to fill their places.

The test sentences were presented at an approximate intensity of 70-75 db SPL. The tape recorder was stopped after each of the subject's responses and the experimenter recorded the subject's response and his response latency. Before proceeding to the next stimulus sentence, the experimenter alerted the subject by saying "ready". All subjects' responses were socially rewarded by the experimenter saying "good".

Results

Seventy-two latencies were recorded for each subject; 48 were responses to probes from meaningful stimuli and 24 were responses to probes from anomalous stimuli. The probes also varied in word class (noun, verb, preposition, pronoun, adverb, and auxiliary), presence or absence in the stimulus sentence (yes, no), and position in the stimulus sentence (1st, 2nd). These three factors and their respective levels form a design which has 24 cells with one response per cell per subject for the meaningful and anomalous stimuli respectively. A replication factor was added to increase the number of times that subjects responded to each of the four function word classes. The replication factor which was not completely crossed with position produced a design in which some cells had more than one response per cell.

The variance of latency scores in latency response studies may be affected by the negative skewness in reaction time measures. Latency scores tend to be negatively skewed because there is a lower limit to the latency of a particular response but no upper limit. The results of such a study may have a positive bias not attributable to experimental variance. The use of a transformation is often indicated and helps to reduce the positive bias. Therefore, a Box and Cox Analysis (Box and Cox, 1964) was performed on the data to test the effectiveness of the log, reciprocal and square root transformations. The results demonstrated the effectiveness of the reciprocal transformation which was then applied to the latency responses to give a measure of response speed, where the shorter the response latency the larger would be the reciprocal latency.

The aim of this study was to study differences in the speed rather than accuracy of response. However, response accuracy must be high in order to meaningfully study speed differences. Although the importance of response accuracy had been emphasized, many subjects did make a small number of errors. The occurrence of these error responses presents a situation in which a portion of the 24 cells have missing data. This missing data added to the variation in the number of responses per cell, already produced by the replication factor, necessitating that the data be collapsed across factors in several ways. Due to the amount of data and the need to collapse the data in different ways, four separate analyses of variance were required. The main analysis involved assessment of age, sex, individual word category and type of probe for meaningful sentences only with data collapsed across the position factor. A second important analysis involved the assessment of meaningful versus anomalous sentences in addition to age, sex, position, content/function word category, and type of probe, with data collapsed across the individual word categories. This analysis permitted me to determine if the meaningfulness of sentences had any effect, and how the effects of age, sex, word category and probe type might vary as a function of meaningfulness of sentences. Two remaining analyses permitted assessment of the effects of word position and lists or tapes, to see if these factors must be considered in interpreting the data. The design is a completely crossed design with subjects nested in groups, sex and tape. The significance levels of all F values were determined with conservative estimates of degrees of freedom (Winer, 1971). This provides a more stringent test for rejection of the null hypothesis in repeated measure designs. All post hoc analysis results are from the Tukey test of honestly significant differences.

The data were first collapsed across the position factor, and medians were taken of correct "yes" and "no" responses to each of the six word categories for each subject. An analysis of variance on the meaningful sentences (Table 3) revealed a significant main effect for grade level ($F = 9.0637$, $df = 4$, $p < .01$) (Figure 5). Post hoc analysis (Appendix A-1) revealed that only the 6th grade level subjects ($\bar{x}$ speed = 13.51) responded significantly faster than subjects at the other grade levels (nursery $\bar{x}$ speed = 6.82, kindergarten $\bar{x}$ speed = 8.60, 1st grade $\bar{x}$ speed = 9.23, 3rd grade $\bar{x}$ speed = 9.93). No significant differences

TABLE 3

Summary of Analysis of Variance
Meaningful Sentences

SOURCE	DF	MS	F
Grade (G)	4	582.89	9.06 **
Sex (s)	1	.13	0.00
G X S	4	30.87	0.48
Error	30	64.31	
Probe Type (Y)	1	57.61	18.32 **
G X Y	4	5.82	1.85
S X Y	1	10.43	3.31
G X S X Y	4	7.11	2.26
Error	30	3.14	
Word Category (W)	5	18.16	14.49 **
G X W	20	.90	.72
S X W	5	.82	.66
G X S X W	20	1.18	.94
Error	150	1.25	
Y X W	5	6.21	4.97 *
G X Y X W	20	1.13	.91
S X Y X W	5	1.39	1.11
G X S X Y X W	20	.78	.62
Error	150	1.25	

* p < .05
** p < .01

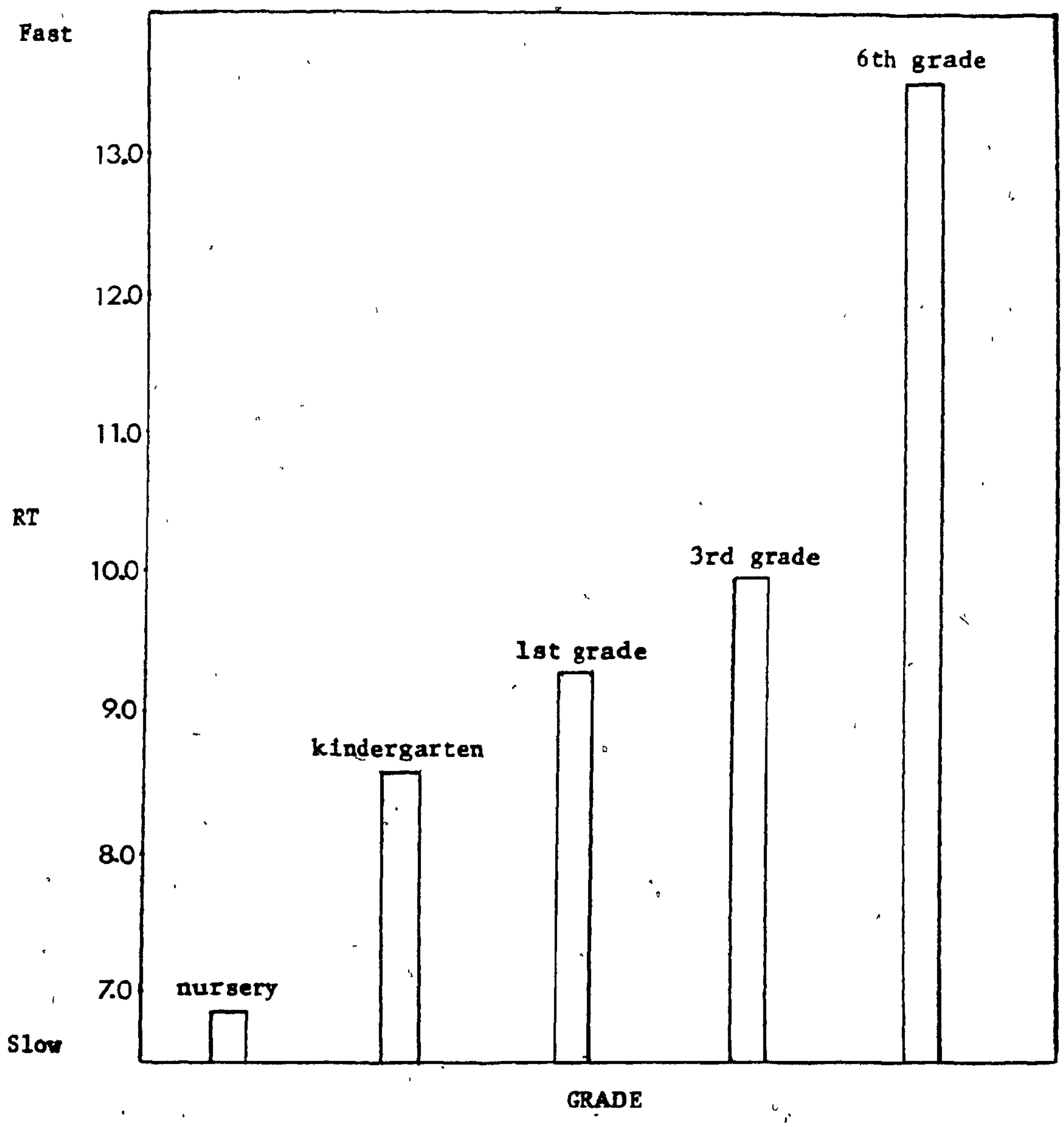
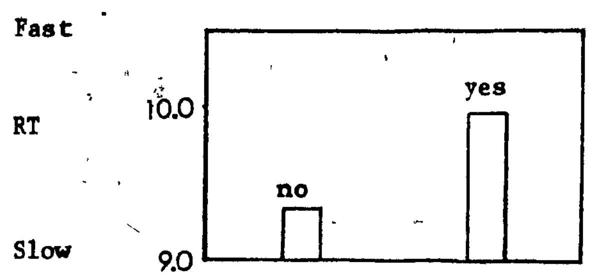


Figure 5. Response Speed as a Function of Grade.
(Speed = 10[1/latency (sec)])

in response times were found between males and females. A significant main effect for probes ($F = 18.3238$, $df = 1$, $p < .01$) indicated that positive probes received significantly faster response times ($\bar{x}$ speed = 9.96) than negative probes ($\bar{x}$ speed = 9.27) (Figure 6).

The main effect for word category was also found to be significant ($F = 14.4853$, $df = 1$, $p < .01$). Within the content category, responses to nouns, verbs and adverbs did not differ, nor were there significant differences among the words within the function category. Between categories, however, responses to nouns ($\bar{x}$ speed = 10.29), verbs ($\bar{x}$ speed = 9.95), and adverbs ($\bar{x}$ speed = 9.86) were significantly faster ($p < .01$) (Appendix A-2) than responses to auxiliaries ($\bar{x}$ speed = 9.15), pronouns ($\bar{x}$ speed = 9.20), and prepositions ($\bar{x}$ speed = 9.26) as illustrated in Figure 7.

The only significant interaction was the word-probe interaction (F, 4.97, df 1, $p < .05$), which occurred because response times between word categories differed for positive probes, but not for negative probes (Figure 8). Within the positive probes, response times to nouns ($\bar{x}$ speed = 10.98), verbs ($\bar{x}$ speed = 10.51), and adverbs ($\bar{x}$ speed = 10.31) were significantly faster ($p < .01$) (Appendix A-3) than response times to pronouns ($\bar{x}$ speed = 9.23), prepositions ($\bar{x}$ speed = 9.28) and auxiliaries ($\bar{x}$ speed = 9.48). Simple effects tests showed that response times to all three positive content probes were significantly faster than responses to negative content probes. Simple effects tests indicated that response times to positive function word probes did not differ from the response times to any of the negative probes with the exception that response time to positive auxiliaries ($\bar{x}$ speed = 9.48) was significantly faster ($p < .05$) than response time to negative auxiliaries ($\bar{x}$ speed = 8.82).



<u>Figure 6</u>. Response Speed as a Function of YES and NO Stimuli.
(Speed = 10[1/latency (sec)])

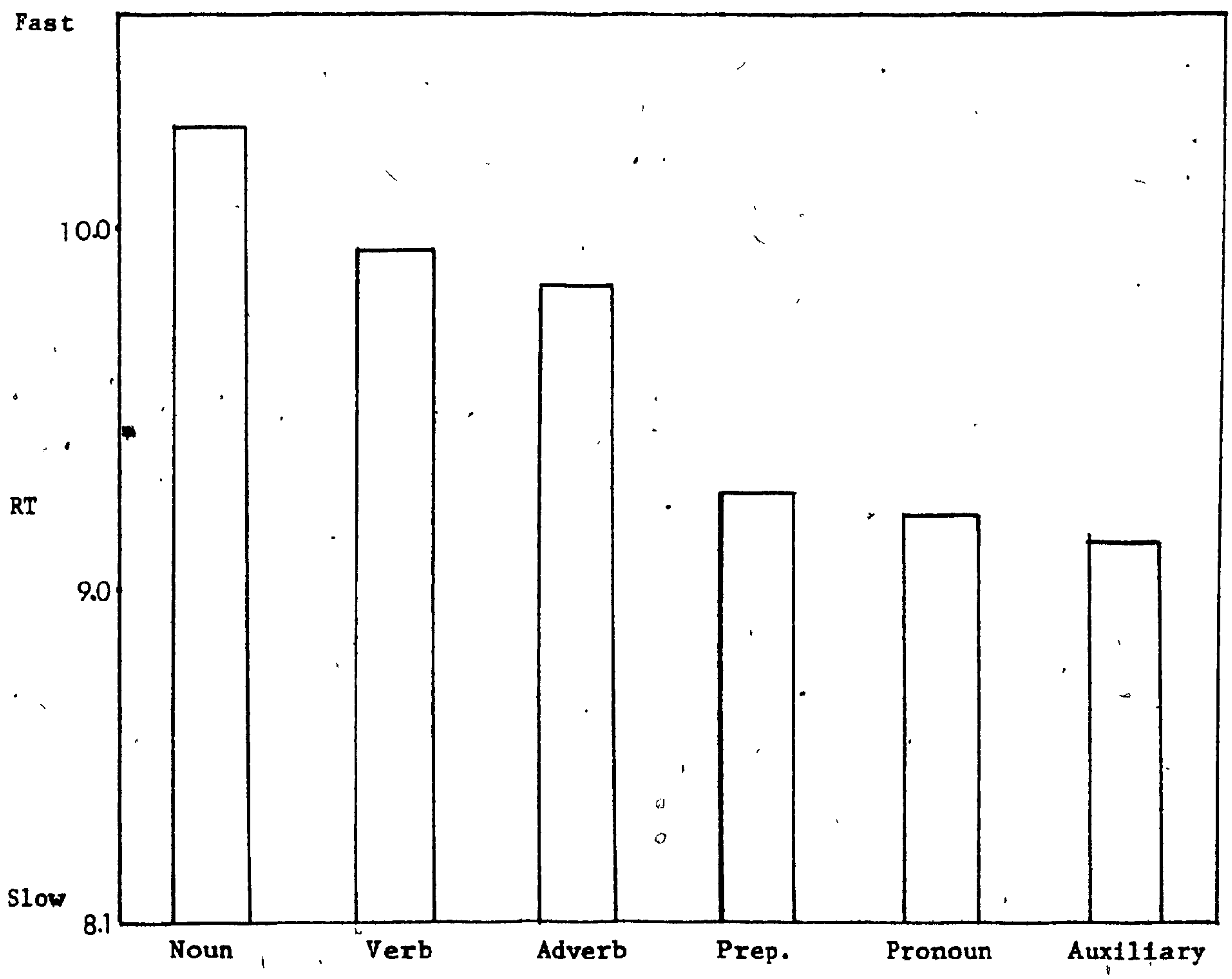


Figure 7. Response Speed as a Function of Word Category.
(Speed = 10[1/latency (sec)])

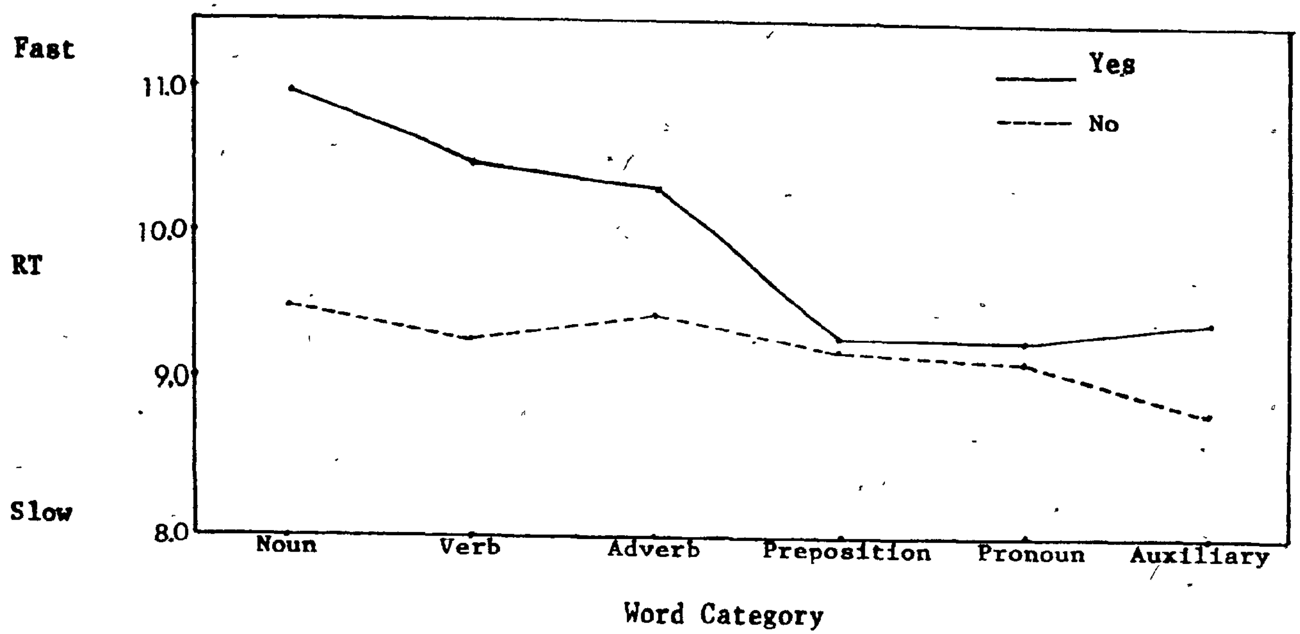


Figure 8. Response Time as a Function of Word Category for YES and NO Stimuli. (Speed = 10[1/latency (sec)])

A second analysis of variance (Table 4) compared the response times for meaningful sentences to those for anomalous sentences. Any main effects and interactions not included in Table 4 were not significant. The results revealed that there was no significant difference between the response times to the meaningful ($\bar{x} = 9.73750$) and anomalous ($\bar{x} = 9.54666$) sentences. There were no significant differences in the way that children of different ages or sex responded to meaningful and anomalous sentence material. There were no interactions with position and the absence of an interaction with word category suggests that the response difference between content and function words was not restricted to meaningful sentences. The word category X probe interaction was the same as that found previously, and a significant meaningfulness X probe X word category interaction ($f = 5.6950$, $df = 1,30$, $p < .05$) was found (Figure 9). Tukey tests (Appendix A-4 and A-5) revealed that within the meaningful sentences and within the anomalous sentences, positive content words received faster response times than positive function words and that responses to positive function words did not differ from the response times to any of the negative probes. Simple effects indicated that meaningfulness did not affect the response times for positive and negative content words and negative function words. However, response times to positive function words were faster when these occurred in meaningful sentence contexts than when they occurred in anomalous sentence contexts.

