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DISCRIMINATION OF ENGLISH AND
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DISSERTATION
Presented in Partial Fulfillment of the Requirements
for the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By
Karen Elizabeth Diamond, B.A., M.S.

The Ohio State University
1974

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Adviser

Department of Psychology
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>iii</td>
</tr>
<tr>
<td>VITA</td>
<td>v</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>vii</td>
</tr>
<tr>
<td>Chapter</td>
<td></td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td>1</td>
</tr>
<tr>
<td>Review of the Literature</td>
<td>4</td>
</tr>
<tr>
<td>II. METHOD</td>
<td>48</td>
</tr>
<tr>
<td>Subjects</td>
<td>48</td>
</tr>
<tr>
<td>Stimuli</td>
<td>49</td>
</tr>
<tr>
<td>Procedure and Apparatus</td>
<td>51</td>
</tr>
<tr>
<td>Behavioral Observations &amp; Cardiac Measures</td>
<td>54</td>
</tr>
<tr>
<td>III. RESULTS</td>
<td>58</td>
</tr>
<tr>
<td>Sample Characteristics</td>
<td>59</td>
</tr>
<tr>
<td>Response to Language Stimuli:</td>
<td></td>
</tr>
<tr>
<td>First 5 seconds</td>
<td>63</td>
</tr>
<tr>
<td>Habituation</td>
<td>69</td>
</tr>
<tr>
<td>Dishabitation</td>
<td>69</td>
</tr>
<tr>
<td>Response to Language Stimuli:</td>
<td></td>
</tr>
<tr>
<td>Second 5 seconds</td>
<td>81</td>
</tr>
<tr>
<td>Behavioral Observations</td>
<td>93</td>
</tr>
<tr>
<td>IV. DISCUSSION</td>
<td>101</td>
</tr>
<tr>
<td>V. IMPLICATIONS</td>
<td>111</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>--------------------</td>
<td>------</td>
</tr>
<tr>
<td>VI. SUMMARY &amp; CONCLUSIONS</td>
<td>117</td>
</tr>
<tr>
<td>APPENDIX</td>
<td></td>
</tr>
<tr>
<td>A.</td>
<td>121</td>
</tr>
<tr>
<td>B.</td>
<td>127</td>
</tr>
<tr>
<td>C.</td>
<td>128</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>129</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Date Range</th>
<th>Event/Position</th>
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</thead>
<tbody>
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<td>November, 1948</td>
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</tr>
</tbody>
</table>
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mean prestimulus heart rate scores</td>
<td>60</td>
</tr>
<tr>
<td>2.</td>
<td>Overall prestimulus heart rate scores: sample and excluded Ss</td>
<td>62</td>
</tr>
<tr>
<td>3.</td>
<td>Deceleration in 5 seconds following stimulus onset: means</td>
<td>64</td>
</tr>
<tr>
<td>4.</td>
<td>Deceleration in 5 seconds following stimulus onset: lowest beats</td>
<td>65</td>
</tr>
<tr>
<td>5.</td>
<td>Analysis of Variance: Deceleration in 5 seconds following stimulus onset: means</td>
<td>67</td>
</tr>
<tr>
<td>6.</td>
<td>Analysis of Variance: Deceleration in 5 seconds following stimulus onset: lowest beats</td>
<td>68</td>
</tr>
<tr>
<td>7.</td>
<td>Magnitude of deceleration to initial stimuli</td>
<td>79</td>
</tr>
<tr>
<td>8.</td>
<td>Decelerations in 2nd 5 seconds following stimulus onset: means</td>
<td>82</td>
</tr>
<tr>
<td>9.</td>
<td>Decelerations in 2nd 5 seconds following stimulus onset: lowest beats</td>
<td>83</td>
</tr>
<tr>
<td>10.</td>
<td>Analysis of Variance: Deceleration in 2nd 5 seconds following stimulus onset: means</td>
<td>84</td>
</tr>
<tr>
<td>11.</td>
<td>Analysis of Variance: Deceleration in 2nd 5 seconds following stimulus onset: lowest beats</td>
<td>86</td>
</tr>
<tr>
<td>12.</td>
<td>Analysis of Variance: Deceleration in 2nd 5 seconds following stimulus onset: age x group x trials interaction</td>
<td>92</td>
</tr>
<tr>
<td>13.</td>
<td>Correlations between magnitude of deceleration and behavioral observations</td>
<td>95</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Deceleration in 5 seconds following stimulus onset: means</td>
<td>70</td>
</tr>
<tr>
<td>2.</td>
<td>Deceleration in 5 seconds following stimulus onset: lowest beats</td>
<td>71</td>
</tr>
<tr>
<td>3.</td>
<td>Deceleration in 5 seconds following stimulus onset: age x trial interaction - means</td>
<td>72</td>
</tr>
<tr>
<td>4.</td>
<td>Deceleration in 5 seconds following stimulus onset: group x trial interaction - means</td>
<td>73</td>
</tr>
<tr>
<td>5.</td>
<td>Deceleration in 5 seconds following stimulus onset: means - phrase/list and list/phrase groups</td>
<td>77</td>
</tr>
<tr>
<td>6.</td>
<td>Deceleration in 5 seconds following stimulus onset: lowest beats - phrase/list and list/phrase groups</td>
<td>78</td>
</tr>
<tr>
<td>7.</td>
<td>Deceleration in 2nd 5 seconds following stimulus onset: phrase/phrase group</td>
<td>87</td>
</tr>
<tr>
<td>8.</td>
<td>Deceleration in 2nd 5 seconds following stimulus onset: phrase/list &amp; list/phrase groups</td>
<td>88</td>
</tr>
<tr>
<td>9.</td>
<td>Deceleration in 2nd 5 seconds following stimulus onset: group x trial interaction - means</td>
<td>89</td>
</tr>
<tr>
<td>10.</td>
<td>Deceleration in 2nd 5 seconds following stimulus onset: age x group x trial interaction - means</td>
<td>90</td>
</tr>
<tr>
<td>11.</td>
<td>Behavioral Observations - Quieting</td>
<td>96</td>
</tr>
<tr>
<td>12.</td>
<td>Behavioral Observations - Orienting</td>
<td>97</td>
</tr>
<tr>
<td>13.</td>
<td>Behavioral Observations - Vocalizations</td>
<td>98</td>
</tr>
</tbody>
</table>
CHAPTER 1
INTRODUCTION

Statement of the Problem

Recent research in language development has focussed on the performance of children who have begun to speak, using at least one-word utterances. Most theories which attempt to account for language acquisition emphasize the difference between competence and performance, noting that what the child says may often be an underestimate of what he understands about the language which he hears. Chomsky (1965, 1968) has been particularly attentive to this discrepancy between competence and performance in the study of language development. In his view, the term competence refers to the ability of the idealized speaker-hearer to associate sounds and meanings in accordance with the rules of his language. Performance refers to the language productions which the individual makes using these rules.

Research has indicated that the events which seem to capture infants' attention to the greatest extent
are those that are moderately discrepant from his knowledge of the world (Kagan & Lewis, 1965; Kagan, 1971; McCall & Kagan, 1967). Coupled with this important finding has been the discovery that the occurrence of cardiac deceleration to stimulus presentation, a measure used to assess attention to a stimulus in adults (Lacey, et al., 1963), is also appropriate for use with children as young as three months of age (Brotsky & Kagan, 1971; Graham & Clifton, 1966; Graham & Jackson, 1970). In recent research with infants, cardiac response, often used in conjunction with an habituation-dishabituation paradigm, has been used to assess the development of attention to and discrimination of various stimuli. In these studies, a stimulus is presented for a number of trials. On the first several presentations, it is anticipated that cardiac deceleration will occur. With repeated stimulus presentation it is expected that the magnitude of the cardiac response will decrease significantly, i.e. habituation of the cardiac response will have occurred. Such habituation is often cited as evidence that the infant has developed some understanding of the stimulus. In many studies, a different stimulus is presented following response habituation. Dishabituation is said to occur
if the infant responds to the new stimulus with a significant increase in the magnitude of the response. This reoccurrence of a response, which had habituated, to a new stimulus is taken as evidence that the infant is able to discriminate between the two stimuli. Using such an habituation-dishabituation paradigm, research has demonstrated, among other things, that, in at least some cases, infants less than one year of age are able to discriminate between speech stimuli on the basis of differences in intonation, place and type of articulation (Eimas, et al., 1971; Kaplan, 1970; McCaffrey, 1972; Moffitt, 1971; Morse, 1972).

The purpose of this study was to investigate the abilities of four and eight month old infants to discriminate between English and nonsense language stimuli, both when linguistic differences between the two stimuli were maximized and when there were minimized. The English language stimulus used here was the English phrase, "Is that okay?" The nonsense word stimulus consisted of a group of nonsense words presented using a pattern of intonation, stress and rhythm which was either identical to or different from that of the English phrase. The primary measure of response to the stimuli was that of habituation and dishabituation of
cardiac response as previously outlined.

The following literature review will focus briefly on several different theories of language acquisition. These will include learning; psycholinguistic and cognitive theories of language development. A consideration of recent studies which have focussed on auditory perception and language comprehension in pre-verbal infants will be included. The introductory section will conclude with a discussion of the research methodology which was used in this study to assess the particular hypotheses.

Review of the Literature:

Theories of Language Development.

The study of language and language development has intrigued psychologists, philosophers and linguists for many years. This is particularly so because the child is able to achieve a basic mastery of his own language (and often of two languages at once, cf. Leopold 1939, 1947, 1949; Friedlander, 1971) at an early age and after a limited sampling of possible linguistic data. Despite the considerable interest in language development, however, most of the studies reported to date have focussed either on the infants' auditory/perceptual abilities (Berg, 1972; Eisenberg, 1964; Steinschneider,
1966; Turkewitz, 1972) or on the development of linguistic ability after the appearance of several words (Brown, 1969; Chomsky, 1957; McNeill 1970; Menyuk, 1971). This review will briefly consider a number of these theories of language development, with some attempt made to evaluate the implications of the various theories for language comprehension. Among other things, these theories focus on the importance of learning, psycholinguistic and cognitive aspects of language perception.

Learning Theories

From a strict learning theory point of view, the production and maintenance of syllabic babbling derives from the self-reinforcing characteristics of one's own speech (Bijou & Baer, 1965) and from the reinforcement of one's own vocalizations by the vocalizations of others, especially the mother. Rheingold, etal (1959) have demonstrated the ability to increase the number of vocalizations made by 3 month old infants by reinforcing their vocalizations with a "social" response (a smile, a pat and the words "tsk-tsk") from an adult. This kind of social reinforcement is seen as being a very important means by which infants and children increase the frequency and types of vocalizations which they use.
In a similar manner, children learn to associate their verbal responses with particular objects or situations through the positive social reinforcement which they receive when producing an accurate verbalization. Most learning theorists suggest that "what is learned" by a child learning language need not necessarily be the relationships between various words and objects, but rather the value and pleasure of using language in a variety of circumstances. Although the mechanisms of reinforcement mentioned above may not be the sole ones controlling the development of language, they are important in its continued growth.

The motor theory of language perception proposed by Liberman and his colleagues (Liberman, et al. 1967a, 1967b; Denes, 1967; Mattingly, et al., 1971) is more closely related to speech perception than to language learning per se. The motor theory suggests that one learns to recognize speech by first learning to interpret auditory percepts in terms of the articulatory movements needed to produce these sounds; language units are then recognized by their association with these articulatory movements. The basis for this theory stems from the fact that the speech signal does not contain segments corresponding to discrete phonemes (Milner, 1970); it is generally true of segmental
phonemes that they are drastically restructured at the level of sound (Liberman, et al, 1967b). These researchers conclude that most phonemes cannot be perceived by a straightforward comparison of the incoming signal with a set of stored phonemic patterns or templates. Thus, it is felt that it is most plausible to assume that speech is perceived by processes also involved in its production; that there is one process, involved in both perception and production (Liberman, et al, 1967b). Mattingly, et al (1971) also produced evidence supporting the existence of a mode for speech perception which differs from, and is distinct from, the auditory mode. This theory thus posits a relationship between speech perception and production, but does not relate specifically to the learning of a language (as opposed to the recognition and categorization of speech sounds).

Braine (1963, 1971) has made an effort to interpret psycholinguistic phenomena in the terms of a learning theory. He suggests that what is learned are the temporal positions of units in verbal arrays and the contingencies between morphemes. The position learned is the position of the unit within the next larger containing unit of a hierarchy of units, and that position within the unit may be defined absolutely or
relative to a reference point. There are thought to be two principle components of a language learning mechanism which are necessary for language acquisition. The first of these is a scanner which receives input sentences. The second component is an ordered series of intermediate memory stores, the last of which is permanent and contains the rules or pattern properties that are finally learned. As he argues that the scanner is "preset" to notice certain features of the input and ignore others, he also seems to recognize the importance of some form of innate predisposition to learn language. Although he sees this model as providing, a set of "discovery procedures" for grammar acquisition, he does not specify exactly what is discovered, or how it is discovered once the child has before him the language input.