The data were then collapsed across the word category factor such that medians were taken separately for correct responses to positive and negative content and function probes in both probe positions for each subject. An analysis of variance on the meaningful data indicated that probes in the 2nd probe position ($\bar{x}$ speed = 9.84) were responded to faster ($F = 4.4199$, $df = 1$, $p < .05$) than probes in the 1st probe

TABLE 4

Summary of Analysis of Variance
Meaningful and Anomalous Stimuli

SOURCE	DF	MS	F
Grades (G)	4	743.66	12.58 **
Sex (S)	1	.32 D-01	.00
G X S	4	52.93	.90
Error	30	59.12	
Meaningfulness (M)	1	5.83	.27
M X G	4	9.89	.47
M X S	1	.16	.01
M X G X S	4	26.07	1.23
Error	30	21.22	
Yes/No (Y)	1	97.12	42.63 **
Y X G	4	7.50	3.29
Y X S	1	6.11	2.68
Y X S X G	4	5.01	2.20
Error	30	2.28	
Content/Func. (C)	1	106.17	69.87 **
Y X C	1	58.64	40.59 **
C X G	4	1.90	1.25
C X S	1	5.56	3.66
C X G X S	4	3.64	2.39
Error	30	1.52	
C X M	1	.33	.22
Error	30	1.49	
Position (P)	1	2.26	1.54
P X G	4	.47	.32
P X S	1	.17	.12
P X S X G	4	1.24	.84
Error	30	1.47	
M X Y X C	1	6.64	5.70 *
Error	30	1.17	
S X P X Y X C	1	10.95	5.95 *
Error	30	1.84	

* $p < .05$
** $p < .01$

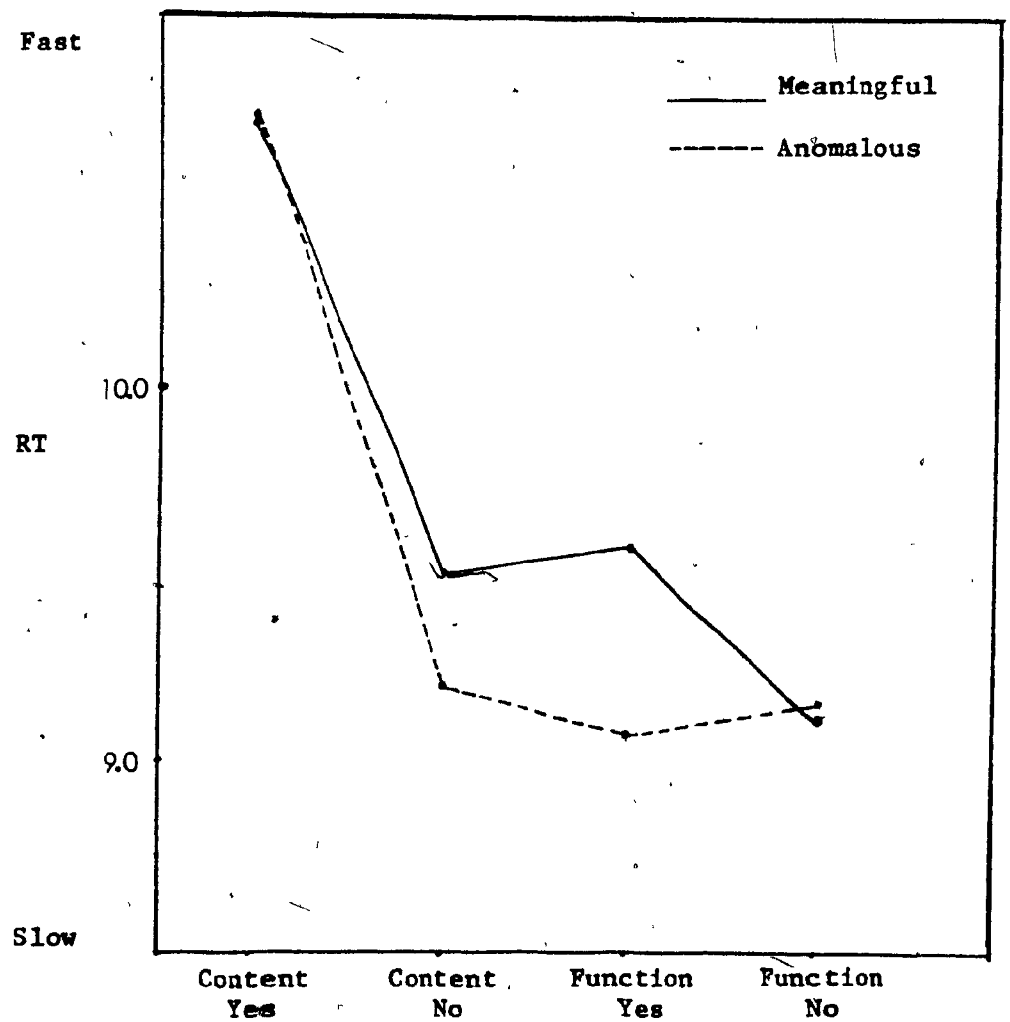


Figure 9. Response Speed as a Function of Word Category and YES and NO probes for Meaningful and Anomalous Stimuli.
(Speed = 10 [1/latency (sec)])

position ($\bar{x}$ speed = 9.64) (Figure 10). The lack of a meaningful X position interaction showed that the position effect was not related to sentence meaning. A significant interaction ($F = 6.92$, $df = 1$, $p < .05$) between sex, position, probe type and word category was found. The position X probe X word category interaction was not significant and the main effect for sex was not significant. Interactions involving sex were not of primary interest in the interpretation of this study. The other results of this analysis are in agreement with the results of the first analysis.

The results of a fourth analysis of variance confirmed that there were no response time differences between subjects receiving different experimental tapes ($\bar{x}$ speed = 9.64, 10.47, 9.86, 8.49).

Discussion

The probe task used in this study demonstrated that there are differences in the way that content and function words are perceived. Children recalled the meaning-bearing content words of a sentence faster than they recalled the function words. These perceptual differences are parallel to those found in the telegraphic language production of young children (Brown and Fraser, 1963; Brown and Bellugi, 1964). The differences appear to be somewhat dependent on task requirements because they appeared for positive but not negative probe words. The differences occur for both meaningful and anomalous stimuli although response times to function words are faster in meaningful sentences. Other important findings were that words classified somewhat tentatively as content and function words, e.g., adverbs, grouped themselves very consistently with respect to response speed for positive probes; that there was a consistent increase in response speed with age but no interaction of age with word category or probe type effects; that there were no important

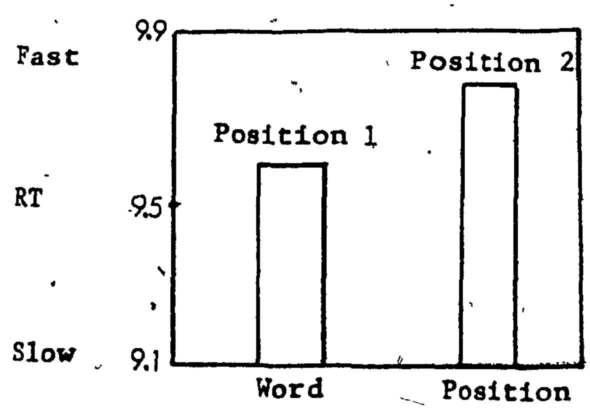


Figure 10. Response Time as a Function of Word Position.
(Speed = 10[1/latency(sec)])

main effects or interactions involving sex, and that more rapid responses to Position 2 indicated a recency effect.

The rapid responses to positive content words indicates that subjects could more directly access content words that had been present in the sentence. The fact that this occurred for both meaningful and anomalous sentences suggests that content words were retrieved in terms of their individual meaning rather than the overall meaning of the sentence. The meaning of the sentence, however, did have an effect on the retrieval of positive function words as evidenced by the more rapid response times to positive function words in meaningful as opposed to anomalous sentences.

Since responses to positive function probes are not significantly faster than responses to negative probes, one might hypothesize that the processing strategies for these two kinds of probes are similar. It may be that responses to these probes require more of a serial processing strategy than responses to positive content probes. Such a strategy would involve multiple successive comparisons of the probe with the different items of the stimulus sentence and would account for the increased time required in responding to negative probes.

The significant main effect found for age was attributable to the fact that sixth grade subjects responded significantly faster than subjects at all other ages. However, the sampling procedures for subjects in this experiment may have accounted for the lack of age trends amongst the younger subjects. Subjects who were not able to do the task were not included in the experiment. There were several subjects at the prekindergarten and kindergarten levels and many at the grade one level who were unable to perform the task. The lack of sex differences and the lack of interactions involving age and sex both argue for the absence of differential developmental trends for the observed effects of word category and probe type.

The significant difference in response times between first and second position probes was expected. Serial position effects have been found in other probe studies (Caplan, 1971; Kennedy and Wilkes, 1970). Theories of short term memory and recall would predict that the responses to second position probes would be faster than responses to first position probes. The auditory trace of second position probes would be stronger than that of first position probes at the time that the probe word is presented.

Conclusions

The results of this initial study reveal that a content-function dichotomy exists in the perceptual processing of sentences by normal language learners and that this perceptual pattern is used in dealing with both meaningful and anomalous sentence stimuli. Further study is needed to clarify the factors responsible for this perceptual pattern. One purpose of the second study was to investigate whether the content-function pattern is characteristic of the way language-delayed learners process similar verbal material; the main purpose was, of course, to determine how language-impaired children respond to stressed words.

Several modifications for the second study were suggested by the results of the first study:

(1) As there was the expected increase in response speed with age, but no interactions of other experimental effects with

age, age variation was not considered to be a variable of primary importance for future study.

(2) Each sentence in the first study was followed by both positive and negative probes. The response times to the positive probes were significantly faster than the response times to negative probes, indicating that positive and negative probes were dealt with in a different manner. To eliminate the possibly-undesirable effects of practice, the sentences in the second study were followed by either a positive or a negative probe, but not both.

(3) As there were no significant differences among the three function words, or among the three content words in the first study, only nouns, verbs, auxiliaries and prepositions were used as probe words in the second study. That is, there were two representatives for the content category and two for the function category, producing a more balanced design.

(4) The errors which subjects made were not included in the analysis of the first study. For the second study a type of error analysis was devised to enable inclusion of both correct and incorrect responses.

(5) Sex will not be a variable.

(6) Position will be a variable.

(7) Semantically and syntactically deviant word strings will be used in the second study to see if responses are affected by syntactic structure.

CHAPTER FIVE

EXPERIMENT 2

Three groups of children responded to probes in the second experiment: 1) language-impaired children; 2) children matched to the language-impaired children in language ability; and 3) children matched to the language-impaired children in age. All the children responded to positive and negative content and function probe words from meaningful sentences and from syntactically and semantically deviant sentences (random probes). The probes from the meaningful sentences were varied for stress in that the sentences were presented in a neutral intonation (neutral probes) or with a marked intonation such that one of the two probe words was stressed (stressed probes) while the other was unstressed (unstressed probes).

Hypotheses

1. There may be interactions involving groups if the language-impaired, language-matched, and age-matched children differ in their responses to content and function words, positive and negative probes, stressed, unstressed and neutral probes, and meaningful and anomalous probes. Interactions involving groups would also be found if groups differed in their error response patterns.

2. There may be interactions involving stress if the response times for stressed, unstressed and neutral probes differ for content and function words, and positive and negative probes.

3. There may be interactions involving meaningfulness if the neutral and random response times differ for content and function words, and positive and negative probes.

4. The response times of older normal children would be the fastest, the response times of the younger normal children would be the next fastest and the response times of the language-impaired children would be the slowest.

5. The response times to content words would be faster than the response times to function words.

6. Response times to positive probes would be faster than response times to negative probes.

7. A word category X positive-negative probe interaction would be found as was found in the first study.

8. The response times to stressed probes would be faster than the response times to unstressed, neutral and random probes.

9. A stress X word category interaction would be found. Stress would affect the response times to content and function words in a different manner.

10. There would be more errors made when responding to function words than when responding to content words.

11. There would be more errors made in responding to unstressed, neutral or random probes than when responding to stressed probes.

Method

Subjects

Three groups of children participated in this study. All were learning English as a first language and came from middle class homes.

The first group consisted of 18 language-impaired children (Table 5). Each child in this group had been diagnosed as being "language-impaired" or "aphasic" by a speech pathologist and all were attending special schools or classes for the language-impaired. None had any gross neurological, physical, psychiatric or hearing abnormalities. To rule out mental retardation as the causal factor of the language problem, it was necessary that each child score within the normal range (80 or above) on at least the performance portion of an acceptable intelligence test. Intelligence Quotients for the group ranged from 83 to 106 with a mean I.Q. of 89.33.

Only children between the ages of 6 years 6 months and 10 years 0 months were selected for the first group. Younger children were not included because of the need to match the language abilities of the language-impaired children to the abilities of children developing language normally. The inclusion of younger language-impaired children would have necessitated the selection of very young normal children, who may not have been able to perform the experimental task. The mean age of the group was 8 years 5 months. There were 12 males and 6 females.

Each child was individually administered the receptive and expressive portions of the Northwestern Syntax Screening Test (NSST) (Lee, 1969). This test was administered with a dual purpose: to make certain that each child was indeed severely language-impaired and to obtain a language score which could be used to match subjects on language ability. In

TABLE 5

Language-Impaired Group

Subject	Sex	Age Years/Months		I.Q. V	I.Q. P	I.Q. FS	I.Q. Test	NSST Expressive Score
1	F	9	3			83	Stanford Binet	27
2	M	8	9			99	Stanford Binet	20
3	F	9	6	75	92	81	WISC	28
4	F	7	3			90	Stanford Binet	22
5	F	7	4			87	Stanford Binet	21
6	M	7	4			106	Stanford Binet	16
7	M	9	3	89	94	91	WISC	19
8	M	8	2			93	Stanford Binet	14
9	M	8	7	90		90	WISC	23
10	M	9	10			90	Stanford Binet	28
11	F	8	3			86	Stanford Binet	25
12	M	8	5			84	Slosson	28
13	M	7	10			106	Stanford Binet	17
14	M	9	11	91	87	88	WISC	26
15	M	8	4	69	97	81	WISC	19
16	F	9	7			85	Stanford Binet	25
17	M	7	8			83	Stanford Binet	22
18	M	6	9			85	Stanford Binet	21
Mean		8	5		89.33			22.28

the receptive portion the examiner describes a group of pictures and the child is asked to point to the picture which corresponds to the examiner's description. In the expressive portion the examiner describes several sets of pictures. The child is required to provide the appropriate description for each picture when it is requested by the examiner. Each of the 40 receptive and 40 expressive responses is scored as correct or incorrect and the child's raw score on the test is the number of correct responses he attains. Inclusion in the study necessitated that the child's raw score on the expressive language section be at the 2nd or 3rd percentile level, i.e., two standard deviations below the mean for his age group. The scores on the NSST expressive portion ranged from 14 to 28 with a mean of 22.28.

The experimental task in this research was a probe task in which a "same-different" response is required. In order to ensure that each child could use the words "same" and "different" in a meaningful way, a same-different task (Appendix B) was administered to each child individually. Six pairs of cards were presented. The cards pictured common geometrical shapes varying in shape and color. The child was told to respond "same" if the images on the cards were the same and "not the same" if the images on the cards differed. It was required that the child respond correctly to four of the five pairs of cards. None of the children had any difficulty identifying objects as being the same or different.

In summary, the language-impaired group consisted of 18 children from middle class homes, who had severe language problems, were of approximately normal intelligence, had no gross neurological, physical, psychiatric or hearing abnormalities, were between six and ten years of age, and could verbally classify objects as being the same or different.

A second group of subjects included 18 children who seemed to be developing language normally (Table 6). These children attended a nursery school located in a middle class community. Intelligence test results were not available. Teachers were asked to select children who they felt were of "average" intelligence. It was explained that I was not looking for children who were extremely bright nor for children who were having difficulties in school. None had any known hearing or speech difficulties. The normal children were selected to match the language-impaired children in language ability. Language ability was assessed by the NSST expressive portion. The raw NSST scores of the matched language group ranged from 17 to 29 with a mean of 23.05. The ages of the children in this group ranged from 3 years 9 months to 4 years 11 months with a mean of 4 years 3 months. Ten of the subjects were male and eight were female. Successful completion of the same-different task was also required by the children in this group.

A third group of 18 subjects (Table 7) was chosen to match the language-impaired children in chronological age. They too had no known hearing or speech difficulties and were, according to their teachers, of average intelligence. The mean age of the group was 8 years 4 months, with ages ranging from 6 years 9 months to 9 years 11; 11 subjects were male and seven were female. The NSST was not given to these children because the age norms were not appropriate for most of the children in this group.

Stimuli

A set of 20 simple active declarative sentences was constructed

TABLE 6

Language Matched Group

Subject	Sex	Age years/months		NSST Expressive Score
1	M	4	2	18
2	F	3	9	17
3	M	4	11	23
4	F	4	10	24
5	F	4	2	22
6	M	4	9	26
7	M	4	9	18
8	M	4	11	29
9	M	4	7	29
10	F	4	2	23
11	F	4	0	17
12	M	4	11	26
13	M	4	1	22
14	F	4	1	21
15	F	4	8	27
16	M	4	0	27
17	F	4	0	23
18	M	3	10	23
Mean		4	3.7	23.05

TABLE 7

Age Matched Group

Subject	Sex	Age years/months	
1	M	9	4
2	M	7	2
3	M	8	7
4	F	7	4
5	F	7	2
6	F	9	5
7	F	8	9
8	F	8	3
9	F	9	2
10	M	6	9
11	M	7	8
12	M	9	4
13	F	8	6
14	M	9	11
15	M	8	0
16	M	8	2
17	M	9	4
18	M	8	3
Mean		8	4

(Table 8). Sentence length was shortened to six words in this study. Each sentence contained a function and a content word adjacent to one another in either the 3rd or 4th word positions of the sentences; these were designated as the 1st and 2nd probe positions. The majority of words were one syllable in length; where a two-syllable word was used, it replaced two one-syllable words. All the words were controlled once again for frequency of usage, being among the first 1,000 words most frequently used (Thorndike and Lorge, 1944; Ling and Ling, 1978). The first four sentences were practice stimuli, and the remaining 16 sentences comprised the test stimuli.

From the 20 sentences, 20 word strings were formed (Table 9). The word strings were like the meaningful stimuli in length, and contained the same words as those used in the meaningful sentences. However, each word string was both syntactically and semantically anomalous. Like the meaningful sentences, each word string contained a function and a content word adjacent to one another in either the 3rd or 4th position. The first four word strings served as practice material and the remaining 16 served as the test stimuli.

Each sentence and word string had associated with it two positive or two negative probes, which were content and function words. Nouns and verbs were chosen to represent the content category and prepositions and auxiliaries were chosen to represent the function category. Figure 11 shows the number and type of stimuli probed. For the following sentence "The cat ran up the tree" the 1st and 2nd probes are positive and are "ran" and "up" respectively. For another sentence "He cried in school today", the 1st and 2nd probes are negative and are "from" and "pot" respectively.

TABLE 8

20 Simple Active Declarative Sentences Used as Test Stimuli in Experiment 2

The ball is on the floor.	is
The bird could fly away.	does
The big boy has lost it.	were
She played with toys upstairs.	toys
The small dish can fall down.	dish, can
The black dog will run fast.	am, truck
He talked with boys outside.	with, boys
The frog jumped on the boat.	used, near
The big bears could eat meat.	bears, could
She played at home all day.	at, home
The old man can sit down.	pen, was
Fish swim to food quickly.	of, ball
The girl stopped near the park.	rubbed, in
The man climbed off the bed.	climbed, off
The girl would like the doll.	would, like
The man must wash the cup.	must, wash
He cried in school today.	from, pat
The boy should hold the cat.	does, ask
The cat ran up the tree.	ran, up
The girl did bake the cake.	are, push

TABLE 9

20 Word Strings Used as Test Stimuli in Experiment 2

The bed with is ball the.	is
It big must bird the bake.	must
Upstairs boy does fly the.	does
Jumped she floor with away.	floor
School the sit could the boy.	sit, could
Man a near bake frog the.	in, cut
Bed the eat should the park.	make, was
Today man on stopped he.	man, on
Cat the fall must boy the.	fall, must
Doll a swim did the home.	bake, will
Fish the with cried school the.	to, snowed
Bears the off played the boat.	off, played
Quickly food in ran he.	clock, off
It fast can dish hold big.	can, dish
Outside meat a talked she.	road, near
Bed small would tree the like.	does, door
Hold the will cup black down.	must, pen
All day girl with home jumped.	girl, with
Old the should cake fast wash.	should, cake
Park the up climbed doll the.	up, climbed

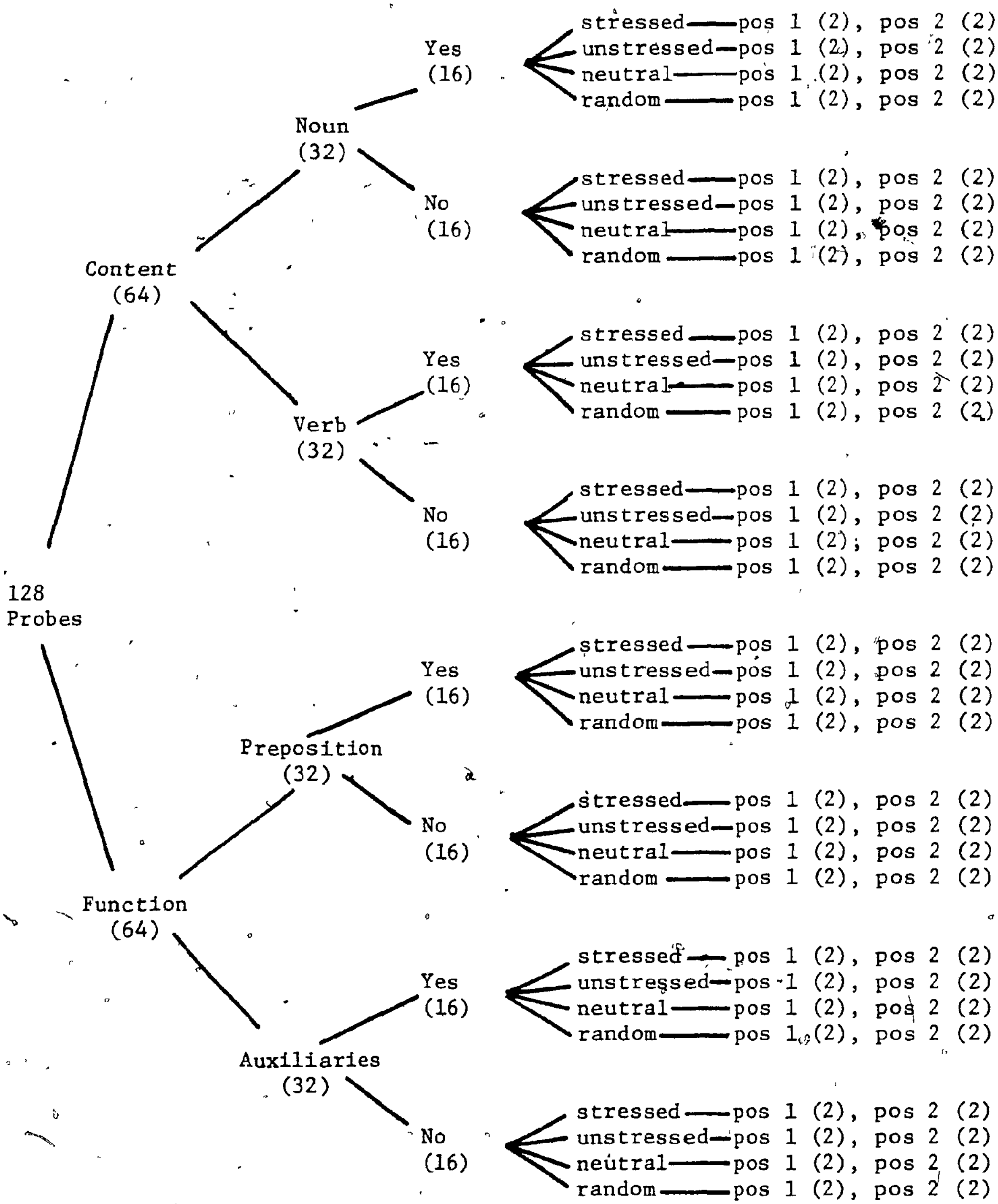


Figure 11. Number and Type of Stimuli Probed

Materials

The sentences and word strings were recorded on a Uher Royal Deluxe tape recorder by a female speaker at a rate slightly slower than normal speech. Each of the meaningful sentences was recorded in three ways:

1. The speaker used a normal falling (neutral) intonation in such a way that all words in the sentence received approximately equal stress.
2. The speaker placed marked stress on the word in the 1st probe position.
3. The speaker placed marked stress on the word in the 2nd probe position.

In order to attain levels of marked stress that approximated those used in everyday speech, the speaker recorded each sentence in response to a question. For example the speaker would be asked "When will the girl bake the cake" to which the speaker would response "The girl did bake the cake", placing marked stress on "did".

The three recordings of each sentence were then placed in a random order and listened to by a panel of three judges. The purpose of this was to ensure that sentence stress had been placed on the desired words and that these words were perceived as being more accented than the other words in the sentence. The judges were sophisticated listeners and had either a master's or doctorate degree in speech pathology. They were told that in some sentences all the words had received approximately equal stress and that in other sentences some of the words had received more stress than other words. They were asked to indicate when all the words received equal stress by writing a -- and to indicate marked stress by writing the word or words they thought had received the greater stress. It had been decided a priori that 100% judge agreement was necessary. Four sentence recordings did not at first achieve the required agreement and were rerecorded until the judges could concur. The random word strings were recorded in only the normal falling intonation.

All the sentence and word string recordings were matched as closely as possible for intensity. VU meter readings on peak and average intensity for each stimulus were taken and a computer program allowed the experimenter to amplify or attenuate the stimuli in small increments as required. The experimenter then listened to each pair of matched stimuli to see that they seemed matched perceptually as well and that no discernible auditory distortion had been introduced.

The probe words, recorded on a Uher Royal Deluxe tape recorder by a male speaker, were similarly matched as closely as possible with their respective sentences or word strings. The intensity of the probe words was matched to the average intensity of the sentence or word string.

A computer program was then used to generate the final test tapes. The sentences followed by a 50 millisecond tone were placed on the first tape channel. Probe words were placed 150 milliseconds after the sentence and a pulse was placed on the second tape channel at the onset of the probe. The 20 sentences recorded in a falling neutral intonation were placed on two tapes, the first of which had the sentences in the original order and the second of which had the sentences in reverse order. Different probe positions were probed on the two tapes. For example, on Tape 1 "The man must wash the cup" was followed by the probe word "must" while on the second tape "The man must wash the cup" was followed by the probe word "wash". Both tapes had equal numbers of 1st and 2nd probes, content and function probes, and positive and negative probes. The order of the sentences was such that these probe characteristics were randomly sequenced. The probes following the neutral sentences will be referred to as neutral probes.

The 20 sentences recorded with marked stress in two positions were arranged in two random sequences. These two sequences and those in reversed order comprised four tapes such that both content and function probe words are probed in both the stressed and unstressed conditions. "The man must wash the cup" appears on all four tapes. On the first of them marked stress was placed on the word "must" and the probe word was the unstressed "wash". On the second tape "wash" received the marked stress and "wash" was also the word probed. On the third tape "must" was the word stressed and it was also the word probed. Lastly, on the fourth of the tapes "wash" was the word stressed but "must" was the word probed. All four tapes had equal numbers of 1st and 2nd position probes, content and function probes, positive and negative probes, and stressed and unstressed probes. The orders of the sentences provided that the probe characteristics were equally distributed and randomly sequenced.

The last two tapes consisted of the 20 word strings arranged in normal and reverse order. Different probe positions were probed on the two tapes. The word string "Bears the off played the boat" was probed for "played" on the first tape and "off" on the second tape. The probe characteristics of position, positive/negative and content/function were equally represented in a random sequence on both tapes. The probes for the word strings are referred to as random probes.

The materials, therefore, consisted of eight tapes: two containing the meaningful neutral stimuli, four containing meaningful stimuli in which one word received marked stress and two containing nonmeaningful random stimuli. Each sentence on each tape was probed for positive or negative content and function words which were either neutral, stressed, unstressed or random. Although stressed, unstressed, neutral and random were grouped together as a single factor, two factors--stress and semantic-syntactic structure were actually being assessed. The full set of materials is tabled in Appendix C.

Apparatus

The equipment used in this study included a Hewlett Packard millisecond timer, a Uher Royal Deluxe reel-to-reel tape recorder, a tape recorder control box, a Uher Diapilot and a response button. The experimenter pressed a button on the recorder control box to start the tape recorder and sound was again transmitted over two sets of headphones to both the subject and experimenter. The Uher Royal Deluxe tape recorder has a built-in diapilot which records and reads mechanical pulses placed on the tape. A mechanical pulse placed on the 2nd tape channel at the beginning of the probe word activated the millisecond timer. A voice operated relay was not used in this study because of the young ages of some of the children and the possibility of getting false starts. Instead, the experimenter, upon hearing the subject's verbal response, pressed a button which stopped the timer. A tone on the 2nd tape channel activated a relay which stopped the tape recorder after each probe word. Figure 12 shows how the equipment was connected for this study.

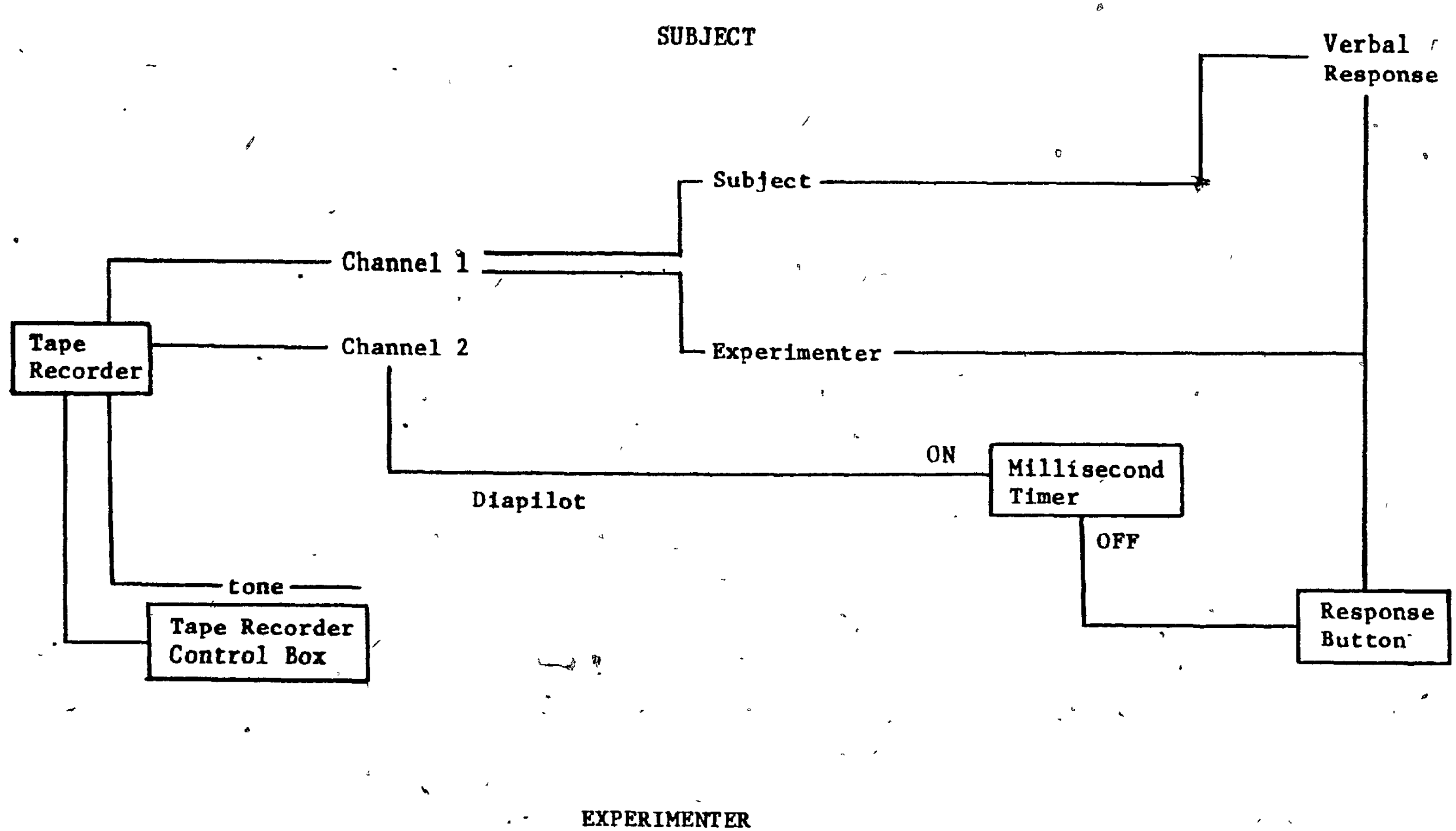


Figure 12. Schematic Diagram of Apparatus for Probe Verification Task.