Hebb, et al. (1971) point to the importance of a capacity for learning in any situation which involves perception. Hebb and his colleagues argue that the definition of innateness is that which is easily learned. How learning occurs, and what specific learning, is as much determined by the learner's heredity as by his environment. In terms of language development, it is argued that to learn the associations between a word and the object associated with it requires connecting the
cell-assembly complex that mediates the visual perception of the object with the parallel complex that mediates the auditory perception of the word. The basis for correct grammar then arises through the association of higher-order cell assemblies. Although not fully elaborated in terms of language development, Hebb seems to suggest that there is some sort of innate predisposition for language learning. In this way his approach is somewhat compatible with the more innately-oriented view of Chomsky (1966) who at times suggests that the language which the child hears is assimilated via some (unelaborated) cognitive process to an innate representation of universal grammatical principles. Although they both seem to argue for some sort of innate predisposition for language learning, they would seem to disagree on exactly how language is learned. Hebb has not expanded on his views to any greater extent, and it becomes difficult to determine precisely what he means by "grammar" or what the relationship is between the grammar and what is spoken or understood by the child.

Few, if any, learning theory approaches to language acquisition focus directly on language perception. It is possible, however, to draw relevant inferences from the theories as they might relate to this question. For the majority of learning theorists, one may suggest-
that language perception is amenable to some sort of stimulus-response analysis. In this view, language might be learned at least partly through learning which utterances that are made are likely to be reinforced in some way by the child's parents. These verbalizations would be approved of by the available adults for being close approximations to the language in the particular environment. One might infer that these rewarded utterances acquire a special distinctiveness and become salient to the child, even when the utterances are spoken by others. These utterances might consist, at first, of a majority of names for objects.

In learning language, some theorists might argue that the child is developing associations between particular visual stimuli and the appropriate verbal responses (e.g., Skinner, 1957; Bijou & Baer, 1965). Others, such as Braine (1963, 1971) and Hebb (1971) might argue that the associations learned are actually between higher-order internal representations for the visual and verbal stimuli. Nevertheless, the main thrust of learning theory for language acquisition would seem to be in the learning of particular stimulus-response associations.
Psycholinguistic Theories

Taking a middle ground between theories of language acquisition emphasizing either learning theory principles or innate structures, Fodor (1966) argues that some of the child's information about his language must be learned. The child must also bring to the language-learning situation some sort of intrinsic linguistic principles. In learning language, the child applies a set of innate rules for processing language which he hears, such that the consequence of applying these rules provides a tentative set of base or universal linguistic rules. By definition, these rules are not, themselves, possible utterances in the language, but do give rise to syntactically correct sentences. Slobin (1966, p. 88) also argues that a child is "born not with a set of linguistic categories but with some sort of process mechanism. . . that he uses to process linguistic data. . . the linguistic universals then are the result of an innate cognitive competence rather than the content of such competence."

which emphasize the presence of innate structures appropriate for language acquisition. Lenneberg (1966) presents evidence for a peculiar, language-specific maturational schedule; speech, which requires precise and swift movements of the tongue, lips and mouth is almost fully developed when most other mechanical skills are far below the levels of their future accomplishments. In addition, he suggests that the preservation of the typical synchrony between motor and language milestones in cases of general retardation is among the most cogent evidence that language acquisition is regulated by maturational phenomena (Lenneberg, 1964). As he points out, however, having knowledge of a language is not identical with the ability to speak, as is evident in cases of congenital anarthria where there is an extreme dissociation between perception and productive abilities, but where perception is age-appropriate (Lenneberg, 1962).

Chomsky's major contribution to the understanding of language learning is in viewing language, in particular syntactic development, as being governed by a number of specific rules. These rules operate within two different levels of language structure. Chomsky uses "...the term 'surface structure' to refer to a representation of the phrases that constitute a linguistic expression and the categories to which these phrases belong
...(while) 'deep structure' (is used) to refer to a representation of the phrases that play a more central role in the semantic interpretation of a sentence." (Chomsky, 1968, p. 105). In his theory, the surface structure determines the phonetic form which the sentence will take, while the grammatical relationships represented in the deep structure are those that determine the meaning underlying the utterance. He argues that knowledge of a language, which may be viewed as essentially knowledge of a grammar, can only be acquired by an organism that is "preset" with a severe restriction on the form of the grammar which may be acquired. It is postulated that this grammar contains a system of base rules of a highly restricted sort (these base rules and the lexicon are the elementary units of which deep structures are constituted), a set of grammatical transformations that relate the deep structures to the surface structures, and a set of phonological rules that assign phonetic interpretations to the surface structures. These relationships may be represented schematically:
Chomsky further states that "... the role of intrinsic organization is very great in perception and . . . a highly restrictive initial schema determines what counts as 'linguistic experience' and what knowledge arises on the basis of this experience" (Chomsky, 1968, p. 172). Thus, his argument is that the child is equipped with an innate knowledge of the base rules appropriate for the acquisition of a language. These rules, essentially, allow for knowledge of those specific aspects of linguistic competence which cannot be extracted from overt speech.

Although Chomsky introduced the notion of a language acquisition device, it has been McNeill who has expanded it into a comprehensive hypothesis about language development. He suggests that this language acquisition device (LAD) is so constructed that it can develop a theory of regularities that underlie the speech to which it has been exposed, thereby resulting in the
grammatical competence of the learner. That is:

Corpus $\rightarrow$ LAD $\rightarrow$ Grammatical Competence

(McNeill, 1970a, p. 70)

By constructing a theory about the regularities of a language, LAD can exclude the nongrammatical constructions in the corpus. In addition, LAD may contain information and rules bearing on the general form of language, but not those rules that are idiosyncratic to one language, to the exclusion of another (McNeill, 1970b). He suggests further that LAD's contents consist of universal linguistic information, with the theory of grammar (universal) as a description of LAD's internal structure.

"A language has the particular grammar it does because the universal principles embodied in linguistic theory constrain the grammar that accounts for the corpus of sentences that LAD has received. We thus have a hypothesis. . .(that) the internal structure of LAD. . .is described in the theory of grammar."

(McNeill, 1970b, pp. 1087-1088)

In general, both Chomsky and McNeill, along with other psycholinguists, seem to be arguing that language perception is dependent to a considerable degree on the presence of some sort of innate structure. As Chomsky (1968, p. 172) states: ". . .the role of intrinsic organization is very great in perception. . .a highly
restrictive initial schema determines what counts as 'linguistic experience' and what knowledge arises on the basis of this experience."

The form of language perception, for these theorists, seems determined by the intrinsic organization, or language acquisition device, which serves to structure the particular verbal events. When it is said, by these theorists, that a person has developed an understanding of a language, this means that he has acquired a system of rule that specify the relationships between sound and the associated meanings. It is the internal language acquisition device which appears to be the critical factor in determining the course and result of language learning. It is, clearly, this device which aids in the appropriate categorization of verbal input by the young infant.

When speaking in a more psychological and less strictly linguistic vein, Chomsky (1966, p. 66) suggests that "...the major contribution of the study of language will lie in the understanding it can provide as to the characteristics of mental processes and the structures they form and manipulate." His approach suggests the importance and validity of considering underlying cognitive structures and processes, perhaps using the
deep structure format of his theory of language as the prototype for these structures.

**Language and Cognitive Development**

In many ways the work of Chomskyan linguists and Piagetian psychologists in the area of language development seems somewhat similar, with each looking at the problem from a different perspective but arriving at sometimes complementary notions of language acquisition. Chomsky has applied his structural theory only to that part of development that relates directly to language, although he has at times suggested that it may be an appropriate model for looking at the whole of cognitive development. Chomsky, however, is not explicit as to how this would be done, and is never really clear as to how "psychological" he believes his linguistic theory to be. In studies of language-learning which draw heavily on the cognitive psychology of Piaget, it is hypothesized that the child comes to the language learning situation with a range of organizing hypotheses about the world in the form of schemata, categories or concepts (Nelson, 1973). Intelligence, according to Piagetian theory, is thought to originate within a biological substrate, beyond which it soon extends. At the core of this substrate are the invariant attributes.
of organization and adaptation (innately present in all intelligent beings); adaptation includes the complementary processes of assimilation and accommodation. Through the continuous use and interaction of these processes, schemas develop and eventually form interlocking systems or networks. A schema is a cognitive structure which is the internal representation of a class of similar action sequences in which the constituent elements are tightly interrelated. Schemas are internal structures which develop as a consequence of accommodatory and assimilative activity (Flavell, 1963). When the infant accommodates to a particular stimulus by imitating it, this accommodation-as-imitation supplies the infant with his first signifiers (that is, the imitative act) which are capable of representing for him the absent significate (the absent stimulus). This is the beginning of the symbolic function, of which language is a part, but which has developed before language is available to the child (Piaget, 1952). The course of language development is thus thought to be dependent upon previous cognitive development as exemplified through the organization of the various schemata. While children all have similar kinds of cognitive abilities and possess similar types of cognitive structures, they also vary to some extent in
terms of their particular pre-language concepts; such variation in content is thought to influence exactly what the child learns. Although the source of this variance in pre-language concepts has not been clearly elucidated, it is suggested that some of these differences result from different experiences in early infancy (Nelson, 1973). Bloom (1970) and Nelson (1973) have both noted that some children's early utterances seem primarily in service of the expression of their own feelings, while other children learn language which is, at first, largely related to the content of their world (e.g., "want more" vs. "that truck").

Both Chomsky and Piaget, to differing degrees, deal with the problems of cognitive development, especially as exemplified through the child's increasing competence with language. The main emphasis of Chomskyan theory is on the development of a model for language acquisition per se, although Chomsky (1968) has suggested that his model for language development might easily be used as a prototype for cognitive development in general. Piaget, on the other hand, views language development as but one example of the overall development of the symbolic function, with language itself as a special, and well-developed, symbol-system. He does not focus on the child's learning of
the grammatical rules which govern the acquisition of any particular language. Both Piagetian and Chomskyan theories share a common interest in the ability of the child to create ways of representing new concepts, either with language or another means of symbolization. In addition, the importance of making a clear distinction between performance and competence in the study of language has also been emphasized, particularly by Chomsky. For Chomsky, a person who has acquired knowledge of a language is thought to have internalized a system of rules that relate sound and meaning in a particular way. The technical term "competence" refers to this ability of the idealized speaker-hearer to associate sounds and meaning in accordance with the rules of his language (Chomsky, 1968). Performance refers to the language productions which the individual makes using these rules.

As Sinclair-de-Zwart (1969) succinctly points out, the major difference between these two theories is an epistemological one. Chomsky and his followers seem to consider language itself as an "object of knowledge"; although language is a means of symbolization it is also something that must be learned as a relatively arbitrary symbol for a particular object or thought. Piaget, and Piagetian psycholinguistics, consider language
within a different framework. For them, language acquisition must be considered within the totality of cognitive development, particularly that of the symbolic function, with language not merely as an object of knowledge. In addition, this view obviates much of the need for postulating specific innate linguistic structures.

Much recent research in cognitive development has stemmed from the theoretical approach of Piaget. Little of this research is in the area of language perception, an area of critical interest for this dissertation. It seems likely, however, that the perception of language would be seen by these theorists in terms of some kind of internal structure for symbolization, in a manner similar to the rest of cognitive development. In this view, language is perceived and coded in terms of the appropriate action schemata. These schemata for language, the precursors of which were primitive reflexes present at birth, aid in the organization of the language input. As with stimuli of other sorts, the language is assimilated to and accommodated by these schemata. It is difficult, from the available literature, to determine how these schemata might be developed from the early reflex activity. As with visual stimuli, however, it might be
suggested that the infant initially responded to verbal stimuli by accommodating to the verbalizations which he, himself, produced. Thus, some sort of initial circular reaction might be developed which consisted of the infant's production of various vocalizations and the organization of those same ones which he hears. Once an initial stimulus for any sort of verbal event is available, the infant would ostensibly be able to accommodate to and assimilate those verbalizations produced by others. Through these mechanisms of organization, accommodation and assimilation, more complex schemata for verbal events would be developed. Eventually it may be assumed that the infant would understand language as one of several means for symbolizing external events.

**Recent Research in Cognitive Development**

Much of the recent research in early cognitive development has focussed on the importance of attention in furthering the development of increasingly complex cognitive structures in the young organism. The importance of the slight discrepancy between a particular stimulus and the expectations of the organism in recruiting attention and enhancing motivation has been noted by a variety of psychologists (Hebb, 1949; Hunt, 1963). This discrepancy notion coupled with the notion of assimilation
(Piaget, 1963) has resulted in the formulation of the so-called discrepancy hypothesis. Briefly, the discrepancy hypothesis suggests that stimuli which represent a moderate degree of discrepancy from an existing schema elicit maximal attention, whereas those stimuli that are very similar or very discrepant recruit minimal attention. Kagan's use in research of Piaget's hypothesized assimilation mechanism has suggested to him that assimilation of some event to a schema is an internally represented cognitive act, where this cognitive activity may be inferred by an observer through the occurrence of a variety of behaviors on the part of the infant. He suggests that these behaviors, such as heart rate change, vocalizations and smiling, may be used as an indication that the infant has modified his existing schemata in a manner such as to assimilate the stimulus to them. (Kagan, 1967; McCall, 1972; Piaget, 1962; Zelazo, 1972). Furthermore, McCall (1972) suggests that when a memory engram (schema) for a given stimulus event is immature or imprecise, renewed attention (as indexed by smiling) occurs most often to the reintroduction of the non-discrepant stimulus. Once the schema is sufficiently well-developed, attention occurs most often to moderately discrepant stimuli, i.e., one perceived as similar but somewhat different from the remembered stimulus. It is suggested that the importance of discrepancy in the
resulting attention of an infant to a stimulus occurs first at the age of about 12 weeks. It is in this preferential attention to optimally discrepant stimuli that the infant is thought to bring his innate abilities and learned associations to bear on new stimuli, thereby enlarging the scope of his experience.