Procedure

The eight stimulus tapes were arranged in six different random orders (Appendix D) of stimulus presentation. The only restriction in these orders was that the first tape of each order had to contain meaningful material. Three subjects from each group of 18 subjects were randomly assigned to each of the six presentation orders.

Each child was escorted to the testing room, seated at a table and given the same instructions as those given to subjects in the first study, with the exception that the child was not to say the answer into a microphone. The experimenter then presented a few very simple oral sentences at a very slow pace. The experimenter would say "Let's say the lady says 'I see a red car' and the man says 'red', you would say?", with the hope that the child would say "same" or "not the same". Three or four oral examples were completed in this way until the experimenter felt that the child understood the task. The earphones were then placed on the child's head and the child was given the four taped practice sentences. It was required that he respond correctly to the last three practice sentences in order to be included in the study. Six children in the language matched group were unwilling to participate as subjects; two language-impaired children became ill and one other language-impaired child was unable to perform the task. Other children were selected to fill their places.

Each child attended six experimental sessions and listened to one meaningful tape at each session. At two of the sessions the child listened to one of the random tapes as well. The test stimuli were again presented at a comfortable hearing level of 70-75 dB SPL. The tape recorder was stopped automatically after each sentence and probe word presentation, and the subject's response and response latency were recorded. Again, the subject was alerted before hearing each stimulus sentence and was socially rewarded by the experimenter after responding.

Results

One hundred and twenty-eight latency responses were recorded for each subject. The 128 probes to which these responses were made varied in four respects: word class (noun, verb, preposition, auxiliary), presence in the stimulus sentence (yes; no), stress value (stressed, unstressed, neutral, random) and position in the stimulus sentence (1st, 2nd). These four factors and their respective levels form a design which has 64 cells with one response per cell per subject. Since one replication per cell was added, there were two responses per cell per subject for a total of 128 responses. Since many subjects made a small number of error responses, a portion of the 64 cells had missing data. Three different procedures were used to determine the best method for dealing with the missing data.

1. Full Data Sets

The analysis of full sets of data required two latency scores for each of the 64 cells. To accomplish this, errors were classified as long latencies whenever they occurred. The length of the latency was determined separately for each subject in three different ways. Each error was replaced by:

1. The longest correct latency per word class + 100 milliseconds.

2. The longest correct latency per content (noun and verb) and function (preposition and auxiliary) + 100 milliseconds.

3. The longest correct latency + 100 milliseconds.

Suppose, for example, that Subject 1 erred in responding to a verb. First, the longest correct response to a verb for Subject 1 plus 100 milliseconds is substituted for the error. Subject 1's error on the same verb would next be replaced with his longest correct latency to any content word (noun or verb) plus 100 milliseconds. Lastly, Subject 1's error on the verb would be replaced by his longest correct latency response to any content or function word plus 100 milliseconds. In this way three full sets of data were formed, each different in that the errors were estimated in different ways.

2. Median Latency Sets

To obtain median latency sets, each of the three full data sets was collapsed across the position and replication factors. This resulted in four response latencies per cell in each set. The median of these four responses was then calculated, resulting in three sets of median data, each having 32 cells with one response, a median response per cell.

3. Shortest Latency Set

To obtain a shortest latency set, the data set was again collapsed across the position and replication factors resulting in four response latencies per cell. In this set, however, the shortest of these four responses was selected to fill the cell. If all four of the possible responses were errors, the longest correct latency for that subject plus 100 milliseconds was substituted. This yielded one set of shortest latency data having 32 cells with one response, the shortest, response per cell.

The F Max statistic was used to test the shortest and median latency sets for homogeneity of variance. In almost all cases, when the reciprocal transformation (1/latency) was applied, F Max ratios were not significant, indicating that homogeneity of variance had been achieved. The reciprocal transformation was then applied to the three full data sets, the three median data sets and to the shortest latency set to decrease the variance in latency scores due to negative skewness of reaction time measures.

Analyses of variance were performed on all the data sets. The statistical design in all these analyses was a completely crossed design with subjects nested in groups. The significance levels of all F values were again determined with conservative estimates of degrees of freedom (Winer, 1971). The significant main effects and interactions found in the seven analyses were virtually identical, indicating that the data were not sensitive to the exact method used for dealing with errors. The analysis of the median data in which error equalled the longest correct latency per content/function plus 100 milliseconds was selected as the most representative analysis, and complete details of the post hoc analyses will be given for that analysis only, but essentially the same results would have been found with any of the analyses. All post hoc analysis results are from the Tukey test of honestly significant differences.

Table 10 shows the summary of the content/function median analysis. The summaries of the other six analyses are given in Appendix E. A significant main effect ($F = 12.14$, $df = 2$, $p < .01$) for language group was found. Post hoc analysis (Appendix F-1) revealed no significant

TABLE 10

Summary of Analysis of Variance
Median Data, Errors = Longest Correct Latency
per Content/Function + 100 milliseconds.

SOURCE	DF	MS	F
Language Group (G)	2	4.53	12.14**
Error	51	.37	
Word Category (W)	3	.35	51.85**
W X G	6	.06	9.45**
Error	153	.01	
Yes/No (Y)	1	.03	.87
Y X G	2	.12	4.17*
Error	51	.03	
W X Y	3	.32	36.48**
W X Y X G	6	.02	2.41
Error	153	.01	
Stress (S)	3	.11	8.40**
S X G	6	.01	.75
Error	153	.01	
W X S	9	.03	5.27*
W X S X G	18	.01	1.38
Error	459	.01	
Y X S	3	.06	7.67**
Y X S X G	6	.01	.98
Error	153	.01	
W X Y X S	9	.01	1.80
W X Y X S X G	18	.00	.75
Error	459	.01	

** p < .01
 * p < .05

differences in the response times of the language-delayed ($\bar{x}$ speed = .41918) and language-matched subjects ($\bar{x}$ speed = .41648). The age-matched subjects ($\bar{x}$ speed = .57145) however, responded significantly faster ($p < .01$) than subjects in the other two groups (Figure 13).

Word category was also found to be a significant main effect (F = 51.85, df = 1, $p < .01$). Post hoc comparison (Appendix F-2) showed that response times to nouns ($\bar{x}$ speed = .49455) and verbs ($\bar{x}$ speed = .48730) were significantly faster ($p < .01$) than response times to prepositions ($\bar{x}$ speed = .43143) and auxiliaries ($\bar{x}$ speed = .46290), indicating that the time required to respond to a content probe is significantly shorter than the time required to respond to a function probe. Within the content category, response times to nouns and verbs did not differ significantly; within the function category, response times to auxiliaries were significantly faster ($p < .01$) than response times to prepositions (Figure 14).

A significant interaction (F = 9.45, df = 2, $p < .01$) was found between word category and group. Post hoc tests (Appendix F-3, F-4) revealed that the response time patterns to the word categories differed for the three language groups (Figure 15). The response pattern of the language-delayed group was as described by the word category main effect; response times were significantly faster ($p < .01$) to content words ($\bar{x}$ speed nouns = .45210, $\bar{x}$ speed verbs = .44936) than to function words ($\bar{x}$ speed auxiliaries = .41104, $\bar{x}$ speed prepositions = .36426) and within the function category, response times to auxiliaries were faster ($p < .01$) than responses to prepositions. The language-matched group followed a similar pattern with responses to content words ($\bar{x}$ speed nouns = .45466, $\bar{x}$ speed verbs = .44332) being faster ($p < .01$) than responses to function

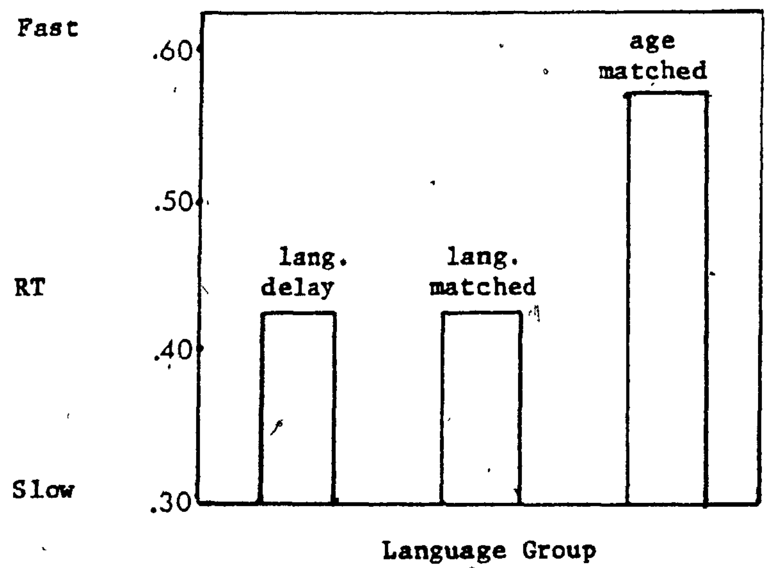
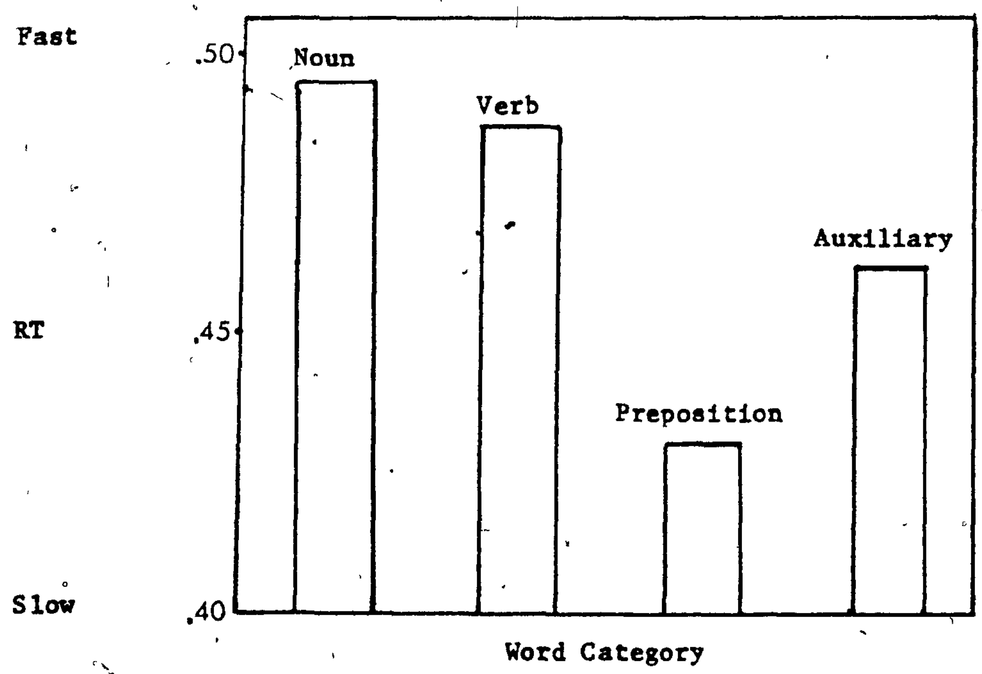


__Figure 13.__ **Response Time as a Function of Language Ability.**
(Speed = 1/latency (sec))



<u>Figure 14.</u> **Response Time as a Function of Word Category. (Speed = 1/latency (sec))**

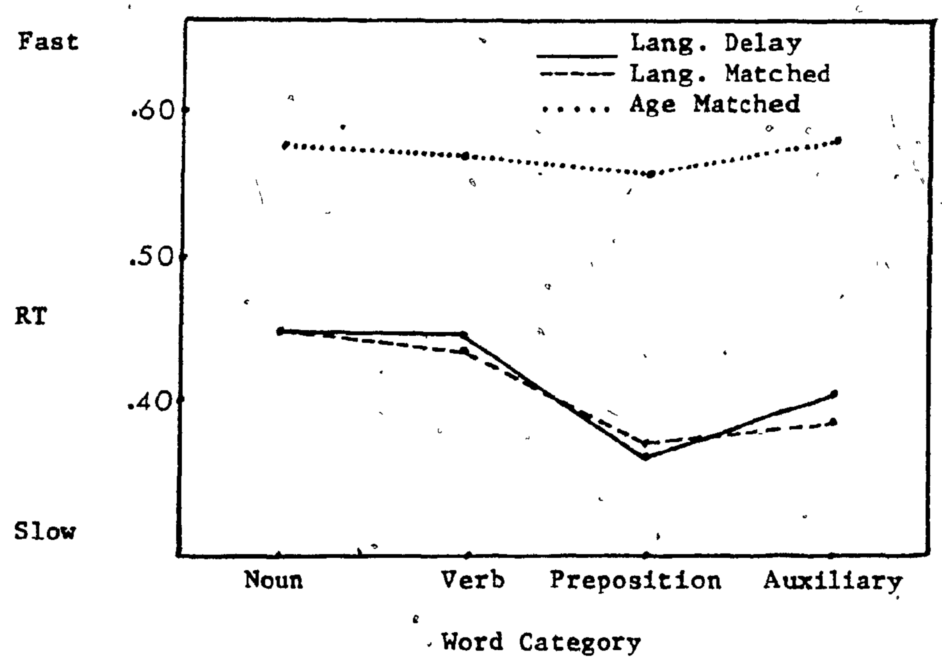


Figure 15. Response Time as a Function of Word Category for Language Delay, Language Matched, and Age Matched Groups.
(Speed = 1/latency (sec))

words ($\bar{x}$ speed auxiliaries = .39631, $\bar{x}$ speed prepositions = .37166). The age-matched group, however, had no significant differences in response times to any of the four word categories.

The main effect for Yes-No was not significant, indicating no difference in response times to positive and negative probes. Although the interaction between groups and Yes/No (Figure 16) was found to be significant ($F = 4.17$, $df = 2$, $p < .05$) a simple effects test did not indicate the site of interaction. It was, therefore, concluded that this interaction was not a meaningful one and that the patterns of response to positive and negative probes did not vary amongst the three language groups.

A significant interaction ($F = 36.48$, $df = 1$, $p < .01$) was found between word category and probe. Post hoc tests (Appendix F-5) revealed that response times amongst positive probes differed as a function of word category while response times amongst negative probes did not differ (Figure 17). Within positive probes, response times to nouns ($\bar{x}$ speed = .53055) were significantly faster ($p < .05$) than responses to verbs ($\bar{x}$ speed = .50195), which were significantly faster ($p < .01$) than responses to auxiliaries ($\bar{x}$ speed = .45461) which in turn were significantly faster ($p < .01$) than responses to prepositions ($\bar{x}$ speed = .40439). The lack of significance for the word category - Yes/No - group interaction indicates that the differing response times among positive but not negative probes was characteristic of all the language groups.