It is instructive to briefly consider the research on visual recognition as it relates to schematic development before considering the even less studied area of speech perception. The majority of studies of the development of perceptual recognition during the first year have focussed on the child's response to visual stimuli. Fantz (1964) was among the first researchers to consider the effect of familiarity on attention to a visual stimulus (picture), using a population of foundling home infants between 6 and 25 weeks of age. Among children over 8 weeks of age, he noted reduced attention (as measured by visual fixation) to repeatedly presented pictures, with increased attention on presentation of a new visual stimulus. Morgan and Ricciuti (1969) report that an infant smiles readily to a human face by about 2 months of age, with frequency of smiling reaching a peak at 3 - 4 months of age. In this regard, Schaffer and Parry (1969) find that by 3 - 4 months of age, infants smile more readily at their mother (presumably a familiar
show greater excitement when approached by her and stop crying sooner when she, rather than a stranger, picks them up. From these response patterns, one might infer that the infant is developing increasingly sophisticated schemata for the human face with a further distinction between familiar and unfamiliar faces.

In light of these and other similar findings, Kagan (1971) suggests that the developmental distribution of visual fixation to various stimuli provides some evidence for the previously mentioned discrepancy hypothesis. According to Kagan, the discrepancy between an event and the child's acquired schema for that event is an obvious determinant of fixation time in infants between 6 and 10 weeks of age. The duration of sustained attention following the initial orientation is presumed to be a curvilinear function of the degree of discrepancy of the event from the schema for that event, with a mildly discrepant event evoking the longest fixation time. In his research, Kagan (1971) reports that prior to 3 months of age, which he claims is before a good schema for the face has been articulated by the infant, photographs of regular or irregular faces are both so discrepant from the infant's existing schemata that the two stimuli elicit equal attention. Between 3 and 5 months of age, during which time the infant has acquired a well-articulated schema for the caretaker's face (the prototype of any human
face) a photograph of an irregular face is optimally discrepant from the infant's existing "face schema" and elicits more attention than does the photograph of a regular face. After 5 months of age, the schema for the face is so well-articulated that photographs of regular or irregular faces elicit relatively equivalent amounts of attention, presumably because neither of these stimuli is particularly discrepant from the infant's schema for the face. Lewis et al. (1967), McCall and Melson (1970) and Melson and McCall (1970) also report data on infant's fixation time to inanimate visual stimuli which would lend some support to the discrepancy hypothesis.

This discrepancy hypothesis may similarly be applied to auditory/linguistic development. In this area, as is the case with visual perception, it may be assumed that the infant attends most to those auditory stimuli which are "optimally" discrepant from his various schemata. When the particular auditory stimulus is language, it may be supposed that the most attention is paid to those combinations of words with which the infant is somewhat familiar, but which cannot be readily assimilated to his schemata for language. Again, in this apparent preferential attention to somewhat unusual stimuli, the infants expands his understanding
of the linguistic world in which he lives.

Although the discrepancy hypothesis may be appropriate as an initial step in trying to understand cognitive development, it consists of essentially circular reasoning. It is said that a discrepant stimulus is one to which an infant responds with maximal attention, while it is then argued that a stimulus to which a maximal response is obtained is an optimally discrepant one. In only a few studies have attempts been made to measure a response to a stimulus which is systematically varied over one dimension.

Response of Pre Verbal Infants to Auditory Stimuli

Methodologies

To understand linguistic development one needs to be aware of the infant's abilities to comprehend the language of those around him; production of sounds has little apparent relationship to language acquisition (McNeill, 1970a). Consequently, research methods which assess an infant's ability to understand language are necessary in studying the language development of pre-verbal infants. A common paradigm used in many studies has been that of habituation and dishabituation of a particular response. When the stimulus used in the particular study is presented initially it may result
in a response by the infant (e.g., heart rate deceleration) which indicates that the infant is paying attention to the stimulus. As the stimulus is presented for a number of times, the infant's attentive responses to the stimulus diminish. Such a diminution in attention is called habituation. The occurrence of habituation is thought to indicate that the infant has developed some sort of cognitive representation for the particular stimulus. After habituation has occurred, the particular stimulus which was presented may be changed to one that differs from it on any of a variety of parameters. Dishabituation is said to have occurred if the responses which originally were present, as indicators of attention to the first stimulus, reappear. The occurrence of dishabituation is often used as evidence that the infant was able to discriminate between the two stimuli. The notion of habituation has been used in studies both alone and with dishabituation following stimulus change.

This habituation-dishabituation paradigm along with the occurrence of a variety of behavioral/motor responses to the stimulus have been the main response measures used in most studies of early auditory/language perception. The physiological response most often used in these studies is the heart rate response.
Among a large number of researchers, Clifton, et al. (1968), Graham, et al. (1968) and Hock (1971) find an acceleratory heart rate response to auditory stimuli in newborns. Graham and her co-workers also report little evidence for habituation of the heart rate response during the first five days of life. Whether this cardiac acceleration is an indication of an immature neural mechanism or evidence for another kind of response is still open to speculation.

Graham, Clifton & Hatton (1968), Graham and Jackson (1970), Kagan (1971) and Lewis (1966) report that by three months of age infants show a pattern of cardiac deceleration to stimulus presentation, habituation of response within a few trials and renewed deceleration (dishabituation) upon stimulus change. This type of response pattern is considered to be an index of attention.

Response to Auditory Stimuli

Among the first systematic studies of neonatal responsiveness to auditory stimuli are those of Eisenberg and her colleagues (Eisenberg, et al. 1964; Eisenberg, 1965; Eisenberg, 1970). In an early study of neonatal responsiveness to auditory stimuli (in which the stimuli consisted of beating a drum, crumpling a piece of onion skin paper, striking two sticks or
blowing a whistle, all at 65 decibels) it was found that the strength of motor responses tended to decrease over a 20-signal presentation sequence. It was noted, in addition, that over the first 9 days of life the infants gradually responded to the stimuli with fewer motor or startle responses and with an increasing number of orienting-quiet types of responses (Eisenberg, 1964). This evidence indicates that infants may give increasing amounts of attention to external stimuli as they mature. Greenfield (1972) also reports unpublished data from Eisenberg's laboratory which indicates that newborns are selectively attentive to the frequency range of human vocalization.

A number of researchers (among them Bartoshuk, 1962; Steinschneider, 1966; Moreau, 1970; Turkewitz, 1972) have found a reliable accelerative heart rate response in neonates to the presentation of white noise. Steinschneider (1966) notes, in addition, that neonates seem to respond differentially to stimuli which differ in intensity; in both cardiac and motor systems, an increase in stimulus intensity is associated with a greater magnitude and shorter latency of response. Ling (1972) also reports an increase in the number of body movements (e.g., eye, head, limb and whole-body movements) made by neonates to white noise stimuli.
as the duration of the stimulus presentation increased from 50 - 1000 msec. Turkewitz, et al. (1972a, 1972b) report that while white noise stimuli are markedly effective in producing cardiac acceleration in infants, none of the pure tone stimuli which they presented to the infants (at the same decibel level) resulted in an effect that was any different from the baseline measures. In sum, evidence so far suggests that neonates are responsive to auditory stimuli, especially sounds within the range of human vocalization, that this responsiveness is to stimuli in which two or more tones are combined, that the cardiac response is an accelerative one, and that infants seem able to discriminate among stimuli which differ in duration or intensity.

Discrimination of auditory stimuli, including synthetic speech and native language.

The first studies discussed were of response to auditory stimuli; these studies consider the infant's ability to discriminate between these stimuli. Berg (1972) reports that infants of approximately 4 months of age are apparently able to discriminate between auditory stimuli differing in frequencies of less than 4/5 octave and with temporal differences on the order of about 0.4 seconds. As the stimuli presented
were either pulsed or continuous pure tones, the infant appears to have developed a responsiveness to pure tone stimuli which was absent at birth. By this age, as well, the cardiac response to stimulus presentation has become a decelerative rather than accelerative one. McCall and Melson (1970) and Melson and McCall (1970) report that 5 month old infants with cardiac response habituation to repeated presentation of one auditory stimulus would respond with cardiac deceleration to a change in the stimulus. Infants whose response did not habituate to the first stimulus showed, in general, less responsiveness to the discrepant stimulus. Again, these studies support the previously mentioned discrepancy hypothesis, by reporting instances where cardiac deceleration has been elicited by "optimally discrepant" stimuli.

Horowitz (1972) presented various 2-tone auditory stimuli to 6 month old infants. Two tones were presented as the initial stimulus; this initial stimulus was identified as the standard. Cardiac response changes were then assessed with the following test stimuli (stimuli used for comparison with the standard): 1) no difference from the standard, 2) tone order reversed, 3) different first tone, same second tone, 4) same first tone, different second tone, 5) both
tones different. The only significant dishabituation (of cardiac response) found was to presentation of the second and third test stimuli listed above, suggesting to Horowitz the importance of the first part of the stimulus in the child's memory. This does not explain why the infant did not respond differentially to the fifth stimulus. In this study, Horowitz presented a standard until the cardiac response to it had habituated (this was determined by visual inspection of the polygraph printout, which is not a particularly reliable method). McCall and Melson (1970), however, found that cardiac deceleration to a new stimulus increases as a function of the amount of familiarity with the standard even after habituation, as measured by cardiac response, is present. In the case of Horowitz' study, it is thought that the infant may have had insufficient exposure to the standard to notice many deviations from it. This would suggest that the fifth stimulus may have been too novel (too discrepant from the possibly incomplete schema acquired for the standard) to elicit any response. However, Clifton and Meyers (1969) found, with 16-18 week old infants, that the effect of the nonfamiliar stimulus on cardiac response appeared to dissipate after one trial. The stimuli in this experiment consisted of pulsed or constant tones,
each of which was presented for 15 trials. They note that in some cases the infant exhibited only partial habituation to the first stimulus, which may have then affected the response to the second stimulus. Berg (1972) not only found that 4 month old infants could discriminate between various pulsed tones, but that there was also a significant decrement in heart rate deceleration within the first six trial presentations of the standard. Change in the stimulus also resulted in greater deceleration and duration of cardiac response for all groups. It is difficult, from the published reports, to suggest what factors could have led to these different results, other than differences in the stimuli or in exposure to and habituation of response to the standard. Nonetheless, research does indicate that infants are responsive to a variety of auditory stimuli, and that in general the greatest response is to stimuli somewhat discrepant from stimuli with which they are familiar. However, there appears to be no research relating magnitude of deceleration to intensity of attention.

It has also been demonstrated that at a surprisingly young age a child is able to discriminate between stimuli which differ only on the basis of one relevant linguistic cue. Using an habituation-dishabituation
paradigm, Eimas, et al. (1971) and Morse (1972) found that one month old infants are able to discriminate between voiced and voiceless stop consonants ("bah" v. "pah"), between consonants that differ in the place of articulation ("bah" v. "gah"), and between consonants that differ only in final rising or falling intonation. In addition, Morse (1972) reports that one-month old infants are able to discriminate between particular speech and non-speech stimuli. (The non-speech stimulus was produced by isolating and synthesizing the acoustic cues which signal the distinction between ba" and ga".) Moffitt (1971) and McCaffrey (1971), using this same paradigm, also provide evidence that infants in the first 6 months of life are able to make a large number of discriminations between speech sounds along the voicing continuum. This discrimination is made in a linguistically relevant manner approximating categorical perception. This mode of perception is identical to the manner in which adults perceive these same sounds. This result lends considerable support to the Chomsky-Lenneberg hypotheses of innately coded language abilities, as it is suggested that these infants have had insufficient time to learn these discriminations.
Among those studies in which behavioral responses were assessed, Wolff (1969) reports that by the second week of life the voice is more interesting to the infant than are inanimate sounds. Response to the face is the same as to any other object. Similarly, Lewis (1963) suggests that at about the fourth week of life the child begins to respond to adult speech; that is, when the child is crying the sound of the mother's voice now often has the capacity to soothe him into silence. Unpublished research by Rosenbloom and Aronson (Friedlander, 1971) has demonstrated that normal infants as young as 3 - 8 weeks of age can detect incongruities between the occurrence of language and the source from which that language was thought to come. In this particular study, these infants became distressed when a tape recording of their mothers speaking to them came from a different part of the room than that in which they saw their mothers who were silently mouthing the tape-recorded words.

A number of studies have attempted to assess the infant's ability to discriminate between familiar and unfamiliar voices at a variety of different ages. Boyd (1973), using an habituation paradigm, found that 2 month old infants were able to discriminate between the voice of their mother and that of a strange female.
Turnure (1971), using distortions of the mother's voice constructed by changing the speed of the tape on which the voice was recorded, reported that there was greater motor quieting with increasing age (3, 6 or 9 months) to all versions of the mother's voice. Distortion of the mother's voice did not result in any systematic effects as measured by behavioral responses. Tulkin (1971) reports that middle class infants (all Ss were 10 month old, first born, Caucasian females) showed significantly more quieting to a 20 second presentation of their mother's voice than to that of a strange female. There were not significant differences in amount of quieting shown by working-class infants. The variety of results reported by these researchers certainly suggests no simple explanation as to what attracts the infant's attention. It should be noted, however, that there was no attempt made in many of these studies to systematically vary various linguistic parameters, and consequently, it is impossible to determine the bases on which the infants did (or did not) discriminate between the various stimuli.

It should also be noted that a number of researchers have noted sex differences in responsiveness to auditory stimuli. Among other things, research has indicated that female infants show a greater stability
of attention (as indexed by cardiac response) to auditory patterns than do males (Kagan and Lewis, 1965). It has also been reported that females are more attentive (as measured by cardiac response dishabituation) than are males to a variety of stimuli (McCall & Kagan, 1967), that newborn females show greater cardiac habituation than do males to auditory stimuli (Hock, 1971) and that females acquire spoken language at a faster rate than do males (Nelson, 1973).

In a slightly different vein, Kaplan (1969) reports that infants are able, at the age of 8 (but not at 4) months, to distinguish (as indicated by cardiac activity) between two sentences spoken with normal English stress patterns, differing only in rising or falling intonation at the end of the sentence (e.g., "See the cat" v. "See the cat?"). As both Eimas, et al. (1971) and Morse (1972) report that one month old infants are able to discriminate between phonemes differing only in final rising or falling intonation, the complexity of the stimulus appears to be an important variable. It may be suggested that the difference between the results of Eimas, et al. (1971) and Morse (1972) and those of Kaplan (1969) is a function of the number of linguistic components (phonemes) of the stimulus, or of the relationship between the number of phonemes and
the number of linguistic dimensions on which these phonemes differ. Kaplan and Kaplan (1971) suggest that until approximately 7 months of age the child is primarily processing suprasegmental aspects of speech, i.e. patterns of intonation, stress and duration. By 8 months of age, the segmental (semantic and syntactic) aspects of speech are thought to become the most important. Friedlander (1968) and Wisdom and Friedlander (1971) also report that 10 - 15 month old infants, when given a choice, prefer to listen to low redundancy, partially familiar and partially unfamiliar auditory/language stimuli. As with much of the previous data, this also suggests that the child progresses in his awareness of language (as well as in other areas of cognitive development) through optimal attention to moderately discrepant stimuli.

**Language Input to the Child**

Nelson (1973) notes that comprehension implies a strategy where the child attends selectively to the talk around him, enlarging his repertoire of the number of utterances which he is able to understand. Thus, in any consideration of language acquisition, it is necessary to consider not only the infant's ability to process language, but also the type of language which he is likely to hear. Nelson (1973) reports some
evidence suggesting that exposure to a great deal of variability in language and to a large number of language models has a facilitating effect on language learning. In addition, she reports that the intrusiveness of the mother seems to influence the rate of progress in acquiring an early vocabulary, with less intrusive mothers having faster-learning children. (Here, intrusive mothers also tended to be domineering and controlling mothers). Friedlander, etal. (1972) in a time-sampling study of the receptive language environment of two 12 month old children report that non-interactive language (such as commands) accounted for the largest proportion of language directed toward these children, with the next largest category being expansions and imitation of the child's utterances. Remick (1972), Snow (1972) and Phillips (1973) report that adults (both women who have children and those who do not; no men were included in these studies) speak to children using a simpler syntax and more restricted vocabulary than they use when speaking to other adults; the simplification of the speech to the child also depended to some extent on the reaction of the child to what was said to him. Nevertheless, most mothers seem to talk to their children in very similar ways. This language, which is high in redundancy
while still providing an appropriate model for speech, seems well-suited to the infant's capabilities.

In summary, the available evidence suggests that infants are, from birth, attentive to and able to discriminate between auditory stimuli differing in frequency and intensity. By 1 - 2 months of age infants seem able to discriminate between stimuli on the basis of linguistically relevant cues. As the infant has increasing interaction with his linguistic environment he uses more cues in comprehending the language around him. And by the time of his first birthday, or shortly thereafter, he has learned to say several words in an appropriate context (Darley & Winitz, 1961; Nelson, 1973).

Research Methodology

McNeill (1970a) notes the difficulties in studying the knowledge that the pre-verbal child has about his language environment. The major methodological problem is devising tests of comprehension and competence that make use of linguistic materials. It is also necessary to find response measures that are thought to be associated with the reaction of the child to the particular language stimuli which he hears. Many of the methods which have been used in recent research
have been derived from Russian studies (especially those of Sokolov) of the development of physiological responses.

Sokolov (1958, 1963) has developed the notions of an orienting-exploratory reflex and of a defensive reflex. He describes the orienting reflex as a system of reactions which is directed toward contact between the organism and an external object, and which facilitates "tuning in" of the perceptual analysers, insuring the best conditions for perception of the stimulus. It is an information processing system in which a neuronal model (similar in idea to Piaget's schema) is acquired as a function of repeated encounters with a stimulus. One of the major indicators of the orienting reflex is thought to be cardiac deceleration upon stimulus presentation. All of the components of the orienting reflex become extinguished when the stimulus is presented repeatedly. As noted earlier, this diminution of response strength to repeated stimulus presentation is called habituation. The response decrement is thought to be stimulus-specific, however, and the orienting reflex reappears when the strength or quality of the stimulus is altered. The defensive reflex, on the other hand, is thought to appear when the organism is trying to keep the environment from intruding upon
him. It often appears in infants when the stimulus is presented suddenly and intrusively. One of the major components of this reflex is cardiac acceleration. Research evidence supporting this distinction between the two reflexes is provided by Lacey (1967) who reports that, in research using adult Ss, cardiac acceleration is related to stimulus rejection while cardiac deceleration following presentation of a stimulus is associated with stimulus intake. As previously mentioned, this type of response pattern is often used as an index of attention.

The research paradigm to be used in this study takes advantage of the previously mentioned cardiac responses to the presentation of a stimulus. In studies of cognitive/perceptual development where this paradigm has been employed (Berg, 1972; Kagan & Lewis, 1965; Kagan, 1971; Moffitt, 1971) the initial stimulus is presented to the child for a number of trials. It is assumed that the initial cardiac response of the child to the stimulus will be a decelerative one. Habituation of the decelerative cardiac response, that is, a significant decrease in the magnitude of the deceleration, is expected to occur to this first stimulus within a few (approximately 10 - 15) trials. Habituation is thought to indicate the development of
a neuronal model (Sokolov) or schema (Piaget) for the particular stimulus. Following the occurrence of response habituation, a second stimulus is presented for discrimination. If the infant is able to discriminate the second stimulus from the first, it is expected that the introduction of the new stimulus will rekindle the child's attention and that cardiac deceleration will reappear. When the decelerative response reoccurs (following habituation) upon presentation of a different stimulus, it is thought that the infant is responding to the difference between the two stimuli.

Many other kinds of responses relating an infant's responses to various stimuli with his cognitive development have also been used in research studies. The rate of habituation to repeated stimulus presentations is often accepted as an index of early learning (Hock, 1971). Kagan (1971) reports that moderately discrepant stimuli elicit the largest decelerations. In addition, he finds that large decelerations are typically accompanied by an obvious decrease in motor activity. There is also some evidence that in younger infants (about 4 months of age) the orienting reflex is more stable in the female than in the male (Brotsky and Kagan, 1971). It is suggested that the physiological bases for this
system mature earlier in the female, and thus result in a more stable system, at least at a young age.

Kagan (1971) reports additional variables that he feels are associated with the orienting reflex and attention in infants. Among these are vocalization following stimulus presentation, which he feels most often accompanies excitement generated by an interesting event, and smiling, which he suggests indicates the successful assimilation of a discrepant event to the schema for that event.

**Experimental Rationale and Hypotheses**

As is apparent, there are very little data on what the preverbal child understands about his language environment. In addition, a number of the studies reported make no attempt to vary the various stimuli across some dimension that can be measured, thus making it at best extremely difficult to determine exactly the dimensions of the stimulus to which the infant is attending. Consequently, this research attempts to determine whether an infant of either 4 or 8 months of age is able to discriminate between speech stimuli differing in their degree of familiarity (English words and nonsense words) to the infant.

The age ranges sampled were determined by research indicating certain capabilities in these infants. For
example, research (Kagan, 1971; Kagan & Lewis, 1965) has shown that by 3 months of age infants attend to the differences between a stimulus and their (inferred) schema for that stimulus. In addition, a decelerative cardiac response as a measure of attention usually stabilizes by 3 months of age, at least in females (Graham & Clifton, 1966; Lewis, 1966; Brotsky & Kagan, 1971). Four months of age was thus chosen as the lower age for this study in order to better assure a reasonable stability in the decelerative cardiac response. Likewise, because of their earlier physiological maturation and greater cardiac response stability, only female infants will be studied in this research. Kaplan and Kaplan (1971) suggest that by 8 months of age the child attends to segmental aspects of speech, although he has not yet begun to speak. Thus, 8 months was chosen as the second age at which to investigate the response of the preverbal infant to English and nonsense languages.

This research will investigate the abilities of four and eight month old female infants to discriminate between English and nonsense language stimuli, both when linguistic differences between the two stimuli are maximized (when the stimuli also differ in phrase structure, i.e. the stimuli will be an English phrase
and a nonsense-word list) and when they are minimized (when the only difference between the stimuli is semantic, i.e. when the stimuli are an English phrase and a nonsense-word phrase). The primary measure of response to and discrimination of the stimuli will be cardiac deceleration, habituation of the cardiac response with repeated presentation of the stimulus and recovery of the decelerative response on presentation of the new stimulus.

These stimuli differ from each other in a number of different ways, many of which have been previously noted. Thus, different responses might be found to these stimuli for infants of differing ages. In general, it is expected that the older children will be able to make finer discriminations than will the younger infants. The major hypotheses follow:

1. Four month old infants will be able to discriminate between an English phrase and a nonsense-word list.

2. Four month old infants will not be able to discriminate between an English phrase and a nonsense-word phrase.

3. Eight month old infants will be able to discriminate between an English phrase and a nonsense-word list.

4. Eight month old infants will be able to discriminate between an English phrase and a nonsense-word phrase.
CHAPTER 2

METHOD

Subjects

The subjects in this study were 18 healthy female infants, 16 - 18 weeks of age (mean age at testing = 119.4 days, range = 111 - 129 days) and 18 healthy female infants 32 - 34 weeks of age (mean age at testing = 229.9 days, range = 224 - 238 days). All subjects selected for study were born at either University or Riverside Hospitals in Columbus, Ohio; mothers were contacted at the time of the infant's birth in the process of collecting survey data to be used in another research project at Ohio State University. Female infants whose mothers were attended by private physicians (i.e., not clinic babies) and who were in good health at birth as determined by lack of major birth defects, and birth weight over 5 ½ pounds were chosen as potential subjects. Parents of these infants were contacted by letter and by follow-up telephone call. Of those contacted, 58 (68%)
agreed to participate by bringing their child to the laboratory. Testing took place when the child was either 16 - 18 weeks of age or 32 - 34 weeks of age.

The infants were seen at the time of day most convenient for the mother and when the child was judged by her mother to be most likely to be awake and alert. During the experimental session, state was monitored by an observer as well as by E. Any Ss judged to be fussy or drowsy for two consecutive stimulus presentations was not included in the data analysis.

Of the younger infants, 3 were excluded because of equipment failure or experimenter error and 10 were not included because of initial fussiness or state changes to fussiness during the experiment. Of the older infants, one was excluded because of equipment failure or experimenter error, while 8 were not included because of initial fussiness or state changes to fussiness during the experiment.

Stimuli

The familiar stimuli were chosen by evaluation of transcripts of the conversations of 9 mothers, not included in this study, with their 4-month old infants during one observed feeding. Complete transcripts may be found in Appendix A. It will be noted that the
majority of the mothers used the phrase "Is that . . ." followed by an adjective, most often "okay". As Bloom (1970) also reports that the words "that" and "okay" were among the first to appear in the vocabularies of the children she studied, the phrase "Is that okay?" was chosen as the familiar phrase in this study. The opposing unfamiliar phrase was constructed to match syllabically with the familiar phrase. The nonsense syllables making up this phrase were chosen from a list (Archer, 1960) containing the association values (for adults) for visually presented nonsense syllables; no similar information could be located for syllables presented in the auditory mode. Those syllables were selected which had the lowest association values, could be pronounced and for which three judges had no particular associations when the syllables were read, either singly or in a phrase pattern. The syllables, "luj buv yig mib", were chosen as fitting the above criteria. Phonetic transcriptions of the stimuli are as follows:  

English phrase Iz ðæt oʊkə?ı?
Nonsense phrase ɹəd bu hɪg mɨb?
Nonsense word list ləj buv ɣəzɨ mɨb

Four different stimuli were formed from combinations of the familiar and unfamiliar words. The familiar words
were always recorded in the form of a question (with rising terminal intonation contour), while the nonsense words were recorded with either the same intonation pattern as the English phrase or in a monotone with a period of $\frac{1}{2}$ second between each word. This second stimulus thus provided for maximal contrast in terms of stress, intonation, and timing with the familiar phrase.

The stimuli were recorded on audio tape by E. The tapes were independently evaluated by three judges and were not considered adequate until all the judges considered the only difference between the stimulus phrases to be due to the words involved, with no differences in volume, intonation, phrasing or stress. The language stimuli were reproduced on a Panasonic Model RQ L21-S cassette tape recorder and were presented through an external speaker located approximately 18 inches to the left of and behind the infant's head.