All groups responded significantly faster ($p < .01$) (Appendix F-6) to stressed items ($\bar{x}$ speed = .49232) than to unstressed ($\bar{x}$ speed = .46692), neutral ($\bar{x}$ speed = .46209) and random ($\bar{x}$ speed = .45486) items. This is shown by the significant main effect for stress ($F = 8.40$, $df = 1$, $p < .01$)

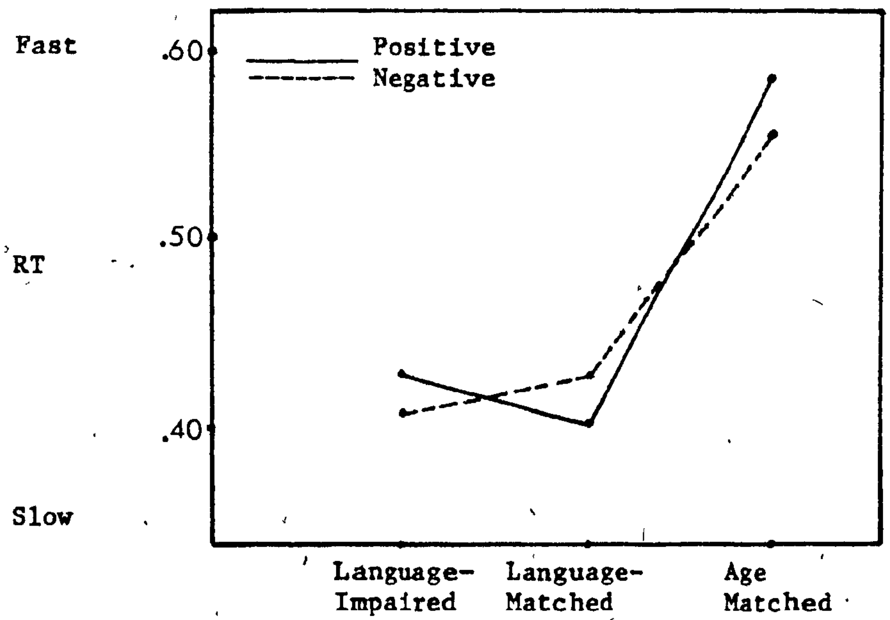
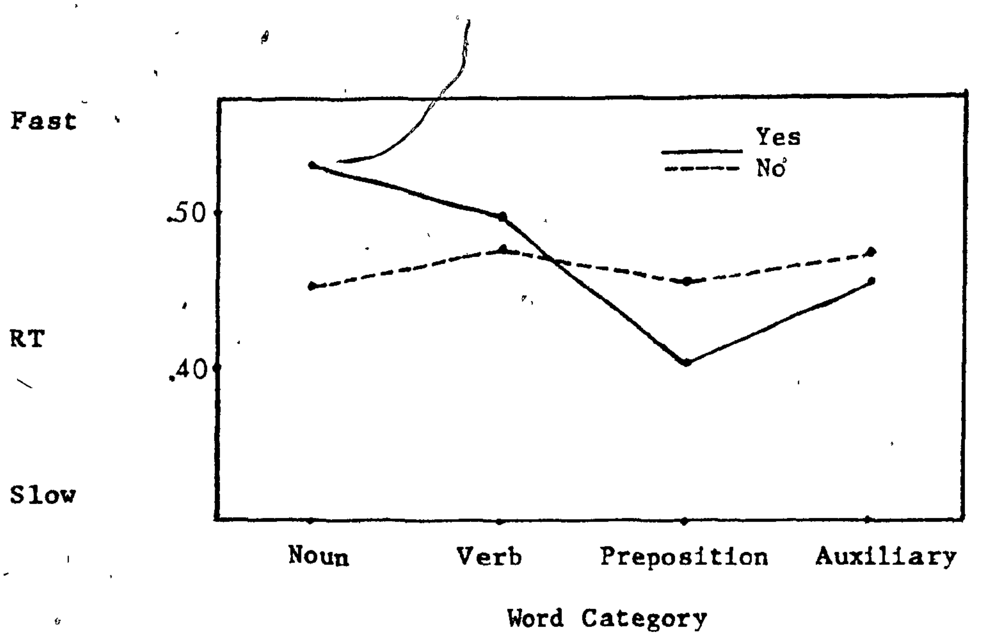


Figure 16. Response Time as a Function of Groups for Positive and Negative Responses. (Speed = 1/latency (sec))



<u>Figure 17</u>. Response Time as a Function of Word Category for YES and NO responses.
(Speed = 1/latency (sec))

(Figure 18) and the absence of a significant interaction between stress and groups (Figure 19). The lack of a significant difference between the response times to neutral and random probes showed that syntactic-semantic structure did not significantly affect response speed. The significant interaction between stress and word category ($F = 5.27$, $df = 1$, $p < .05$) (Figure 20) revealed that variations in stress condition affect the speed of response to function probes but have little or no effect on the response speeds to content probes. Simple effects indicated that response times to nouns ($\bar{x}$ stressed = .49840, $\bar{x}$ unstressed = .48874, $\bar{x}$ neutral = .49417, $\bar{x}$ random = .49691) did not differ under varying stress conditions, and a Tukey test subsequent to a significant simple effects test, (Appendix F-7) revealed that response times to verbs ($\bar{x}$ stressed = .50961, $\bar{x}$ unstressed = .49326, $\bar{x}$ neutral = .48917, $\bar{x}$ random = .45715) were significantly longer ($p < .05$) under the random condition only. On the other hand, response times to stressed prepositions ($\bar{x}$ speed = .46404) were significantly faster ($p < .01$) than response times to unstressed ($\bar{x}$ speed = .41719) and neutral ($\bar{x}$ speed = .41073) prepositions (Appendix F-8) and response times to stressed auxiliaries ($\bar{x}$ speed = .49722) were marginally faster ($p < .1$) than response times to unstressed auxiliaries ($\bar{x}$ speed = .4684) and significantly faster ($p < .01$) than response times to neutral ($\bar{x}$ speed = .45427) and random auxiliaries ($\bar{x}$ speed = .43163) (Appendix F-9). The significant interaction ($F = 7.67$, $df = 1$, $p < .01$) between stress and yes/no (Figure 21) revealed that marked stress increased ($p < .01$) the speed of response to positive probes ($\bar{x}$ speed = .51050) but had no effect on the speed of response to negative probes ($\bar{x}$ speed = .47414). The absence of group comparisons in all the significant interactions involving the stress factor (Figures 19 and 22) indicates that all three

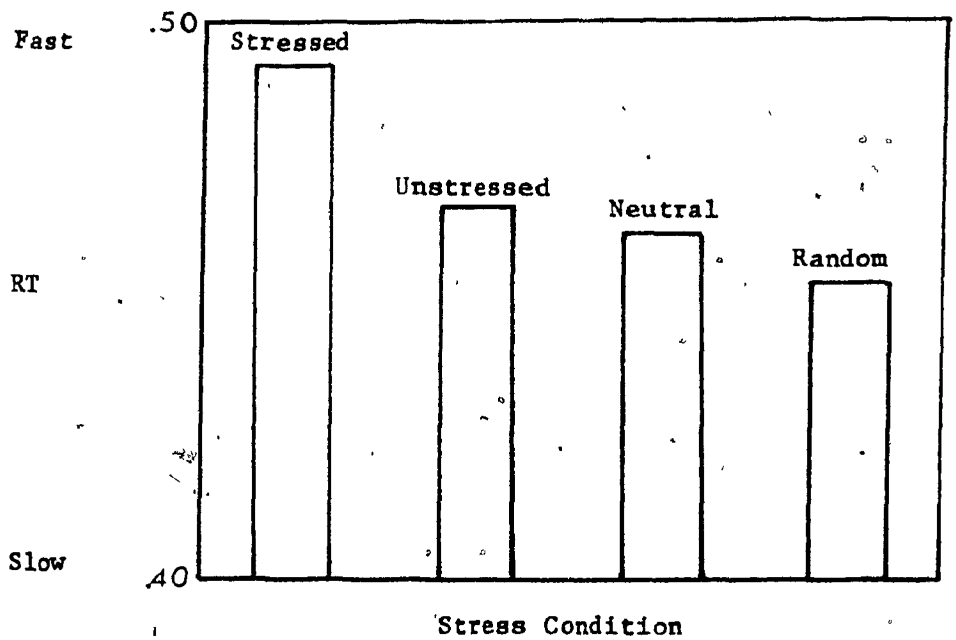


Figure 18. Response Time as a Function of Stress Condition.
(Speed = 1/latency (sec))

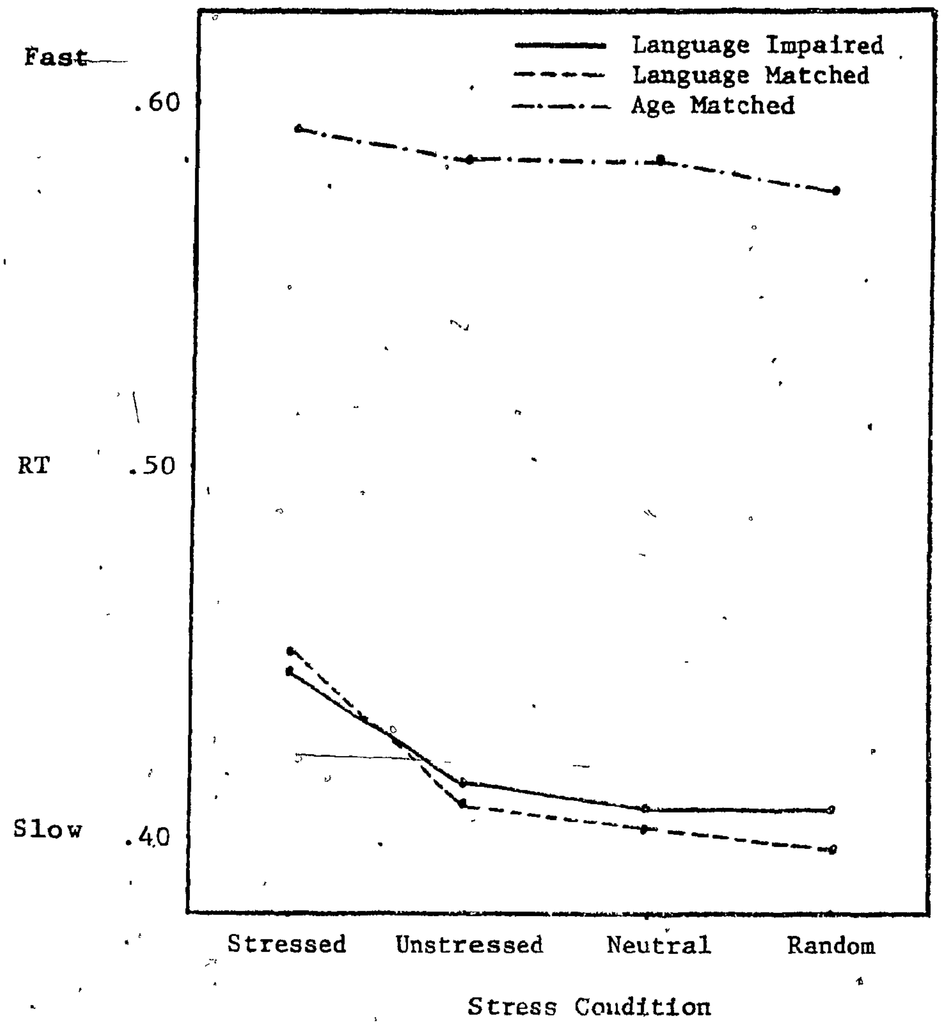


Figure 19. Response Time as a Function of Stress Condition for Language-Impaired, Language-Matched and Age-Matched Groups.
(Speed = 1/latency (sec))

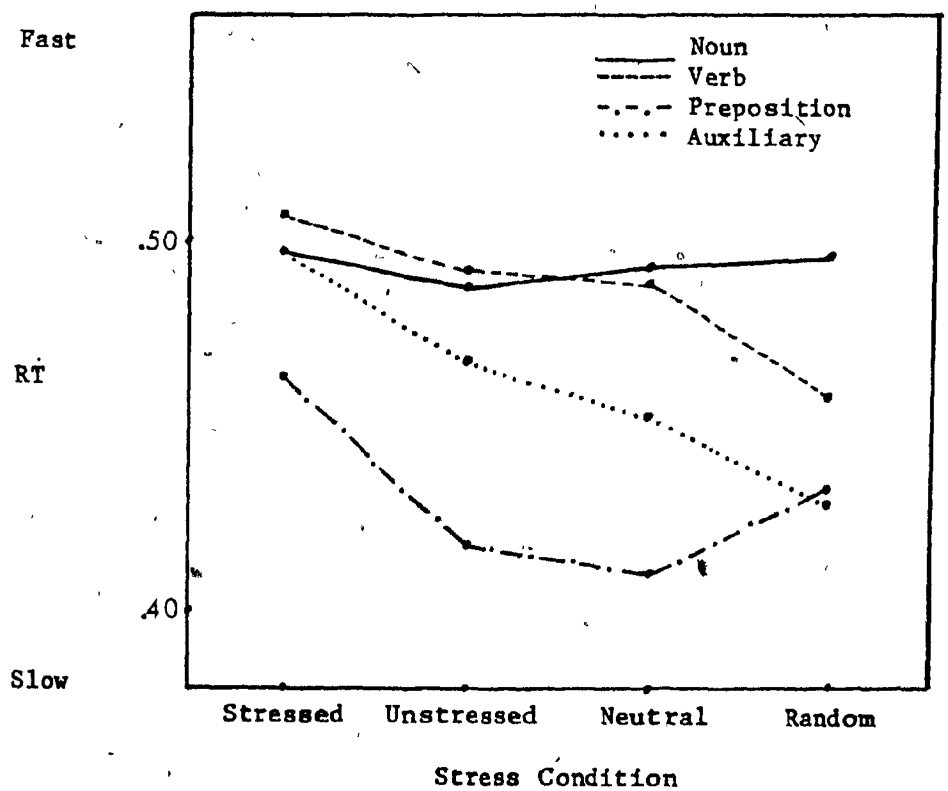


Figure 20. Response Time as a Function of Stress Condition for Noun, Verb, Preposition and Auxiliary Word Categories.
(Speed = 1/latency (sec))

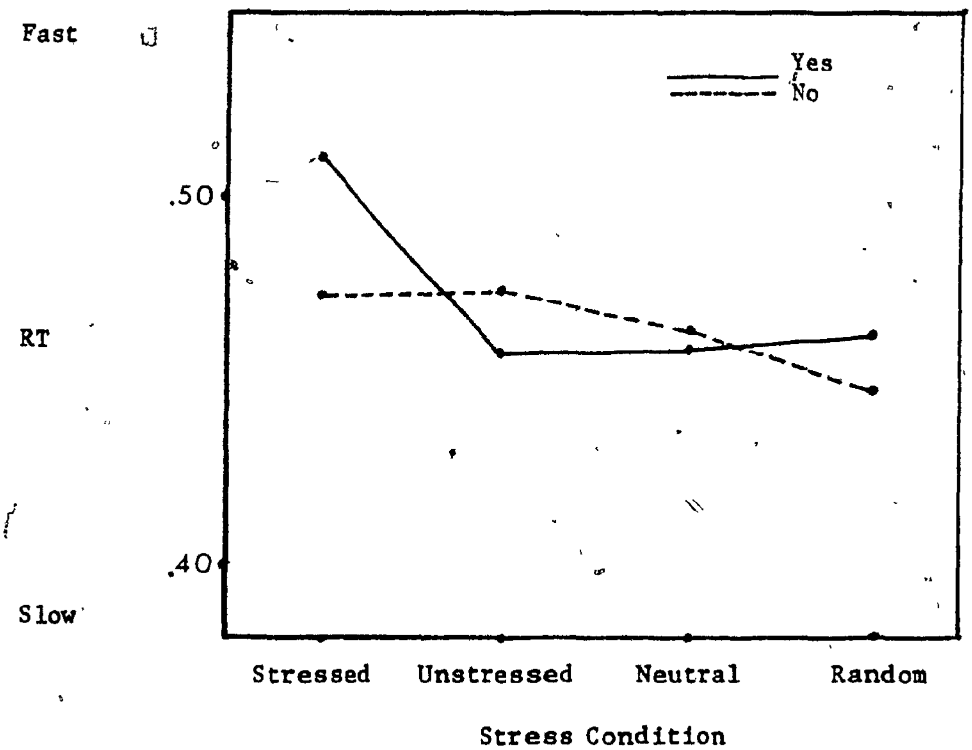


Figure 21. Response Time as a Function of Stress Condition for YES and NO responses. (Speed = 1/latency (sec))

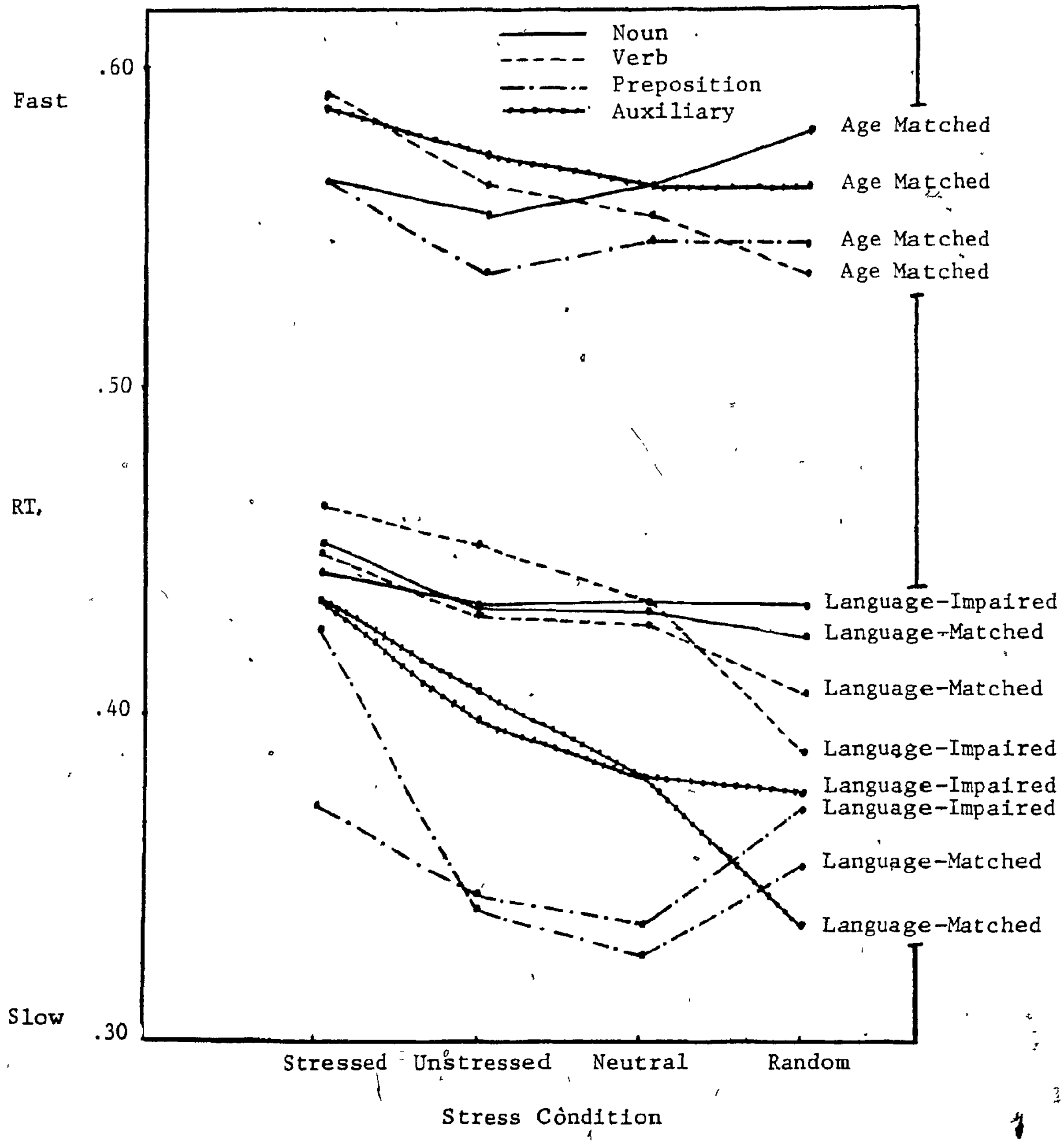


Figure 22. Response Time as a Function of Stress Condition and Word Category for Language-Impaired, Language-Matched and Age-Matched Groups. (Speed = 1/latency (sec))

language groups respond to variations in stress and variations in syntactic and semantic structure in about the same way.

Results of Other Analyses

The full data analysis (Appendix E-1) contained two factors not present in the median and shortest data sets, position and replications. The position factor was found to be significant ($F = 14.03$, $df = 1$, $p < .01$), and indicated that probes in the second position ($\bar{x}$ speed = .47732) were responded to faster than probes in the first position ($\bar{x}$ speed = .46732) (Figure 23). The other factor involved was the replication factor, which was found to be non significant, indicating that the results were not specific to only one group of the stimuli.

Several interactions involving the position factor were found to be significant. However, as most of these interactions did not include group comparisons they were not of primary interest in the interpretation of this study and will not be considered further. One of the significant interactions (Figure 24) ($F = 4.92$, $df = 2$, $p < .05$) did involve groups and word category. The large difference between content and function word responses of the language-impaired and language-matched groups occurred for words in Position 1 only.

Interactions involving the replication factor are not of primary interest in the interpretation of this study and therefore will not receive any further consideration.

Error Analysis

An analysis of variance was performed on the errors made by the language-delayed and language-matched groups. The age-matched group was

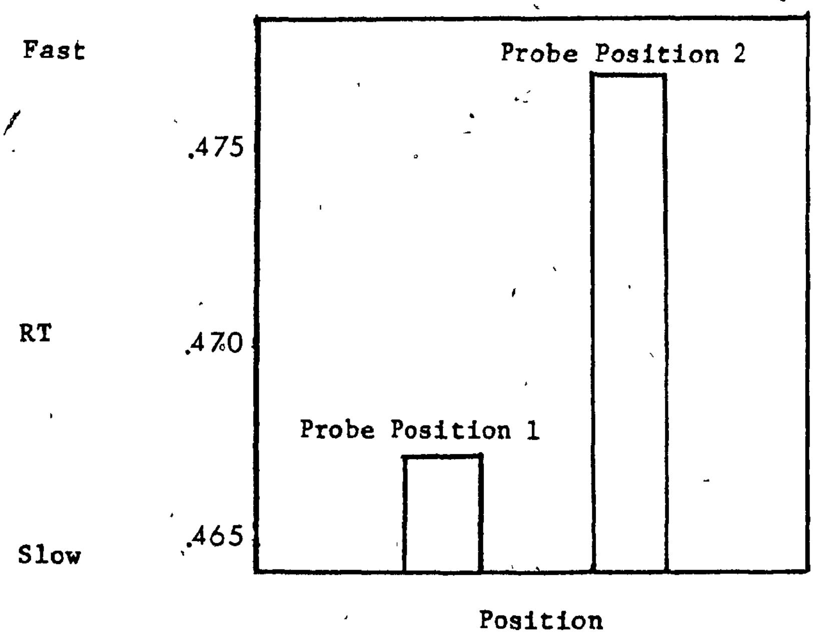


Figure 23. Response Time as a Function of Probe Position.
(Speed = 1/latency(sec))

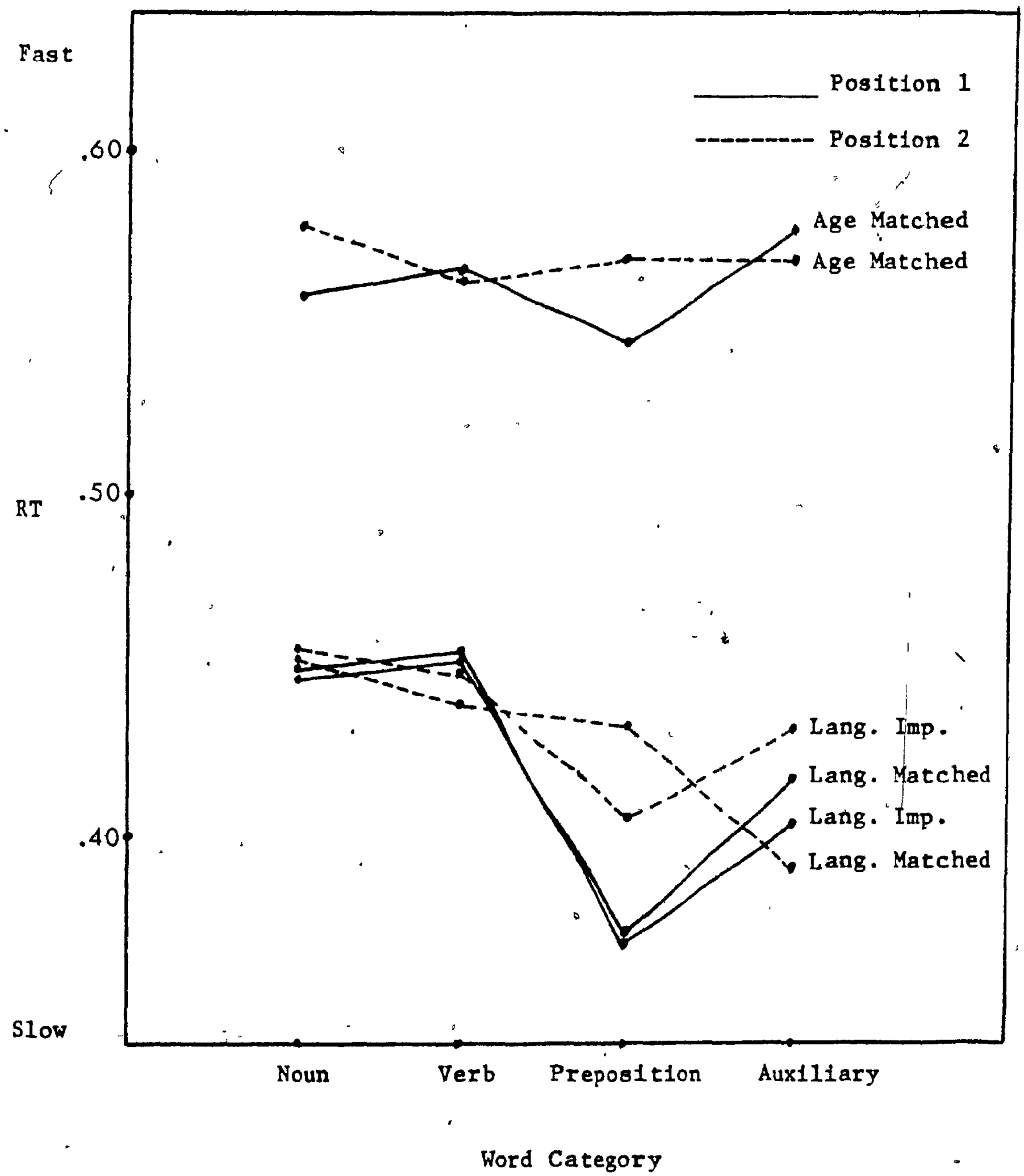


Figure 24. Response Time as a Function of Word Category and Position for Language-Impaired, Language-Matched, and Age-Matched Groups.
(Speed = 1/latency (sec))

not included in this analysis as subjects in this group did not make a significant number of errors. A full data set was partially collapsed across the word category factor and completely collapsed across the yes/no and position factors such that the number of errors were summed for each of the four stress conditions separately for content and function words for each subject (Appendix G). This forms a completely crossed design which has eight cells with one score per cell per subject, that is, an error score. Table 11 shows the results of the analysis. It was found that a significantly greater number of errors ($F = 60.89$, $df = 1$, $p < .01$) were made when responding to function words ($\bar{x}$ number of errors = 3.47) than when responding to content words ($\bar{x}$ number of errors = 1.56) (Figure 25). A significant main factor was found for stress ($F = 7.88$, $df = 1$, $p < .01$) and a subsequent Tukey test (Appendix F-10) revealed that significantly fewer errors ($p < .03 - .01$) were made when responding to stressed probes ($\bar{x}$ number of errors = 1.97) then when responding to unstressed ($\bar{x}$ number of errors = 2.54), neutral ($\bar{x}$ number of errors = 2.79) and random probes ($\bar{x}$ number of errors = 2.75) (Figure 26). The error rate was not affected by the semantic-syntactic structure of the sentence. Again, the interactions involving group comparisons were not significant, indicating that the language-delayed and language-matched groups did not differ in the way their errors were distributed amongst content and function words as a function of stress, or as a function of semantic and syntactic structure.

TABLE 11

Summary of Analysis of Variance
Errors

SOURCE	DF	M	F
Language Group (G)	1	.89	.12
Error	34	7.32	
Word Category (W)	1	260.68	60.89**
W X G	1	5.01	1.17
Error	34	4.28	
Stress (S)	3	10.25	7.88**
S X G	3	0.25	.19
Error	102	1.30	
W X S	3	5.97	4.00
W X S X G	3	.73	.50
Error	102	1.46	

** $p < .01$

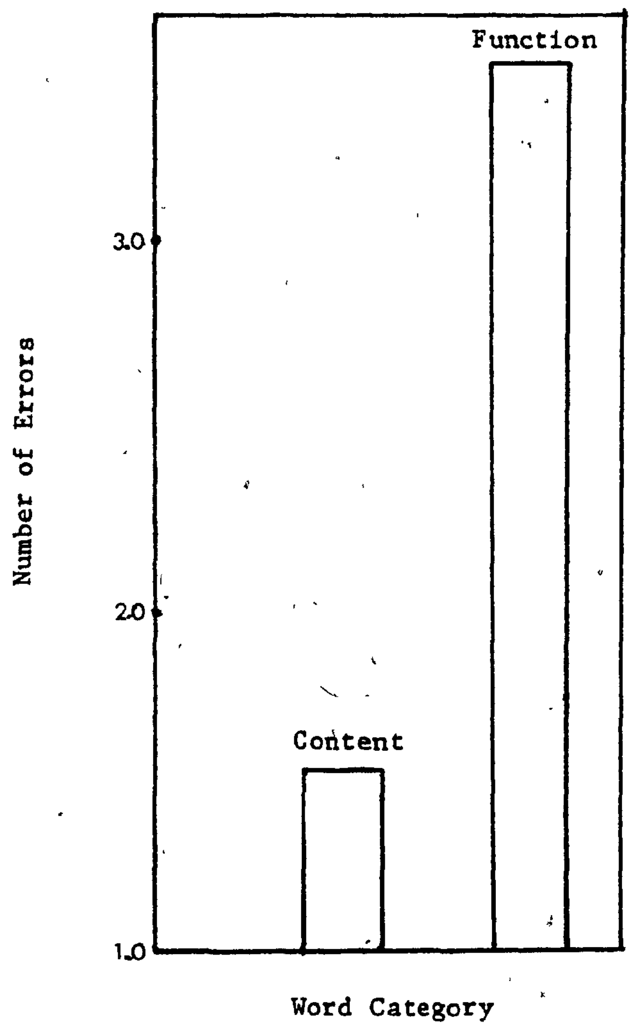


Figure 25. Number of Errors as a Function of Word Category.

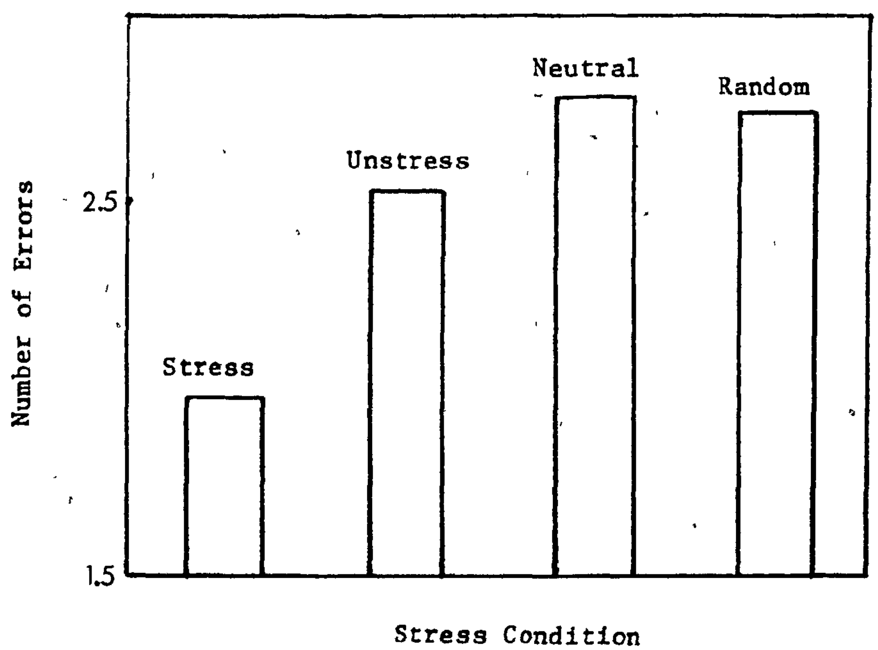


Figure 26. Number of Errors as a Function of Stress Condition.

CHAPTER SIX

GENERAL DISCUSSION

The results of both studies will be discussed together in this final section. However, it is first necessary to review the background and rationale of the research. The research was aimed at a preliminary exploration of how stress is used by language-impaired children in the comprehension of spoken language. Studies on adult processing of sentences have shown that the expectation of stress modifies how adults disperse their attention among the words of a sentence. In normal children, investigators have found that stress may be a determining factor in the differential saliency of sentence elements. Research on language-impaired children provides evidence that these children have difficulty processing auditory stimuli of short duration and that an increase in exposure improves perception. Although the grammatical forms which language-impaired children acquire more easily are those that are stressed and of longer duration, while the forms which they have more difficulty acquiring are those that are not stressed and of shorter duration, there has been little systematic research concerning the effects of stress variations on language processing of language-impaired children.

In this <u>first</u> study of how language-impaired children respond to sentence stress, an attempt was made to devise a rigorous experimental paradigm that would yield precise information about how responses to stress interact with other linguistic variables. In Experiment 1 it was ascertained that the probe latency technique was sensitive to the effects of word category and word position on the responses of children developing language normally. A second experiment was designed to study the effects of stress in relation to word category, word position and sentence meaningfulness for language-impaired as compared to normal children. The results of Experiment 2 did provide interesting and interpretable new information about the effect of sentence stress on language processing of language-impaired children. Due to the exploratory nature of the research, it could not be predicted in advance which variables would be most salient to the main interest of studying stress effects, and how the experiment should be designed to best reveal the interactions of these variables with the effects of stress. Having now completed the experiment, it is much more obvious how further research should be designed. The reader will have noted in proceeding through Experiment 1 and 2 that it is difficult to bear in mind the implications of significant and nonsignificant main effects and interactions regarding the main focus of stress effects on the language-impaired. The reader may also have noted that the hypotheses are somewhat vague and tentative, and that the design of Experiment 2 did not permit a direct assessment of a potentially important phenomenon--the interaction of stress and sentence meaningfulness. As I review the results of the two experiments, I will point out those places where the experimental paradigm and the experimental design might be improved in future research. I shall try to discuss these preliminary findings in a systematic enough manner such that directions for further research will be clearly indicated.

A probe latency technique was used in Experiment 1 to determine the effects of varying the type of word, its position in a sentence and the meaningfulness of the sentences on the speed of a decision by normal children in the kindergarten, first, third and sixth grades, as to whether a probe word given immediately after a sentence had been present in the sentence. The usefulness of the paradigm for the subsequent study of stress effects would be suggested by the finding of differential effects of experimental variables. If there were no effects other than improvement with age, the paradigm might not be appropriate, since response speed might simply be a function of short-term memory for a random series of auditory stimuli.

Experiment 2 was designed with the knowledge that the probe latency paradigm was sensitive to certain variables that might be relevant to stress effects in language-impaired children. A more elaborate experiment was designed in which the effects of stress and language impairment were studied in relation to the previously investigated effects of word category, word position and sentence meaningfulness. I will now review the results of Experiments 1 and 2, taking each variable separately, and as interacts with other variables, leading up to a consideration of how the experimental variables interacted with the language-impaired children's responses to stressed words.