Procedure and Apparatus

The rooms in which the experiment was conducted were not sound attenuated. However, all equipment was located in the observation room with a connecting door to the experimental room. The ambient noise level in the experimental room with all equipment running and
the door closed was 55 db. as measured by a General Radio 1565-A sound level meter. The speech stimuli were presented at an average of 72 db measured at the site of the infant's head.

Upon arrival at the experimental room, the infant was placed in an infant seat in a semireclining position. The first 5 or 10 minutes of the session were spent explaining the purpose of the study to the parent(s) and allowing the infant to adapt to the strange surroundings. After this was accomplished, active electrodes were taped at the base of the sternum and between the shoulder blades; the ground electrode was placed about 1 inch above and to the left of the navel. The infant seat was placed facing a plain wall with the speaker to the left of and behind the infant; the one-way observation mirror was to the left of the infant. The mother was seated in a chair approximately three feet to the right of and behind the infant. As the mother was clearly in the child's field of vision, she was instructed to sit quietly and not distract her child unless the infant became fussy and irritable. The mother was asked to soothe her infant if this occurred; if the child did not fuss during 2 consecutive trials, the experiment was continued but data
from the trial in which fussing occurred were excluded from the analysis.

Four different stimulus groups were formed from combinations of the English and nonsense words. With counterbalancing of stimulus order on the English/nonsense dimension, the stimulus combinations resulted in the following four experimental groups:

Initial Stimulus/Comparison Stimulus

Group 1:  
a - English phrase/Nonsense phrase  
b - Nonsense phrase/English phrase

Group 2:  
a - English phrase/Nonsense word list  
b - Nonsense word list/English phrase

There were five 16-week and five 32-week old infants in Groups 1a and 1b, and four infants at each age level in Groups 2a and 2b.

The research design followed an habituation-dishabituation paradigm, similar to those described in the first chapter. This method called for presentation of the initial stimulus for 12 trials, theoretically until habituation had occurred. On the thirteenth trial, a new stimulus was introduced. This stimulus was presented for 6 trials to determine whether dishabituation would occur. If dishabituation did occur, this was taken as evidence that the infants were, in fact, able to discriminate between the two stimuli.
Complete counterbalancing of habituation-dishabituation trials for all stimulus conditions (presentation of all three stimuli to each infant) was not attempted because of high Ss loss rate. Pretesting as well as other reports (e.g., Kaplan, 1969) suggested that 4 month old infants could remain quiet for a task such as this for no more than 8 - 10 minutes. Stimuli were approximately 1 - 2 seconds in length and were presented every 30 seconds, resulting in a total experimental time of 9 minutes.

Behavioral Observations and Cardiac Measures

Through the entire experimental session, the person in the observation room rated the infant with respect to five state categories (alert, fussy, crying, daze/drowse, asleep), orientation of gaze (left, right, center) and body movement (including: quiet, smile and vocalization) at 10 second intervals. (The behavioral checklist and definitions of the response measures may be found in Appendix B). Two observers performed the behavioral observations; interrater reliability on those trials in which both observers rated yielded correlation coefficients of $r = +.89$ for state; $r = +.67$ for orientation of gaze and $r = +.61$ for body movement. When all was running smoothly, E also attempted to
record behavioral observations on the polygraph chart paper.

Heart rate was recorded by a Grass Model 7 polygraph, with the chart speed set at 10 mm/sec. The R-R intervals, i.e., the differences between the largest waves in the heart rate cycle, were read and simultaneously converted into a graph of heart rate (HR) response in beats per minute (bpm) by a Grass cardiotachograph. This graph was read by E, with data converted to per second averages of HR in bpm from the 5 seconds preceding to 10 seconds following stimulus onset. As stimuli were of short duration (1 - 2 seconds) and as Lewis (1971) has argued that deceleration to stimulus onset reflects cognitive activity while response to stimulus offset is a simple function of energy changes in the surround, only response to stimulus onset was evaluated. The 10 second interval including seconds -5.0 to +5.0 was selected for analysis of the heart rate response to stimulus onset; visual inspection of the data indicated that the lowest beat in response to the stimulus invariably occurred in the five second period following stimulus onset. Analyses of heart rate response in seconds -5.0 to 0 and +6.0 to +10.0 were also performed. Intervals
of equal length were chosen so as to minimize the effect of normal HR variability on difference scores.

It will be recalled that the first stimulus was presented for 12 trials, while the second was presented for 6 trials. Trials were grouped into blocks of three, following the method used by Graham and her associates (Graham & Clifton, 1966; Graham & Jackson, 1970). The score for each of the trial blocks was the mean of the scores for the three trials comprising the trial block. Thus, there were four trial blocks of the first stimulus and two trial blocks of the second stimulus. Two different methods of data analysis were used; in the first, mean HR scores were determined for the 5 second period preceding and the two 5 second periods following stimulus onset. Difference scores were calculated for each TB for each infant by first determining the mean HR score in the TB for the prestimulus period and each of the two post-stimulus periods used in the analysis (i.e., prestimulus = seconds -5.0 to 0; post₁ = seconds 0 to 5.0; post₂ = seconds +6.0 to +10.0). The mean HR score in the prestimulus period was then subtracted from the mean heart rate score in each of the two post-stimulus periods, resulting in the two difference scores for that TB (i.e., post₁ - pre; post₂ - pre).
Negative difference scores indicated cardiac deceleration while positive difference scores indicated cardiac acceleration. Overall scores were determined for each group at each age by finding the mean difference scores for each TB; these scores were used in the subsequent data analysis. The second method of data analysis utilized lowest beat scores. In this analysis, scores were obtained by comparing the lowest beat in the 5 second period preceding stimulation with the lowest beats in each of the two 5 second periods following stimulus onset. This is the same method (using lowest beat scores) as that used to derive difference scores for the means, as explained above.
CHAPTER 3
RESULTS

For all analyses, data were averaged into trial blocks (TB) of three trials, following the method employed by Graham and her associates (Graham & Clifton, 1966; Clifton & Meyers, 1969; Graham & Jackson, 1970). As the major interest was in dishabituation to the new stimulus, and as initial analyses indicated no order effects, groups differing only on order were combined. This resulted in two groups to be used in the analysis. That is, data were analyzed for the combined phrase groups (Group 1: a - English phrase/Nonsense phrase; b - Nonsense phrase/English phrase -- N = 10 at each age) and the combined phrase-list groups (Group 2: a - English phrase/Nonsense list; b - Nonsense list/English phrase -- N = 8 at each age). The trial blocks considered in the analysis were TB 1 (trials 1 - 3), TB 4 (trials 10 - 12, the last 3 trials of the first stimulus), TB 5 (trials 13 - 15, the first 3 trials of the second stimulus) and TB 6 (trials 16 - 18).

Numerous investigators (e.g., Lacey, 1963; Hock, 1971; Moffitt, 1971) have reported significant correlations between prestimulus HR level and magnitude of response, a
relation entitled the "law of initial values" by Lacey (1967). A similar relation was found in this study for response on several of the trial blocks (correlations may be found in Appendix C). Analyses of covariance as well as analyses of variance were performed. Both analyses resulted in similar findings and only the analyses of variance will be reported.

Sample Characteristics

Initial analyses focussed on age differences in prestimulus heart rate. The prestimulus HR in the 5 seconds preceding each of the four TBs, for each age as measured both by mean scores and by lowest beat scores will be found in Table 1. There were no significant differences across TBs although the 32 week old infants had significantly lower prestimulus HRs than did the 16 week olds. (F = 41.6, df = 1, 136, p < .01; F = 42.9, df = 1, 136, p < .01 for mean and lowest beat scores respectively). Previous data reported by Kagan (1971) and Graham and Jackson (1970) have indicated a similar developmental trend in HR scores. Heart rate increases for the first few months following birth, and then gradually decreases throughout childhood. As will be noted more fully later, where there was a difference between the two age groups in magnitude of deceleration, the 32
TABLE 1
Mean Prestimulus Heart Rate Scores
Reported in Beats Per Minute (BPM)

A. Prestimulus Heart Rate, Using Means

<table>
<thead>
<tr>
<th></th>
<th>TB 1</th>
<th>TB 4</th>
<th>TB 5</th>
<th>TB 6</th>
<th>( \bar{X} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-week olds</td>
<td>164.2</td>
<td>166.1</td>
<td>167.0</td>
<td>167.2</td>
<td>166.1</td>
</tr>
<tr>
<td>32-week olds</td>
<td>155.9</td>
<td>156.8</td>
<td>158.1</td>
<td>158.8</td>
<td>157.6</td>
</tr>
</tbody>
</table>

B. Prestimulus Heart Rate, Using Lowest Beats

<table>
<thead>
<tr>
<th></th>
<th>TB 1</th>
<th>TB 4</th>
<th>TB 5</th>
<th>TB 6</th>
<th>( \bar{X} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-week olds</td>
<td>162.7</td>
<td>163.4</td>
<td>164.9</td>
<td>164.4</td>
<td>163.8</td>
</tr>
<tr>
<td>32-week olds</td>
<td>153.2</td>
<td>153.9</td>
<td>155.3</td>
<td>156.3</td>
<td>154.5</td>
</tr>
</tbody>
</table>
week old infants evinced a greater deceleration than did the 16 week olds, which might suggest that the 32 week olds were more attentive to the stimuli than were the younger infants.

As Lewis and Johnson (1971) report that on tasks where the data were available, infants unable to complete an experiment showed different patterns of attention from those able to complete the session, an attempt was made to analyze the data from those infants who did not complete this study. Thus, prestimulus HR levels and magnitude of deceleration of four 16 week old and five 32 week old infants who completed the first three trials but were excluded from the sample because of later fussiness were compared with the study subjects (Table 2). Although no differences were found between the two 32 week old groups, the 16 week olds excluded from the sample had significantly lower heart rates than did the 16 week old sample subjects ($F = 8.5$, $df = 1, 131$, $p < .01$). An analysis of magnitude of deceleration showed no significant differences for either ages or subject groups, although this may be attributed, at least in part, to the small number of Ss for whom data were available. It is difficult to know what the effect of the exclusion of such Ss was on the final outcome of the study; nevertheless,
TABLE 2
PRESTIMULUS HEART RATE SCORES - FIRST THREE TRIALS
SAMPLE AND EXCLUDED Ss

### Mean Scores and Magnitude of Deceleration
(in beats per minute)

<table>
<thead>
<tr>
<th>Subjects</th>
<th>16-Week old Ss</th>
<th>32-Week old Ss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Ss</td>
<td>N=18</td>
<td>N=18</td>
</tr>
<tr>
<td>164.3 bpm</td>
<td>154.5 bpm</td>
<td></td>
</tr>
<tr>
<td>2.5 bpm decel</td>
<td>5.3 bpm decel</td>
<td></td>
</tr>
<tr>
<td>Excluded Ss</td>
<td>N=4</td>
<td>N=5</td>
</tr>
<tr>
<td>154.5 bpm</td>
<td>155.4 bpm</td>
<td></td>
</tr>
<tr>
<td>3.75 bpm decel</td>
<td>4.2 bpm decel</td>
<td></td>
</tr>
</tbody>
</table>

### Lowest Beat Scores and Magnitude of Deceleration
(in beats per minute)

<table>
<thead>
<tr>
<th>Subjects</th>
<th>16-Week old Ss</th>
<th>32-Week old Ss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Ss</td>
<td>N=18</td>
<td>N=18</td>
</tr>
<tr>
<td>163.8 bpm</td>
<td>154.8 bpm</td>
<td></td>
</tr>
<tr>
<td>3.5 bpm decel</td>
<td>6.7 bpm decel</td>
<td></td>
</tr>
<tr>
<td>Excluded Ss</td>
<td>N=4</td>
<td>N=5</td>
</tr>
<tr>
<td>152.4 bpm</td>
<td>151.8 bpm</td>
<td></td>
</tr>
<tr>
<td>6.4 bpm decel</td>
<td>4.4 bpm decel</td>
<td></td>
</tr>
</tbody>
</table>
support is given to Lewis' notion of differences in attention among those Ss able or unable to complete the experiment.

Response to Language Stimuli in the First 5 Seconds Following Stimulus Onset for All Trials

Two analyses of variance were performed, one using the difference scores for the means of pre and post HR response, the other using the difference scores between the lowest beats of pre and post HR response, on data of the two combined groups and TBs 1, 4, 5 and 6. Summaries of the data on which these analyses were based may be found in Tables 3 and 4.

For the analysis using the difference scores of the means, significant effects were obtained for trials \(F = 3.37, \text{df} = 3, 96, p < .025\), age x trials \(F = 3.81, \text{df} = 3, 96, p < .01\) and group x trials \(F = 2.93, \text{df} = 3, 96, p < .05\). In addition, significant quadratic trends were found in the age x trials interaction for the 32 week olds \(F = 9.9, \text{df} = 1, 68, p < .01\).