Probe Type

The probe latency technique necessitated the use of both positive and negative probes to evaluate the effects of the experimental variables on decision times. In both experiments it was quite a consistent finding that the experimental effects of interest only occurred for positive probes. There were no differences in the response times for negative probes as a function of word position, stress, or word category. The lack of difference with respect to position and stress is not surprising since the subject had no way of knowing which word position the negative probe was a control for, or any way of knowing whether the negative probe was a control for a stressed or unstressed element. The finding that word category per se of negative probes did not significantly effect responses to content and function words indicates that the different responses to content and function words for positive probes was based on the word as it occurred in the actual sentence, and was not an effect based on the abstract or stored properties of the word class.

In the remaining parts of the discussion, all other effects will be discussed with reference to positive probes, unless otherwise stated and in future research it would be best to analyze positive and negative probe effects separately.

Word Category

The probe latency technique was sensitive to word category with faster responses to words that provide information about the content of a sentence than words that provide more abstract syntactic information. The very consistent content-function difference in both experiments provides a firm basis for studying the possible differential effects of word stress on content and function words in the language-impaired.

There may be a linguistic purpose for the primary accessing of content words. The primary access of content words may be necessary or helpful in accessing function words. Knowledge of the content words of a sentence establishes to a large degree the meaning of the sentence and simultaneously limits the number of permissible function words, thereby determining which function words are more likely to occur in specific locations. An opposing view has been suggested by Petretic and Tweeney (1974). They propose that the presence of function words may have a facilitative effect on the detection of content words in that they act as markers to help listeners focus on the content words. Under these circumstances, however, one would expect that response times to function words would be faster than the response times to content words.

Word Position

The results for word position were also consistent in both experiments. Responses to words in the second probe word position were much faster than responses to words in the first probe word position. Since the occurrence of the position effects were found for both meaningful and meaningfulness sentences, they may provide some insight into the storage-retrieval process that was used in leciding if a probe word was in a sentence. A recency effect or perhaps backward word-by-word comparisons without regard to overall meaning may account for the results. There is not enough information for further interpretation at this point but the results strongly demonstrate the need to control for word position in future studies.

Sentence Meaning

The effects of sentence structure were studied in different ways in the two experiments. Experiment 1 compared meaningful and meaningless but syntactically appropriate sentences. The lack of difference in decision time between the meaningful and meaningless sentences suggests that comprehension of overall sentence meaning did not influence decision time. This may perhaps be due to the subject scanning the words in a backwards fashion, as suggested above with reference to the position effect. In experiment 2 meaningful sentences were compared to random word strings devoid of both semantic and syntactic structure. Again, there were no differences in decision times to probes for meaningful sentences (neutral probes) and those for random word strings (random probes), suggesting that subjects used neither semantic or syntactic structure in reaching decisions about probe words. These results together with those for position suggest that the probe latency task, even though sensitive to word category, may not be sufficiently similar to how words are processed in spoken discourse. The subjects may have responded to the task demands by scanning the sentence as a string of unrelated words. It would be better, in future research, to study stress with a paradigm that forced the subject to respond to sentence meaning, if such a task could be found that provided as precise an index of decision time as this task.

Interactions of Word Category, Word Position, and Sentence Meaning

The lack of consistent first order interactions among these variables indicates that word category effects do not depend on position or sentence meaning. These results suggest that the subjects' decisions were based more on the word category itself and were less related to variations in the structure of the word string. The significant word category X meaningful interaction for positive probes provides only weak evidence that the meaning of the sentence may affect word category decisions. These results as a whole once more suggest that the probe latency method may be too artificial, although other studies (Gamlin, 1971; Kennedy and Wilkes, 1971) have shown the probe task to be sensitive to meaningfulness and semantic function.

Stress

The results of experiment 2 demonstrate that the probe latency technique was sensitive to the effects of stress. Subjects responded to each probe word in the same sentence context on two occasions; in one instance the probe word was stressed, while in the other it was unstressed. The speed of response to positive function words was increased significantly by word stress. Stress, therefore, increased the perceptual saliency of function words and allowed the speaker to direct the attention of the children to selective parts of the same sentence. This finding is in keeping with the Blasdell and Jensen (1970), Risley and Reynolds (1970) and Dupreez (1974) studies which also found positive effects for stress. The lack of a response time difference to stressed and unstressed content words indicated that the placement of stress on a function word in a sentence did not affect the response time to the unstressed content word in the same sentence. That is, although stress increased the perceptual saliency of the function words, it was not to the detriment of the way subjects responded to content words.

Researchers (Snow, 1977; Garnica, 1977) have noted that the speech directed to children is structurally simple, consistent and marked for excessive intonation and stress. Children at a young age may learn that the content words of an utterance are carriers of important information and expect stress to fall on the content words. Other stressed items would, therefore, be treated as potential carriers of important information and would get the attention generally accorded the content words of the sentence. In further research, another experimental paradigm might perhaps reveal the role of stress in emphasizing the uniqueness of content words.

Interaction of Stress with Position and Sentence Meaning

There were no significant interactions of stress with position or sentence meaning, indicating that the effect of stress on positive function words was not influenced by the position of the probe word or the meaningfulness of the sentence. It seems that stress effects in this paradigm were solely to enhance relatively slow, weak decisions regarding positive function words. However, the experimental design did not permit direct inferences regarding an interaction with sentence meaning, as there were no stressed probe words in random word strings. Different stress effects might have been found for random sentences and this would need to be investigated in future research by comparing responses to stressed and unstressed words in both meaningful and meaningless sentences.

Language Ability

As expected from Experiment 1, the older (age matched) subjects responded faster than the younger (language matched) subjects with normal language. The finding that the language-delayed group did not differ significantly from the language-matched group in overall response time, indicates that decision time is not just a function of chronological age, as would be expected in simple response time to a nonlinguistic stimulus, but reflects the time necessary to make linguistic decisions. The probe latency index of language development seems to correspond to the indices used as selection criteria for the language-impaired and language-matched groups.

Interaction of Language Ability with Word Category, Word Position and Sentence Meaning

No significant differences were found between groups for the effects of word position. There was no direct test of the difference between groups in response to meaningful and random stimuli because the meaningful versus random comparison was part of the stress factor; but one would have expected a significant stress X groups interaction if there had been a marked difference between groups. The stress X groups interaction did not at all approach significance ($F = .75$) as illustrated in Figure 19.

There was a word category by group interaction. The language-impaired children and the younger (language-matched) normals responded significantly faster to the content words of a sentence than to the function words. This pattern of response was also displayed by the normal older children in Experiment 1 but not by the normal older (age matched) children in Experiment 2, who responded with equal speed to both content and function words. The more rapid responses of the language-impaired and young normal children to content words provides evidence that for children, at their language level, the meaning-bearing content words of a sentence are more attended to and more easily accessed than the function words. The similarities in response pattern and speed for language-impaired and young children suggest that these two groups of children are operating under some common constraint and that the strategy of attending to content words is of advantage to these children in processing speech. The small short term memory spans of normal young children and the possibly deficient short term memory spans of language-impaired children (Menyuk and Looney, 1972) may necessitate this differential attention to content words. These children may "know" that they can only retain a certain number of words from which they must determine the content of a sentence. By attending primarily to the content items of speech and only secondarily to the function words, these children are assured that they will at least obtain the meaning of the speech presented to them. The similarity between the language-impaired and language matched subjects is also evident in the significant word category X position X group interaction which showed that the large difference between content and function word responses occurred for words in the first word position.

In processing the simple sentences of Experiment 2 the older (age-matched) children no longer attended differentially to content and function words. Perhaps older children possess better "chunking" abilities which would consume less of their available short term memory spans. The residual part of the memory span may then allow them to more directly access the words, be they content or function, within a chunk. With the longer sentences in Experiment 1, however, normal older children even at older ages (sixth grade) perform as the younger children do, that is, they revert to the content-function dichotomy.

Interaction of Stress and Language Ability

Once again the design of Experiment 2 precluded a direct test of the differential stress effects on groups because the stress effects were assessed in the same factor as the meaningful and random effects. However, there was no hint of any interaction, as evidenced by the nonsignificant stress X groups interaction ($F = .75$). From an examination of the means in Figure 21, one can tentatively conclude that the language-impaired subjects responded to the stress conditions in about the same way as the language-matched subjects. Further research with a more direct assessment of the stress X groups interaction is required.

Interaction of Stress, Language Ability and other Variables

In keeping with the main goal of the experiment, it is of primary interest to determine if the groups differed in sensitivity to stress in relation to the other experimental variables, i.e., word category, word position and sentence meaning. A word category effect would have been revealed by a word category X stress X groups interaction, which was found to be not significant (Figure 22), indicating that the stress X word category interaction was the same for both the language-impaired and language matched children. The absence of a significant position X stress X groups effect indicated that there were no differences between groups in processing position in relation to stress. There was no direct test of the difference between groups in the interaction of stress with sentence meaning because of the design. Although there is no reason to expect any difference in regards to meaningfulness, as meaningfulness has no other major effects, it is nevertheless an important aspect to investigate and one which should be more directly tested in future research.

Response Errors

The results of the error analysis generally confirmed the trends found in the latency data. Word category and stress affected the accuracy of response for the language-impaired and younger normal children in that more errors were made in responding to function words and fewer errors were made in responding to stressed words. There were no differences in error rate between neutral and random probes indicating that semantic-syntactic structure had no effect on error rate. With age there was a decrease in response errors such that no errors were present in the responses of the age matched group.

Research Implications

The probe latency technique clearly revealed that the language-impaired children showed responses to word stress and word category in keeping with their other language skills. No differences were found in how their stress responses were influenced by word category or word position. However, the probe latency technique appears to provide only a limited indication of how stress affects the actual processing of spoken discourse as all subjects seemed to process the sentences in a word-by-word fashion rather than as meaningful wholes. Furthermore, there was no opportunity to test the hypothesis that the language-impaired tended to make less use of sentence meaning than the other groups in responding to stress. In future research, one might seek a paradigm which forces the subject to comprehend meaningful sentences and compare the interactions of stress, word category and word position for both meaningful and meaningless sentences.

Clinical Implications

The similarity of the normal and language-impaired children's response patterns to stress variations suggests that the strategies that language-impaired children use for processing stress resemble those used by normal children. While the grammatical forms which language-impaired children have difficulty acquiring are those that generally lack stress, it does not appear that the lack of stress on function words accounts for their delayed acquisition as there were no differences in the way that language-impaired and normal children responded to unstressed and neutral probes, that is, lack of stress. It, therefore, does not appear that the absence of sensitivity to stress is a major causative factor of the impaired language of language-impaired children. Further research is needed to investigate how best to incorporate stress into structured language therapy programs.

Original Contribution to Knowledge

There have been no previous systematic investigations of the perception of stress by language-impaired children. The present results clearly demonstrated that language-impaired children did not differ in their perception of stress from normal children at approximately the same stage of language development.

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APPENDIX A

Q Statistic

Tukey Tests of Honestly Significant Differences

Experiment 1

APPENDIX A

1. Grade - Response Times for Nursery, K, 1st, 3rd and 6th Grades.

Grade	K	1	3	6
N	2.17	2.94	3.79	8.18*
K		.77	1.63	6.01*
1			.86	5.24*
3				4.38*

*p < .01 k = 5 df = 150

2. Word Category - Response Times to Nouns, Verbs, Adverbs, Prepositions, Pronouns, Auxiliaries.

Word Category	Verbs	Adverbs	Prepositions	Pronouns	Auxiliaries
Nouns	2.74	3.46	8.19**	8.69**	9.12**
Verbs		0.72	5.45**	5.95**	6.38**
Adverbs			4.73**	5.23**	5.65**
Preposition				0.50	0.93
Pronouns					0.42

*p < .05 k = 6 df = 150
**p < .01

3. Word Category - Positive Probe - Response Times to Positive Noun, Verb, Adverb, Preposition, Pronoun and Auxiliary Probes.

Word Category	Verb	Adverb	Preposition	Pronoun	Auxiliary
Noun	2.71	3.84	9.68**	9.91**	8.0**
Verb		1.13	6.86**	7.19**	5.77**
Adverb			5.83**	6.05**	4.64**
Preposition				0.22	8.18
Pronoun					1.41

*p < .05 k = 6 df = 150
**p < .01

4. Meaningfulness - Probe Type - Word Category - Response Times to Positive and Negative Content and Function Words for Meaningful Sentences.

Word Category X Probe Type	Content Negative	Function Positive	Function Negative
Content Positive	10.17**	9.70**	13.21**
Content Negative		.47	3.04
Function Positive			3.52

**p < .01 k = 4 df = 30

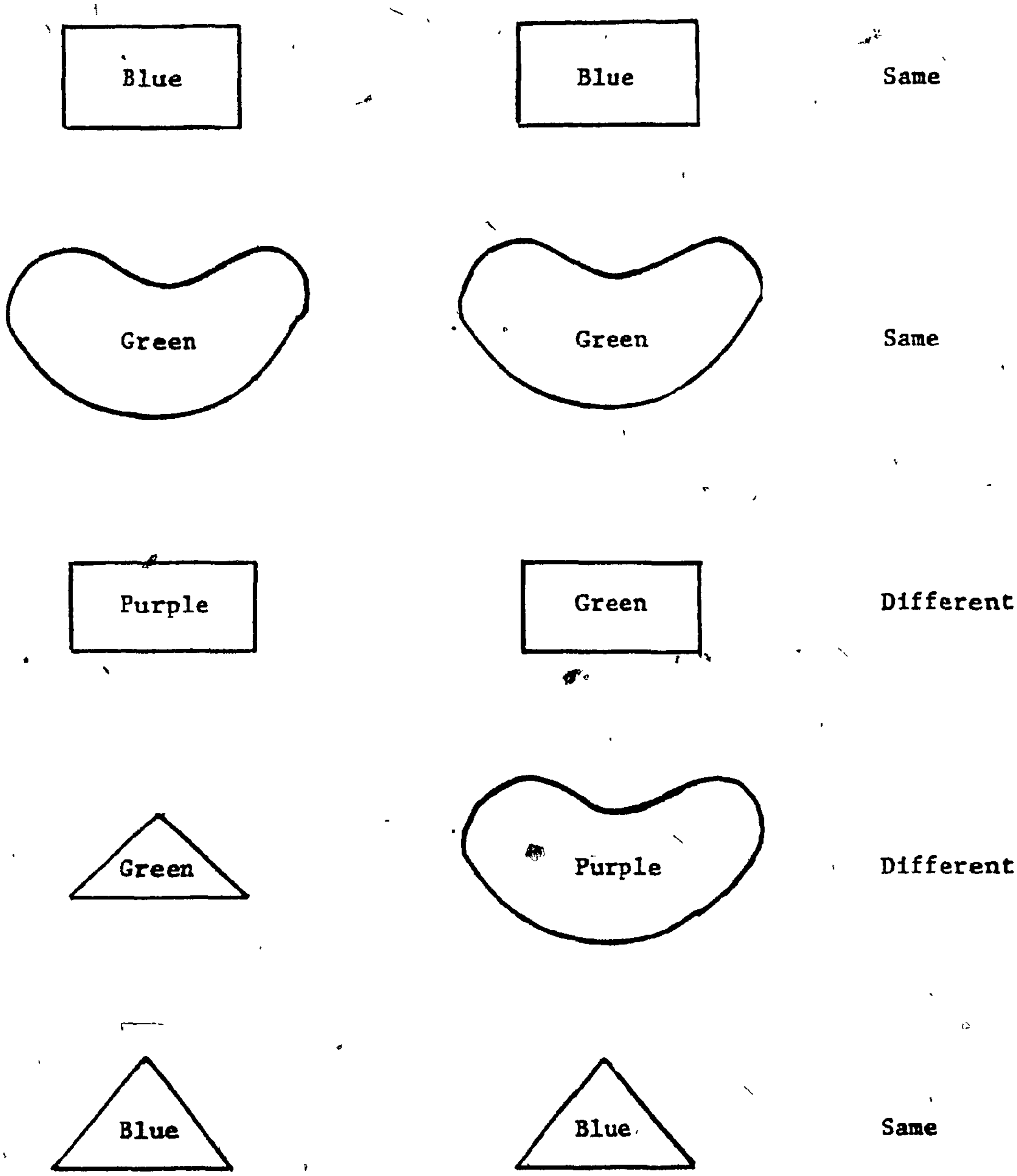
5. Meaningfulness - Probe Type - Word Category - Response Times to Positive and Negative Content and Function Words for Anomalous Sentences.