Similar results were obtained using the difference scores of the lowest beats. In this analysis, significant effects were obtained for trials \(F = 4.98, \text{df} = 3, 96, p < .005\) and group x trials \(F = 3.39, \text{df} = 3, 96, p < .02\) with the age x trials \(F = 2.34, \text{df} = 3, 96, p < .08\).
### TABLE 3
DECELERATIONS IN FIVE SECONDS FOLLOWING STIMULUS ONSET - MEANS*

<table>
<thead>
<tr>
<th></th>
<th>16-Week Old Ss</th>
<th></th>
<th>32-Week Old Ss</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group 1a</td>
<td>Group 1b</td>
<td>Group 2a</td>
<td>Group 2b</td>
</tr>
<tr>
<td>TB 1</td>
<td>4.4 bpm</td>
<td>3.5 bpm</td>
<td>1.9 bpm</td>
<td>1.9 bpm</td>
</tr>
<tr>
<td>TB 4</td>
<td>1.7 bpm</td>
<td>2.9 bpm</td>
<td>2.2 bpm</td>
<td>2.8 bpm</td>
</tr>
<tr>
<td>TB 5</td>
<td>2.9 bpm</td>
<td>2.6 bpm</td>
<td>2.8 bpm</td>
<td>3.5 bpm</td>
</tr>
<tr>
<td>TB 6</td>
<td>1.1 bpm</td>
<td>2.3 bpm</td>
<td>2.0 bpm</td>
<td>2.3 bpm</td>
</tr>
</tbody>
</table>

Group 1a = English phrase/ Nonsense phrase
Group 1b = Nonsense phrase/ English phrase
Group 2a = English phrase/ Nonsense list
Group 2b = Nonsense list/ English phrase

*Scores for groups varying only in order of presentation are presented separately, even though they are combined in the analysis.
### TABLE 4
DECELERATIONS IN FIVE SECONDS FOLLOWING STIMULUS ONSET - LOWEST BEATS*

<table>
<thead>
<tr>
<th></th>
<th>16-Week Old Ss</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group 1a</td>
<td>Group 1b</td>
<td>Group 2a</td>
<td>Group 2b</td>
</tr>
<tr>
<td>TB 1</td>
<td>4.1 bpm</td>
<td>4.1 bpm</td>
<td>2.4 bpm</td>
<td>2.8 bpm</td>
</tr>
<tr>
<td>TB 4</td>
<td>1.5 bpm</td>
<td>3.2 bpm</td>
<td>2.2 bpm</td>
<td>2.6 bpm</td>
</tr>
<tr>
<td>TB 5</td>
<td>2.8 bpm</td>
<td>0.9 bpm</td>
<td>4.3 bpm</td>
<td>3.8 bpm</td>
</tr>
<tr>
<td>TB 6</td>
<td>1.2 bpm</td>
<td>0.8 bpm</td>
<td>2.8 bpm</td>
<td>2.3 bpm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>32-Week Old Ss</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group 1a</td>
<td>Group 1b</td>
<td>Group 2a</td>
<td>Group 2b</td>
</tr>
<tr>
<td>TB 1</td>
<td>10.6 bpm</td>
<td>7.2 bpm</td>
<td>5.8 bpm</td>
<td>2.0 bpm</td>
</tr>
<tr>
<td>TB 4</td>
<td>1.4 bpm</td>
<td>2.8 bpm</td>
<td>0.8 bpm</td>
<td>3.5 bpm</td>
</tr>
<tr>
<td>TB 5</td>
<td>1.3 bpm</td>
<td>2.0 bpm</td>
<td>5.8 bpm</td>
<td>0.8 bpm</td>
</tr>
<tr>
<td>TB 6</td>
<td>3.3 bpm</td>
<td>6.5 bpm</td>
<td>2.1 bpm</td>
<td>2.0 bpm</td>
</tr>
</tbody>
</table>

Group 1a = English phrase/ Nonsense phrase
Group 1b = Nonsense phrase/ English phrase
Group 2a = English phrase/ Nonsense list
Group 2b = Nonsense list/ English phrase

*Scores for groups varying only in order of presentation are presented separately, even though they are combined in the analysis.
and age x group (F = 3.2, df = 1, 32, p < .06) interactions tending toward significance. Again, significant linear (F = 29, df = 1, 76, p < .01) and quadratic trends (F = 37.09, df = 1, 76, p < .01) were found for Group 1 in the group x trials interaction. Both the interaction effects and the trend analyses will be discussed more fully in later sections of this dissertation. These analyses are reported in Tables 5 and 6. These data indicate that all of the 32-week olds infants did attend to the first auditory stimulus, as measured by an initial decelerative cardiac response. The data for the 16-week olds do not provide such strong evidence for the occurrence of an initial period of attention (i.e., cardiac deceleration). A more restricted analysis, using just this group, was performed in an attempt to clarify this question.

This additional comparison of the response in TB 1 by the 16 week olds to the initial language stimulus was made using both mean and lowest beat scores. The use of a repeated-measures design resulted in a fairly large error term in the analysis of variance in this instance, thereby reducing the chances for obtaining significant results. Results obtained using a more restricted comparison, which were comparable for both
<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1</td>
<td>15.93</td>
<td>15.93</td>
<td>2.06</td>
</tr>
<tr>
<td>Group</td>
<td>1</td>
<td>5.76</td>
<td>5.76</td>
<td>0.75</td>
</tr>
<tr>
<td>Trial Blocks</td>
<td>3</td>
<td>66.92</td>
<td>22.31</td>
<td>3.38*</td>
</tr>
<tr>
<td>Age x Group</td>
<td>1</td>
<td>5.90</td>
<td>5.90</td>
<td>0.76</td>
</tr>
<tr>
<td>Age x Trial Blocks</td>
<td>3</td>
<td>75.53</td>
<td>25.18</td>
<td>3.81*</td>
</tr>
<tr>
<td>16 Weeks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS Between</td>
<td>3</td>
<td>8.48</td>
<td>2.83</td>
<td>0.61</td>
</tr>
<tr>
<td>SS Within</td>
<td>68</td>
<td>317.67</td>
<td>4.67</td>
<td></td>
</tr>
<tr>
<td>32 Weeks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS Between</td>
<td>3</td>
<td>134.52</td>
<td>44.84</td>
<td>4.61**</td>
</tr>
<tr>
<td>SS Linear</td>
<td>1</td>
<td>33.01</td>
<td>33.01</td>
<td>3.42#</td>
</tr>
<tr>
<td>SS Quad</td>
<td>1</td>
<td>95.94</td>
<td>95.94</td>
<td>9.93**</td>
</tr>
<tr>
<td>SS Within</td>
<td>68</td>
<td>661.63</td>
<td>9.70</td>
<td></td>
</tr>
<tr>
<td>Group x Trial Blocks</td>
<td>3</td>
<td>75.55</td>
<td>19.37</td>
<td>2.93*</td>
</tr>
<tr>
<td>Group 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS Between</td>
<td>3</td>
<td>107.17</td>
<td>35.72</td>
<td>3.85*</td>
</tr>
<tr>
<td>SS Linear</td>
<td>1</td>
<td>24.01</td>
<td>24.01</td>
<td>2.54</td>
</tr>
<tr>
<td>SS Quad</td>
<td>1</td>
<td>76.05</td>
<td>76.05</td>
<td>8.21**</td>
</tr>
<tr>
<td>Group 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS Between</td>
<td>3</td>
<td>17.89</td>
<td>5.96</td>
<td>1.13</td>
</tr>
<tr>
<td>SS Within</td>
<td>60</td>
<td>321.82</td>
<td>5.27</td>
<td></td>
</tr>
<tr>
<td>Age x Group x Trial</td>
<td>3</td>
<td>33.84</td>
<td>11.28</td>
<td>1.71</td>
</tr>
<tr>
<td>Within Ss</td>
<td>32</td>
<td>247.04</td>
<td>7.72</td>
<td></td>
</tr>
<tr>
<td>Within Trials x Ss</td>
<td>96</td>
<td>634.49</td>
<td>6.61</td>
<td></td>
</tr>
</tbody>
</table>

**p < .01  
* p < .05  
# p < .10
### TABLE 6

ANKALYSIS OF VARIANCE SUMMARY:

DECELERATION IN FIVE SECONDS FOLLOWING STIMULUS ONSET

LOWEST BEATS

<table>
<thead>
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<th>Source</th>
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<th>F Ratio</th>
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<td>Trial Blocks</td>
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<td>180.41</td>
<td>60.14</td>
<td>4.98**</td>
</tr>
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<td>40.99</td>
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<td>122.29</td>
<td>40.98</td>
<td>3.39*</td>
</tr>
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</table>

**Group 1**
- SS Between: 3 270.29 90.09 21.81**
- SS Linear: 1 118.81 118.81 28.02**
- SS Quad: 1 151.23 151.23 37.09**
- SS Within: 68 313.98 4.13

**Group 2**
- SS Between: 3 24.04 8.02 2.21#
- SS Within: 60 218.13 3.64

| Within Ss                     | 32  | 406.27        | 12.69       |
| Within Trials x Ss            | 96  | 1158.75       | 12.07       |

**p < .01**
**p < .05**
#p < .10
scores, indicated that the initial cardiac response of the 16 week olds in this study was a deceleration which was significantly different from 0 (t$_{35}$ = 1.74, p < .05; t$_{35}$ = 2.12, p < .05 for mean and lowest beat scores respectively). This result provides some evidence suggesting that the 16-week olds did, indeed, attend to the initial stimulus, as measured by cardiac deceleration.

Habituation and Dishabituation of Cardiac Response in the First 5 Seconds Following Stimulus Onset

There follows a discussion of some of the major findings of the preceding analyses. Both overall findings and trend analyses will be considered. First to be examined is the data relevant to habituation, i.e. the analyses for trials, age x trials and group x trials. These results can be examined graphically in Figures 1 through 4. A Newman-Keuls post hoc comparison (Winer, 1971) of mean decelerative response for the four TBs yielded a significant difference between TB 1 and TB 4 (p < .05). Similar results were also found for the 32-week olds in the age x trials interaction and for Group 1 in the group x trials interaction.

Post-hoc trend analyses (Winer, 1971) of the above-mentioned significant interactions also revealed
FIGURE 1
DECELERATION IN FIVE SECONDS FOLLOWING
STIMULUS ONSET - MEANS
Phrase/Phrase & Phrase/List Groups
FIGURE 2
DECELERATION IN FIVE SECONDS FOLLOWING STIMULUS ONSET - LOWEST BEATS
Phrase/Phrase & Phrase/List Groups
FIGURE 3
AGE X TRIALS INTERACTIONS MEANS
FIGURE 4
GROUP X TRIALS INTERACTIONS
MEANS AND LOWEST BEATS
significant quadratic trends in the data \((p < .01)\) for those infants who were in Group 1, and those who were 32-weeks old. The fact that these are both quadratic trends of a particular shape provides evidence for the occurrence of both habituation and dishabituation of cardiac response, but not evidence for the occurrence of one or the other alone. There was not conclusive evidence supporting the occurrence of habituation in either group of 16-week old infants or in the 32-week old infants in the phrase/list comparison group. These results suggest that at least the 32-week olds initially attended to the stimulus, but that the pattern of attention was no longer present by TB 4, the final presentation of the initial stimulus.

When considering data relevant to the occurrence of dishabituation, many of the interactions mentioned in terms of habituation to the initial stimulus are quite important. Many of these analyses involved a comparison of the difference scores in both TB 5 and TB 6 (the two trials blocks following stimulus change) with the scores obtained for TB 4 (the last trial block of the initial stimulus). Although the analysis of variance for trial blocks did not reach significance, quadratic trends for both group x trials (phrase/phrase group) and age x trials (for 32-week olds) interactions
suggest that dishabituation had in fact occurred in some instances. As previously noted, these quadratic trends provide evidence for the occurrence of both habituation and dishabituation, but not for either of the phenomena alone. A t-test on the magnitudes of deceleration at TB 4 and TB 6 for 32-week olds in the phrase/phrase comparison group approached significance ($t_{18}=1.57, p<.10; t_{18}=1.64, p<.10$ for mean and lowest beat scores respectively). Thus strong, but certainly not unequivocal, evidence suggests that dishabituation of cardiac response occurred on TB 6 for 32-week olds in the phrase/phrase comparison group. It is to be noted that the greatest amount of deceleration occurred in TB 6, the second trial block following stimulus change, not in TB 5 as was predicted following results of previous studies (e.g., Berg, 1972; Clifton & Meyers, 1969; Graham & Jackson, 1970; Kaplan, 1969; Moffitt, 1971; Morse, 1972). The evidence does not indicate the occurrence of dishabituation in either group of 16-week olds or among the 32-week olds in the phrase/list comparison group.

Previous analyses had indicated no effects of order for any of the stimulus groups. In an attempt to further examine the data for the 16-week and 32-week olds in
the phrase/list comparison groups, graphs were drawn for these two groups (Figures 5 and 6). When considering the graphic evidence, cardiac deceleration appeared to be present for the phrase/list and list/phrase groups for the first trial block. Significant statistical evidence (previously reported) also indicates the occurrence of deceleration to the initial stimulus in these groups of 16-week and 32-week old infants. Habituation seems to have occurred by TB 4 for the 32-week olds in the phrase/list group, with some indication of dishabituation on TB 5 (a t-test comparing magnitude of deceleration between TB 4 and TB 5 yielded the following values for mean and lowest beat scores respectively: $t_{6}=1.55, p < .10; t_{6}=1.61, p < .10$).

A similar graphic pattern of deceleration was not evident for those 32-week olds who were presented with the same stimuli for comparison but for whom the order of presentation was reversed. These Ss heard 12 trials of the nonsense list stimulus and were then presented with 6 trials of the English phrase. Although the differences were not significant, deceleration on the initial TB appeared to be smaller to the nonsense list stimulus than to either of the two phrase stimuli (Table 7). Yet by TB 4, those 32-week olds in the
DECELERATION IN FIVE SECONDS FOLLOWING STIMULUS ONSET - MEANS

Phrase/List and List/Phrase Groups
FIGURE 6
DECELERATION IN FIVE SECONDS FOLLOWING STIMULUS ONSET - LOWEST BEATS
Phrase/List and List/Phrase Groups
TABLE 7
MAGNITUDE OF DECELERATION TO INITIAL STIMULI

**Mean Scores** (decelerations in beats per minute)

<table>
<thead>
<tr>
<th>Initial Stimulus</th>
<th>16-Week Old Ss</th>
<th>32-Week Old Ss</th>
</tr>
</thead>
<tbody>
<tr>
<td>English phrase</td>
<td>3.33 bpm</td>
<td>5.98 bpm</td>
</tr>
<tr>
<td>Nonsense phrase</td>
<td>1.50 bpm</td>
<td>6.12 bpm</td>
</tr>
<tr>
<td>Nonsense list</td>
<td>1.87 bpm</td>
<td>2.70 bpm</td>
</tr>
</tbody>
</table>

**Lowest Beat Scores** (decelerations in beats per minute)

<table>
<thead>
<tr>
<th>Initial Stimulus</th>
<th>16-Week Old Ss</th>
<th>32-Week Old Ss</th>
</tr>
</thead>
<tbody>
<tr>
<td>English phrase</td>
<td>3.23 bpm</td>
<td>8.22 bpm</td>
</tr>
<tr>
<td>Nonsense phrase</td>
<td>4.12 bpm</td>
<td>7.22 bpm</td>
</tr>
<tr>
<td>Nonsense list</td>
<td>2.85 bpm</td>
<td>2.00 bpm</td>
</tr>
</tbody>
</table>
list/phrase group did not show any graphic evidence of habituation. One might interpret the data to indicate that these infants were actually manifesting greater decelerations to the later stimuli than to the initial stimulus presentation. When compared with TB 5, the first TB following stimulus change, there was graphic evidence for a greater deceleration on TB 4. Graphic evidence also indicates that the largest decelerations by the 16-week olds seemed to have occurred on the TB following stimulus change, suggesting prolonged attention resulting from the changed stimulus.

There is, thus, equivocal evidence (which is not supported by statistically significant results) indicating discrimination of the two stimuli by 32-week olds in the phrase/list comparison group. Among the 32-week olds in the list/phrase comparison group, the largest magnitude of deceleration apparently occurred on TB 4, the TB preceding stimulus change. Conversely, for the 16-week olds, magnitude of cardiac deceleration seemed to increase slightly following stimulus change. These results provide no evidence for the discrimination of these stimuli by the 16-week olds or the 32-week olds in the list/phrase comparison group. It should be remembered that these results are based on graphic
evidence (not statistically significant) from a small number of Ss. It should be viewed as no more than interesting speculations concerning what might possibly be happening with these infants.

Response in Second 5 Seconds Following Stimulus Onset - For All Trials

Clifton & Meyers (1969) and Graham and Jackson (1970) have reported evidence for isolating identifiable HR response patterns up to 20 seconds following stimulus onset. Consequently, the second five-second group (seconds 6.0 - 10.0) following onset was analyzed in an attempt to clarify further the infant's response to the language stimulus and to stimulus change. As in the previous analyses, difference scores for the scores of the means and those of the lowest beats in the five seconds prior to stimulus onset and in the second five-second group following onset (post - pre) were obtained. Data used in these analyses may be found in Tables 8 and 9.

Results of the analysis of the means scores (Table 10) showed a significant effect of age (F = 15.2, df = 1, 32, p < .001), group x trials (F = 3.29, df = 3, 96, p < .03) and age x group x trials (F = 3.29, df = 3, 96, p < .03). Significant quadratic trends
TABLE 8
DECELERATIONS IN SECOND FIVE SECONDS FOLLOWING
STIMULUS ONSET - MEAN SCORES

16-Week Old Ss

<table>
<thead>
<tr>
<th></th>
<th>Group 1a</th>
<th>Group 1b</th>
<th>Group 2a</th>
<th>Group 2b</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB 1</td>
<td>1.2 bpm</td>
<td>1.4 bpm</td>
<td>0.5 bpm</td>
<td>0.4 bpm</td>
</tr>
<tr>
<td>TB 4</td>
<td>-0.2 bpm</td>
<td>0.2 bpm</td>
<td>0.4 bpm</td>
<td>2.6 bpm</td>
</tr>
<tr>
<td>TB 5</td>
<td>0.2 bpm</td>
<td>1.0 bpm</td>
<td>0.1 bpm</td>
<td>3.2 bpm</td>
</tr>
<tr>
<td>TB 6</td>
<td>-0.5 bpm</td>
<td>0.4 bpm</td>
<td>0.1 bpm</td>
<td>1.8 bpm</td>
</tr>
</tbody>
</table>

32-Week Old Ss

<table>
<thead>
<tr>
<th></th>
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<th>Group 1b</th>
<th>Group 2a</th>
<th>Group 2b</th>
</tr>
</thead>
<tbody>
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<td>4.1 bpm</td>
<td>3.0 bpm</td>
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<tr>
<td>TB 4</td>
<td>0.0 bpm</td>
<td>0.8 bpm</td>
<td>2.1 bpm</td>
<td>4.5 bpm</td>
</tr>
<tr>
<td>TB 5</td>
<td>1.0 bpm</td>
<td>1.7 bpm</td>
<td>4.3 bpm</td>
<td>0.5 bpm</td>
</tr>
<tr>
<td>TB 6</td>
<td>4.3 bpm</td>
<td>5.2 bpm</td>
<td>1.8 bpm</td>
<td>0.2 bpm</td>
</tr>
</tbody>
</table>

Group 1a = English phrase/Nonsense phrase
Group 1b = Nonsense phrase/English phrase
Group 2a = English phrase/Nonsense list
Group 2b = Nonsense list/English phrase
TABLE 9

DECELERATIONS IN SECOND FIVE SECONDS FOLLOWING
STIMULUS ONSET - LOWEST BEAT SCORES

16-Week Old Ss

<table>
<thead>
<tr>
<th></th>
<th>Group 1a</th>
<th>Group 1b</th>
<th>Group 2a</th>
<th>Group 2b</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB 1</td>
<td>0.3 bpm</td>
<td>2.9 bpm</td>
<td>1.4 bpm</td>
<td>0.4 bpm</td>
</tr>
<tr>
<td>TB 4</td>
<td>-1.1 bpm</td>
<td>0.0 bpm</td>
<td>0.2 bpm</td>
<td>1.4 bpm</td>
</tr>
<tr>
<td>TB 5</td>
<td>0.7 bpm</td>
<td>0.3 bpm</td>
<td>1.2 bpm</td>
<td>3.5 bpm</td>
</tr>
<tr>
<td>TB 6</td>
<td>-0.5 bpm</td>
<td>-1.3 bpm</td>
<td>2.0 bpm</td>
<td>0.3 bpm</td>
</tr>
</tbody>
</table>

32-Week Old Ss

<table>
<thead>
<tr>
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<th>Group 1a</th>
<th>Group 1b</th>
<th>Group 2a</th>
<th>Group 2b</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB 1</td>
<td>7.3 bpm</td>
<td>5.2 bpm</td>
<td>5.0 bpm</td>
<td>3.0 bpm</td>
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<tr>
<td>TB 4</td>
<td>-0.2 bpm</td>
<td>1.3 bpm</td>
<td>1.1 bpm</td>
<td>5.0 bpm</td>
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<tr>
<td>TB 5</td>
<td>-0.2 bpm</td>
<td>2.3 bpm</td>
<td>4.7 bpm</td>
<td>-0.1 bpm</td>
</tr>
<tr>
<td>TB 6</td>
<td>3.3 bpm</td>
<td>6.8 bpm</td>
<td>1.4 bpm</td>
<td>1.2 bpm</td>
</tr>
</tbody>
</table>

Group 1a = English phrase/Nonsense phrase
Group 1b = Nonsense phrase/English phrase
Group 2a = English phrase/Nonsense list
Group 2b = Nonsense list/English phrase
TABLE 10  
ANALYSIS OF VARIANCE SUMMARY:  
DECELERATION IN SECOND FIVE SECONDS FOLLOWING  
STIMULUS ONSET — MEANS

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<td>111.83</td>
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<td>5.26</td>
<td>0.72</td>
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<tr>
<td>Trial Blocks</td>
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<td>26.09</td>
<td>8.69</td>
<td>1.39</td>
</tr>
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<td>Age x Group</td>
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<td>6.24</td>
<td>6.24</td>
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<td>Age x Trial Blocks</td>
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<td>27.12</td>
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<td>3</td>
<td>61.42</td>
<td>20.47</td>
<td>3.28*</td>
</tr>
</tbody>
</table>

Group 1

| SS Between                    | 3  | 75.94         | 25.31       | 2.73*   |
| SS Linear                     | 1  | 0.04          | 0.04        | 0.004   |
| SS Quad                       | 1  | 5.71          | 5.71        | 6.31*   |
| SS Within                     | 76 | 703.82        | 9.26        |         |

Group 2

| SS Between                    | 3  | 9.42          | 3.14        | 0.55    |
| SS Within                     | 60 | 340.80        | 5.68        |         |

| Age x Group x Trial           | 3  | 61.63         | 20.54       | 3.29*   |
| Within Ss                     | 32 | 235.27        | 7.35        |         |
| Within Trials x Ss            | 96 | 599.94        | 6.25        |         |

**p < .01  
*p < .05
were obtained in the group x trials interaction for the phrase/phrase comparison group \((F = 6.3, \ df = 1, 76, p \leq .025)\) and for the 32-week olds in the phrase/phrase group in the age x group x trials interaction \((F = 12.9, \ df = 1, 36, p < .01)\). The only other significant trend obtained was in the age x group x trials interaction where a significant linear trend was found for 32-week old infants in the phrase/list group \((F = 4.73, \ df = 1, 28, p < .05)\). For the lowest beat analysis (Table 11), significant effects were found for age \((F = 24.8, \ df = 1, 32, p < .001)\), and trials \((F = 3.16, \ df = 3, 96, p < .03)\) with the group x trials \((F = 2.17, \ df = 3, 96, p < .10)\) and age x group \((F = 3.66, \ df = 1, 32, p < .07)\) interactions approaching significance. A graphic representation of these data may be found in figures 7 - 10. As with the previous analyses, graphs of the data provide some indication that the 32-week olds in the phrase/list group responded to the initial stimulus in a manner different from those infants in the list/phrase group. This finding will be discussed more fully later.

This analysis (of the second 5-seconds following stimulus onset) reinforces many of the results reported in the previous one. Again the significant effects of
<table>
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<td>188.83</td>
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<td>39.12</td>
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<td>Within Ss</td>
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<td>7.62</td>
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<tr>
<td>Within Trials x Ss</td>
<td>96</td>
<td>1188.40</td>
<td>12.38</td>
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</table>

**p < .01  
*p < .05  
#p < .10
FIGURE 7
DECELERATION IN SECOND FIVE SECONDS FOLLOWING STIMULUS ONSET
Phrase/Phrase Group

MEANS, LOWEST BEATS
16-week olds - Phrase/Phrase Group
32-week olds - Phrase/Phrase Group
FIGURE 8
DECELERATION IN SECOND FIVE SECONDS FOLLOWING STIMULUS ONSET
Phrase/List and List/Phrase Groups

16-week olds - Phrase/List Group
16-week olds - List/Phrase Group
32-week olds - Phrase/List Group
32-week olds - List/Phrase Group
FIGURE 9

DECELERATION IN SECOND FIVE SECONDS

GROUP X TRIAL INTERACTION.
FIGURE 10
DECELERATION IN SECOND FIVE SECONDS
AGE X GROUP X TRIAL INTERACTION
trials and the significant quadratic trends suggest that the presence of an initial deceleratory cardiac response which habituates over the first 12 trials may be found in seconds 6.0 - 10.0 following stimulus onset. As previously noted, the trend analysis provides evidence for an entire pattern of response, rather than for any particular component of the response. In this time period, the deceleratory pattern is evident only in the 32-week old data, where these infants have maintained significantly larger decelerations than did the 16-week olds.

When looking at evidence for renewed deceleration to the second stimulus, it is instructive to consider the significant quadratic trends in the group x trials and age x group x trials interactions. These results provide additional evidence for the recovery of the deceleratory response following habituation on TB 4. Separate analyses of each of the four trial blocks in the age x group x trials interaction were also performed to investigate more fully the significant trends previously reported. These results of these analyses may be found in Table 12.