Word Category X Probe Type	Content Negative	Function Positive	Function Negative
Content Positive	12.76**	13.82**	13.18**
Content Negative		1.06	.42
Function Positive			.64

** $p < .01$ $k = 4$ $df = 30$

APPENDIX B

Same-Different Task


Blue
Blue
Same
Green
Green
Same
Purple
Green
Different
Green
Purple
Different
Blue
Blue
Same

APPENDIX C

Stimulus Lists

NEUTRAL SET 1

The ball is on the floor.	is
The bird could fly away.	does
The big boy has lost it.	were
She played with toys upstairs.	toys
The small dish can fall down.	dish
The black dog will run fast.	am
He talked with boys outside.	boys
The frog jumped on the boat.	used
The big bears could eat meat.	could
She played at home all day.	at
The old man can sit down.	pen
Fish swim to food quickly.	ball
The girl stopped near the park.	in
The man climbed off the bed.	climbed
The girl would like the doll.	like
The man must wash the cup.	must
He cried in school today.	from
The boy should hold the cat.	ask
The cat ran up the tree.	up
The girl did bake the cake.	are

<u>NEUTRAL SET II</u>

The ball is on the floor.	is
The bird could fly away.	does
The big boy has lost it.	were
She played with toys upstairs.	toys
The girl did bake the cake.	push
The cat ran up the tree.	ran
The boy should hold the cat.	does
He cried in school today.	pot
The man must wash the cup.	wash
The girl would like a doll.	would
The man climbed off the bed.	off
The girl stopped near the park.	rubbed
Fish swim to food quickly.	of
The old man can sit down.	was
She played at home all day.	home
The big bears could eat meat.	bears
The frog jumped on the boat.	near
He talked with boys outside.	with
The black dog will run fast.	truck
The small dish can fall down.	can

STRESS SET I

The ball is on the floor.	is
The bird could fly away.	does
The big boy has lost it.	were
She played with toys upstairs.	toys
He cried in school today.	pot
The cat ran up the tree.	ran
The boy should hold the cat.	does
The girl did bake the cake.	push
The man must wash the cup.	wash
He talked with boys outside.	with
The man climbed off the bed.	off
The girl stopped near the park.	rubbed
Fish swim to food quickly.	of
The small dish can fall down.	can
She played at home all day.	home
The big bears could eat meat.	bears
The old man can sit down.	was
The girl would like a doll.	would
The black dog will run fast.	truck
The frog jumped on the boat.	near

STRESS SET II

The ball is on the floor.	is
The bird could fly away.	does
The big boy has lost it.	were
She played with toys upstairs.	toys
The frog jumped on the boat.	used
The cat ran up the tree.	up
The girl would like a doll.	like
The man climbed off the bed.	climbed
The girl stopped near the park.	in
The man must wash the cup.	must
The old man can sit down.	pen
The boy should hold the cat.	ask
The black dog will run fast.	am
The small dish can fall down.	dish
He talked with friends outside.	boys
She played at home all day.	at
He cried in school today.	from
Fish swim to food quickly.	ball
The big bears could eat meat.	could
The girl did bake the cake.	are

STRESS SET III

The ball is <u>on</u> the floor.	is
The bird <u>could</u> fly away.	does
The big <u>boy</u> has lost it.	were
She played with <u>toys</u> upstairs.	toys
The frog <u>jumped</u> on the boat.	near
The black dog <u>will</u> run fast.	truck
The girl <u>would</u> like a doll.	would
The old <u>man</u> can sit down.	was
The big bears <u>could</u> eat meat.	bears
She played at <u>home</u> all day.	home
The small <u>dish</u> can fall down.	can
Fish swim <u>to</u> food quickly.	of
The girl stopped <u>near</u> the park.	rubbed
The man <u>climbed</u> off the bed.	off
He talked <u>with</u> boys outside.	with
The man must <u>wash</u> the cup.	wash
The girl will <u>bake</u> the cake.	push
The boy <u>should</u> hold the cat.	does
The cat ran <u>up</u> the tree.	ran
He cried in <u>school</u> today.	pot

STRESS SET IV

The ball is on the floor.	is
The bird could fly away.	does
The big boy has lost it.	were
She played with toys upstairs.	toys
The girl did bake the cake.	are
The big bears could eat meat.	could
Fish swim to food quickly.	ball
He cried in school today.	from
She played at home all day.	at
He talked with friends outside.	boys
The small dish can fall down.	dish
The black dog will run fast.	am
The boy should hold the cat.	ask
The old man can sit down.	pen
The man must wash the cup.	must
The girl stopped near the park.	in
The man climbed off the bed.	climbed
The girl would like a doll.	like
The cat ran up the tree.	up
The frog jumped on the boat.	used

RANDOM SET I

The bed with is ball the.	is
It big must bird the bake.	must
Upstairs boy does fly the.	does
Jumped she floor with away.	floor
Park the up climbed doll the.	climbed
Old the should cake fast wash.	should
All day girl with home jumped.	with
Hold the will cup black down.	pen
Bed small would tree the like.	does
Outside meat at talked she.	near
The fast can dish hold big.	dish
Quickly food in ran he.	clock
Bears the off played the boat.	off
Fish the with cried school the.	snowed
Doll a swim did the home.	bake
Cat the fall must boy the.	ball
Today man on stepped he.	man
Bed the eat should the park.	was
Man a near bake frog the.	in
School the sit could the boy.	sit

RANDOM SET II

The bed with is ball the.	is
It big must bird the bake.	must
Upstairs boy does fly the.	does
Jumped she floor with away.	floor
School the sit could the boy.	could
Man a near bake frog the.	cut
Bed the eat should the park.	make
Today man on stopped he.	on
Cat the fall must boy the.	must
Doll a swim did the home.	will
Fish the with cried school the.	to
Bears the off played the boat.	played
Quickly food in ran he.	off
The fast can dish hold big.	can
Outside meat at talked she.	road
Bed small would tree the like.	door
Hold the will cup black down.	must
All day girl with home jumped.	girl
Old the should cake fast wash.	cake
Park the up climbed doll the.	up

APPENDIX D

Random Orders of Stimulus Presentation

1. Stress 3, Random 1, Stress 4, Stress 2, Stress 1, Neutral 2, Random 2, Neutral 1.

2. Neutral 2, Neutral 1, Stress 1, Random 2, Stress 2, Random 1, Stress 4, Stress 3.

3. Stress 1, Stress 3, Random 1, Neutral 1, Random 2, Neutral 2, Stress 2, Stress 4.

4. Stress 4, Neutral 2, Stress 3, Random 2, Neutral 1, Stress 1, Random 1, Stress 2.

5. Neutral 1, Stress 2, Neutral 2, Stress 4, Random 1, Stress 3, Stress 1, Random 2.

6. Stress 2, Stress 1, Random 2, Stress 4, Stress 3, Neutral 1, Neutral 2, Random 1.

APPENDIX E

Summary Tables of Analyses of Variance

1. Summary of Analysis of Variance
Full Data, Errors = Longest Correct Latency
per Function/Content + 100 milliseconds.

SOURCE	DF	MS	F
Language Group (G)	2	14.86	11.46 **
Error	51	1.30	
Replication (R)	1	.01	.61
R X G	2	.01	1.22
Error	51	.01	
Word Category (W)	3	.67	40.24 **
W X G	6	.16	9.80 **
Error	153	.02	
Yes/No (Y)	1	.29	3.83
Y X G	2	.29	3.82 *
Error	51	.07	
W X Y	3	1.00	52.92 **
W X Y X G	6	.02	1.32
Error	153	.02	
Stress (S)	3	.37	9.57 **
S X G	6	.03	.69
Error	153	.04	
W X S	9	.05	4.15 *
W X S X G	18	.01	.87
Error	459	.01	
Y X S	3	.12	6.59 *
Y X S X G	6	.02	1.05
Error	153	.02	
Position (P)	1	.17	14.03 **
P X G	2	.02	1.33
Error	51	.01	
W X P	3	.22	18.54 **
W X P X G	6	.06	4.92 *
Error	153	.01	

**p < .01
*p < .05

2. Summary of Analysis of Variance
Full Data, Errors = Longest Correct Latency
per Word Category + 100 milliseconds.

SOURCE	DF	MS	F
Language Group (G)	2	14.34	10.97 **
Error	51	1.31	
Replication (R)	1	.00	.15
R X G	2	.01	1.03
Error	51	.01	
Word Category (W)	3	.55	31.30 **
W X G	6	.14	7.82 **
Error	153	.02	
Yes/No (Y)	1	.35	5.34 *
Y X G	2	.21	3.22 *
Error	51	.07	
W X Y	3	.78	46.72 **
W X Y X G	6	.02	1.10
Error	153	.02	
Stress (S)	3	.36	9.35 **
S X G	6	.02	.65
Error	153	.04	
W X S	9	.04	3.79
W X S X G	18	.01	1.01
Error	459	.01	
Y X S	3	.12	7.02 *
Y X S X G	6	.02	.96
Error	153	.02	
Position (P)	1	.12	11.39 **
P X G	2	.02	1.95
Error	51	.01	
W X P	3	.18	17.01 **
W X P X G	6	.04	4.48 *
Error	153	.01	

* $p < .05$
** $p < .01$

3. Summary of Analysis of Variance
Full Data, Errors = Longest Correct Latency
per Subject + 100 milliseconds.

SOURCE	DF	MS	F
Language Group (G)	2	15.56	12.35 **
Error	51	1.26	
Replication (R)	1	.02	1.76
R X G	2	.01	1.10
Error	51	.01	
Word Category (W)	3	.75	42.01 **
W X G	6	.19	10.66 **
Error	153	.02	
Yes/No (Y)	1	.25	2.62
Y X G	2	.26	2.75
Error	51	.09	
W X Y	3	.17	51.13 **
W X Y X G	6	.02	.95
Error	153	.02	
Stress (S)	3	.41	9.91 **
S X G	6	.03	.63
Error	153	.04	
W X S	9	.07	5.09 *
W X S X G	18	.01	.99
Error	459	.01	
Y X S	3	.14	7.35 **
Y X S X G	6	.02	1.15
Error	153	.02	
Position (P)	1	.26	18.72 **
P X G	2	.02	1.60
Error	51	.01	
W X P	3	.25	21.38 **
W X P X G	6	.06	5.06 **
Error	153	.01	

* $p < .05$
** $p < .01$

4. Summary of Analysis of Variance
Median Data, Errors = Longest Correct
Latency per Word Category + 100 milliseconds.

SOURCE	DF	MS	F
Language Group (G)	2	4.32	11.62 **
Error	51	.37	
Word Category (W)	3	.29	45.81 **
W X G	6	.05	8.63 **
Error	153	.01	
Yes/No (Y)	1	.05	2.11
Y X G	2	.09	3.54 *
Error	51	.03	
W X Y	3	.27	36.10 **
W X Y X G	6	.01	2.02
Error	153	.01	
Stress (S)	3	.10	8.10 **
S X G	6	.01	.69
Error	153	.01	
W X S	9	.02	4.79 *
W X S X G	18	.01	1.45
Error	459	.00	
Y X S	3	.04	6.82 *
Y X S X G	6	.01	.88
Error	153	.01	
W X Y X S	9	.01	1.66
W X Y X S X G	18	.00	.78
Error	459	.01	

** $p < .01$
* $p < .05$

5. Summary of Analysis of Variance
Median Data, Errors = Longest Correct Latency
per Subject + 100 milliseconds.

SOURCE	DF	MS	F
Language Group (G)	2	4.76	13.06 **
Error	51	.36	
Word Category (W)	3	.42	55.64 **
W X G	6	.08	10.11 **
Error	153	.01	
Yes/No (Y)	1	.01	.34
Y X G	2	.11	3.16
Error	51	.04	
W X Y	3	.36	34.42 **
W X Y X G	6	.02	2.21
Error	153	.01	
Stress (S)	3	.13	8.84 **
S X G	6	.01	
Error	153	.01	
W X S	9	.03	5.56 *
W X S X G	18	.01	1.41
Error	459	.01	
Y X S	3	.06	8.18 **
Y X S X G	6	.01	1.02
Error	153	.01	
W X Y X S	9	.01	1.88
W X Y X S X G	18	.00	.76
Error	459	.01	

* $p < .05$
** $p < .01$

6. Summary of Analysis of Variance
Shortest Latency Data

SOURCE	DF	MS	F
Language Group (G)	2	2.19	7.34 **
Error	51	.30	
Word Category (W)	3	.07	12.39 **
W X G	6	.03	5.31 *
Error	153	.01	
Yes/No (Y)	1	1.0	6.21 *
Y X G	2	.04	2.60
Error	51	.02	
W X Y	3	.07	12.53 **
W X Y X G	6	.01	1.12
Error	153	.01	
Stress (S)	3	.21	18.28 **
S X G	6	.00	.13
Error	153	.01	
W X S	9	.00	.72
W X S X G	18	.00	.65
Error	459	.00	
Y X S	3	.02	2.73
Y X S X G	6	.00	.60
Error	153	.01	
W X Y X S	9	.01	2.30
W X Y X S X G	18	.00	1.07
Error	459	.00	

* $p < .05$
** $p < .01$

APPENDIX F

Q Statistic

Tukey Tests of Honestly Significant Differences

Experiment 2

1. Language Group - Response Times for Language-Impaired, Language-Matched and Age-Matched Groups.

Language Group	Language-Matched	Age-Matched
Language-Impaired	0.106	5.9801*
Language-Matched		6.0862*

* $p < .01$ $k = 3$ $df = 51$

2. Word Category - Response Times to Nouns, Verbs, Prepositions and Auxiliaries.

Word Category	Verbs	Prepositions	Auxiliaries
Nouns	1.8314	15.9447 *	7.9951 *
Verbs		14.1132 *	6.1636 *
Prepositions			7.9496 *

* $p < .01$ $k = 4$ $df = 153$

3. Word Category - Group - Response Times to Nouns, Verbs, Prepositions and Auxiliaries for Language-Impaired Subjects.

Word Category	Verbs	Prepositions	Auxiliaries
Nouns	0.3996	12.8109 *	5.9883 *
Verbs		12.4113 *	5.5887 *
Prepositions			6.8226 *

* $p < .01$ $k = 4$ $df = 51$

4. Word Category - Group - Response Times to Nouns, Verbs, Prepositions and Auxiliaries for Language-Matched Subjects.

Word Category	Verbs	Prepositions	Auxiliaries
Nouns	1.6539	12.1050 *	8.5100 *
Verbs		10.4511 *	6.8561 *
Prepositions			3.5950

* $p < .01$ $k = 4$ $df = 51$

5. Word Category - Response Times to Positive Probes.

Word Category	Verbs	Prepositions	Auxiliaries
Nouns	4.7532*	20.9674 **	12.6210 **
Verbs		16.2142 **	7.8678 **
Prepositions			8.3464 **

* $p < .05$ $k = 4$ $df = 302$
** $p < .01$

6. Stress Condition - Response Times to Stressed, Unstressed, Neutral and Random Probes.

Stress Condition	Unstressed	Neutral	Random
Stressed	4.5187 *	5.3779*	6.6641 *
Unstressed		0.8593	2.1455
Neutral			1.2862

* $p < .01$ $k = 4$ $df = 153$

7. Stress - Word Category - Response Times to Stressed, Unstressed, Neutral and Random Verbs.

Stress Condition	Unstressed	Neutral	Random
Stressed	1.9883	2.4857	6.3795**
Unstressed		0.4974	4.3913*
Neutral			3.8939*

*p < .05 k = 4 df = 489
**p < .01

8. Stress - Word Category - Response Times to Stressed, Unstressed, Neutral and Random Prepositions.

Stress Condition	Unstressed	Neutral	Random
Stressed	5.6973*	6.4829*	3.6871**
Unstressed		0.7856	2.0102
Neutral			2.7958

* p < .01 k = 4 df = 489
** p < .1

9. Stress - Word Category - Response Times to Stressed, Unstressed, Neutral and Random Auxiliaries.

Stress Condition	Unstressed	Neutral	Random
Stressed	3.4950	5.2231**	7.9763**
Unstressed		1.7280	4.4812*
Neutral			2.7532

* $p < .05$ k = 4 df = 489
** $p < .01$

10. Stress - Errors as a Function of Stressed, Unstressed, Neutral and Random Stress Conditions.

Stress Condition	Unstressed	Neutral	Random
Stressed	4.2355*	6.09495**	5.7850**
Unstressed		1.8595	1.5496
Neutral			.30995

* $p < .03$ k = 4 df = 102
** $p < .01$

APPENDIX G

Distribution of Errors

Group	Type of Stimulus	No. of Errors	Stress	Unstress	Neutral	Random
Language-Impaired	Content	0	1	3	2	6
		1	11	5	7	1
		2	1	5	6	5
		3	3	5	2	3
		4	1	1	1	1
		5	1	0	0	1
		6	0	0	0	1
		7	0	0	0	0
		8	0	0	0	0
Language-Impaired	Function	0	1	1	0	2
		1	4	1	0	1
		2	3	3	5	3
		3	6	3	2	3
		4	3	5	3	3
		5	1	4	4	3
		6	0	1	3	0
		7	0	0	1	3
		8	0	0	0	0
Age-Matched	Content	0	5	2	3	4
		1	7	10	7	7
		2	5	4	5	4
		3	1	1	2	2
		4	0	0	1	0
		5	0	1	0	1
		6	0	0	0	0
		7	0	0	0	0
		8	0	0	0	0
Age-Matched	Function	0	3	1	0	0
		1	3	1	2	2
		2	6	2	2	2
		3	1	6	4	3
		4	0	5	1	3
		5	2	0	5	5
		6	3	1	3	1
		7	0	1	1	1
		8	0	1	0	1