These additional analyses of the deceleratory response in the second five-second period following
TABLE 12
ANALYSIS OF VARIANCE SUMMARY:
DECELERATION - SECOND FIVE SECONDS FOLLOWING STIMULUS ONSET
AGE X GROUP X TRIALS INTERACTION FOR MEANS

<table>
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<th>Mean Square</th>
<th>F Ratio</th>
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</thead>
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<td>Age</td>
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<td>71.11</td>
<td>71.11</td>
<td>8.86**</td>
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<td>Group</td>
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<td>0.37</td>
<td>0.37</td>
<td>0.05</td>
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<tr>
<td>Age x Group</td>
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<td>0.71</td>
<td>0.09</td>
</tr>
<tr>
<td>Within Ss</td>
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<td>256.81</td>
<td>8.02</td>
<td></td>
</tr>
<tr>
<td><strong>Age x Group at Trial Block 2</strong></td>
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<td>32</td>
<td>114.31</td>
<td>3.57</td>
<td></td>
</tr>
<tr>
<td><strong>Age x Group at Trial Block 4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>1</td>
<td>36.45</td>
<td>36.45</td>
<td>9.44**</td>
</tr>
<tr>
<td>Group</td>
<td>1</td>
<td>18.14</td>
<td>18.14</td>
<td>4.71*</td>
</tr>
<tr>
<td>Age x Group</td>
<td>1</td>
<td>44.83</td>
<td>44.83</td>
<td>11.52**</td>
</tr>
<tr>
<td>Within Ss</td>
<td>32</td>
<td>123.45</td>
<td>3.86</td>
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</tr>
</tbody>
</table>

**p < .01; *p < .05; #p < .10**
stimulus onset support the previous results. There, habituation of cardiac response to the initial stimulus, with recovery of the deceleratory response to the presentation of the new stimulus was found for 32-week old infants in the phrase/phrase comparison group. This second deceleratory response for these infants was greatest during TB 6, the second TB following stimulus change, while 32-week old infants in the list/phrase comparison group did not respond differentially to the stimulus change. Those 32-week old infants in the phrase/list group did seem to respond immediately to the changed stimulus. Although no differences were significant for the 16-week olds alone, graphic representation of the data seems to suggest that those 16 week olds in the phrase/phrase group continued to habituate to the stimulus through the 18 trials, while those in the phrase/list and list/phrase groups maintained the initial deceleratory response for a longer period of time and over a greater number of trials.

Behavioral Observations

Frequencies of quieting, orienting, vocalizing and smiling - behaviors which have been hypothesized to be associated with attention in infants (Kagan, 1971) -
were also included in an analysis of response to stimulus onset and change. Initially, correlations between overall magnitude of deceleration (in the first five seconds following stimulus onset) and occurrence of the behavioral response were calculated. These correlations may be found in Table 13. Unlike the results of Kagan (1971) and others, there was no significant correlation found between orienting to the stimulus and magnitude of deceleration at either age. The strongest relationships between cardiac deceleration and behaviors were for quieting and vocalizing in the 32-week old infants.

Cochran's Q-statistic (Winer, 1971) was used to test for differences in occurrence of each of these behavioral responses for groups and for ages on the various trial blocks. Graphic representations of frequency of occurrence of each of these responses may be found in figures 11 - 14. There was a significant effect of trial blocks (p < .05) for quieting in the phrase/list group at both ages (with no effects of stimulus order on any of the behavioral responses) and in the phrase/phrase group for 32-week olds, with the greatest amount of quieting in response to the stimulus occurring on TB 1. Orienting also occurred significantly more frequently on TB 1 for both the phrase/phrase and
### TABLE 13
**CORRELATIONS BETWEEN MAGNITUDE OF DECELERATION AND BEHAVIORAL OBSERVATIONS**

#### Mean Scores

<table>
<thead>
<tr>
<th>Behaviors</th>
<th>16-Week Old Ss</th>
<th>32-Week Old Ss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orienting</td>
<td>$r = +.14$</td>
<td>$r = -.004$</td>
</tr>
<tr>
<td>Quietting</td>
<td>$r = +.32$ #</td>
<td>$r = +.36$ #</td>
</tr>
<tr>
<td>Smiling</td>
<td>N/A</td>
<td>$r = +.31$</td>
</tr>
<tr>
<td>Vocalizing</td>
<td>$r = +.04$</td>
<td>$r = +.37$ #</td>
</tr>
</tbody>
</table>

#### Lowest Beat Scores

<table>
<thead>
<tr>
<th>Behaviors</th>
<th>16-Week Old Ss</th>
<th>32-Week Old Ss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orienting</td>
<td>$r = +.18$</td>
<td>$r = +.19$</td>
</tr>
<tr>
<td>Quietting</td>
<td>$r = +.24$</td>
<td>$r = +.41$ *</td>
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<tr>
<td>Smiling</td>
<td>N/A</td>
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<tr>
<td>Vocalizing</td>
<td>$r = -.06$</td>
<td>$r = +.57$ **</td>
</tr>
</tbody>
</table>

---

**p < .01**

* p < .05

# p < .10
FIGURE 11

BEHAVIORAL OBSERVATIONS - QUIETING

Phrase/Phrase and Phrase/List Groups
FIGURE 12
BEHAVIORAL OBSERVATIONS - ORIENTING
Phrase/Phrase and Phrase/List Groups
FIGURE 13

BEHAVIORAL OBSERVATIONS - VOCALIZATIONS

Phrase/Phrase and Phrase/List Groups
FIGURE 14

BEHAVIORAL OBSERVATIONS - SMILING

Phrase/Phrase and Phrase/List Groups - 32-week olds
the phrase/list groups of 32-week olds ($p < 0.025$) and tended toward significance for both groups of 16 week olds ($p < 0.10$). There were no significant effects for smiling or vocalizing for either group at either age; smiling never occurred in the 16-week olds. It should be noted that the frequencies of occurrence of all of the behaviors except for orienting were fairly low.
CHAPTER 4
DISCUSSION

The present study was undertaken to investigate the ability of 16-week and 32-week olds infants to discriminate between familiar and unfamiliar language, when the differences between them were only semantic (i.e., the differences between the stimuli were only in word/phrase meaning) as well as when both supra-segmental (i.e., the differences between the stimuli were in intonation, stress and rhythm) and semantic differences were present. The analyses focussed on cardiac deceleration and habituation to the initial stimulus, and especially, the effects of stimulus change on cardiac response.

Responses of 16-week old infants indicated an initial cardiac deceleration, although habituation did not occur with stimulus repetition. Similarly, Clifton and Meyers (1969) reported no evidence in 4 month old infants for habituation of cardiac response over a 15 trial presentation of either a continuous or pulsed tone. Kagan and Lewis (1965) also report no marked
change in degree of cardiac deceleration over trials for 6-month old infants presented with various auditory stimuli. Conversely, Berg (1972) has reported rapid habituation of a deceleratory cardiac response in 16-week old infants presented with pure tone stimuli of 10 seconds duration for 6 trials. Moffitt (1971) also reports habituation of cardiac response to synthetic speech stimuli by 20-24 week old infants. Both of these researchers also report cardiac decelerations of 10-15 beats per minute. Decelerations of the 16-week olds in this study were no larger than 5 beats per minute. Little research exists to support any speculations as to why differences in magnitude of deceleration or occurrence of cardiac habituation in young infants are found.

Scheibel and Scheibel (1964), Graham and Jackson (1970) and others have reported evidence that of the primary sensory areas of the human cortex, the auditory area is the least developed up to the age of 6 months. The stimuli used in this experiment were extremely short (1 - 2 seconds) as compared to those used in similar studies. Particularly notable is Moffitt's study (1971) where each of the synthetic speech stimuli was presented ten times (1 per second) for each trial.
Thus, the stimulation period where he found cardiac deceleration in 20 week old infants was 10 seconds in length, where stimuli were presented for only 1 - 2 seconds in this study. In this context, Berg, Berg & Graham (1971) have reported evidence that the magnitude of cardiac deceleration in 4-month old infants is a function of stimulus intensity. It is, thus, speculated that the failure to find cardiac decelerations as large as those reported in other studies, or cardiac habituation, may indicate a lack of arousal sufficient to evoke sustained attention to the auditory stimulus because of its relatively short duration and intensity. What is suggested, then, is that although the one second auditory episode did elicit attention by the young infant, it did not intrude to a degree large enough to sustain that attention or to manifest a concomitant habituation of HR response. As yet, however, there are no studies in which the effect of stimulus length as a factor in eliciting attention in infants, as indexed by cardiac deceleration, is investigated.

The 32-week olds infants in the phrase/phrase comparison group did manifest a clear deceleratory response to the initial language stimulus, with
habituation clearly present by trial block 4. The results of a trend analysis of the data for these infants suggests that the deceleratory cardiac response did reoccur on trial block 6. This trial block, where the deceleration was again in evidence, consists of the fourth, fifth and sixth presentation of the new stimulus; there was no discernibly different response to TB 5 (the first three presentation following stimulus change) than to TB 4 (the last presentation of the first stimulus). This result was unexpected and surprising as no similar findings of a lag between stimulus change and response to the changed stimulus have been previously reported. When re-examining some of the literature where data were available, however, results in one part of Kaplan's dissertation (1969), where comparison was between rising and falling terminal intonation contours in either stressed or unstressed phrases, suggests a similar phenomenon may be present. It is rather difficult to compare the results of Kaplan's study with the current one as procedure and analysis of cardiac response were considerably different. In her study, Kaplan used an increase of cardiac activity following stimulus change as the only prerequisite for discrimination, without regard for direction of change.
(Cardiac activity was measured in terms of deviation of scores from the first mean in each interval). She found a significant amount of change in cardiac activity at the change point in the 8-month olds, where the discrimination to be made was between rising and falling terminal contours in identical phrases read with normal stress patterns (See the cat v. See the cat?). She, therefore, concluded that these 8-month olds could discriminate between intonation patterns under such circumstances. The interesting comparison with this study comes with the 8-month olds in her study who were presented with similar phrases for discrimination where the phrases were unstressed, thereby making them somewhat more unusual than the stressed phrases. Her results indicated no change in cardiac activity at the point of stimulus change; however, a significant change in activity which was not discussed was found between the first and second presentation of the second stimulus. This may also be another instance of a lag in responding to stimulus change. The direction of change in cardiac activity is not noted.

It is suggested, then, that where there are situations which present very subtle differences between two stimuli, it may be only after several trials that the infant
"recognizes" that the stimulus has changed and responds to it as such. This type of situation would seem to be analagous to one in which music on the radio changes from one song to another without interruption; it may take several beats or longer to recognize that the song has changed, particularly if neither are especially familiar ones. And it would seem most likely that such a lag in language discrimination would occur at the time schemata or memory for spoken words have begun to develop but are not yet well articulated, just as a trained musician is better able than a layman to discriminate between two musical passages. It would seem, as well, that the older infants in this study are at a level of development where they would fit the degree of schema articulation suggested above as being present in situation where a lag between stimulus change and discrimination of language (detected by cardiac deceleration) is noted. By 32-weeks of age infants have entered a stage of intonated babbling and are thought to attend to segmental aspects of speech (Kaplan & Kaplan, 1971). Additionally, McCarthy (1954) reports that infants are thought to begin to attend to familiar words at about the age of 8 months; the age range for beginning speech is reported to be from 11 -
14 months. Thus, it is suggested that the 32-week old infants in this study were able to discriminate between the phrases composed of English and those composed of nonsense words, but only after several exposures to the second stimulus following stimulus change. It is felt that such a lag between stimulus change and response to the changed stimulus results from the subtlety of the stimulus change and the relative lack of articulation of the infant's schema for English speech and language. The schema is not so unarticulated that no attention is paid to the words which compose the phrase; neither is it so well articulated that a change in words without a concomitant change in some suprasegmental feature elicits immediate attention to the change.

The statistical analysis for the 32-week olds in the phrase/list group provided neither evidence for habituation nor dishabituation, although the response to the initial stimulus was a deceleratory one. Graphically, however, the cardiac responses of the 32-week olds in the phrase/list and list/phrase groups to stimulus presentation and change seem very different. Graphic evidence for this difference provides some basis for speculation about the differences between the groups.
Such a difference suggests that different phenomena may be occurring in the two different groups. As only four Ss were in each of the two groups, the following speculative hypotheses are advanced based on suggestive graphic evidence rather than statistically significant findings. The 32-week old infants in the phrase/list group did seem to respond as originally predicted. That is, there was graphic evidence of cardiac deceleration to the initial stimulus, habituation of the response by TB 4, and dishabituation on TB 5. Had there been a greater number of Ss, these differences might have been statistically significant ones. One may interpret this pattern of response as suggesting that these infants are, in fact, able to discriminate between these stimuli. This hypothesis is one deserving further study before either being accepted or rejected.

A different pattern of response appears graphically for those 32-week olds Ss who heard the nonsense list as the initial stimulus. For these Ss, magnitude of cardiac deceleration appears to increase over the first four TBs, and then decrease when the stimulus is changed. In this instance one may speculate that the nonsense list was so unlike anything that these infants had previously heard that it required a few presentations
of the stimulus before really capturing their attention; once their attention was gained, however, they remained attentive throughout the first four trial blocks. As habituation to this initial stimulus never seemed to occur in this group, it was theoretically impossible to use cardiac deceleration as an index of discrimination. In fact, the graphic evidence suggests that less attention was paid to the new stimulus (which was the English phrase) following stimulus change. One may interpret these response patterns as being indicative of a particular phenomenon which did not seem to appear in the data for the 16-week olds infants. Perhaps this is because the younger infants had less experience with language (and correspondingly less well-developed schemata for it) and thus did not find the nonsense list as unusual (or discrepant) as did the 32-week olds.

The above discussion of the role of schema development in the response of the 32-week olds to the two different orders of presentation of the English phrase/nonsense list stimuli is necessarily highly speculative. It is based on graphic evidence, rather than on statistically significant results. Consequently, this discussion should be viewed as a consideration of
potential areas for future study, rather than as an evaluation of hypotheses which are strongly supported by statistically significant results.
CHAPTER 5

IMPLICATIONS

The results of this study suggest both changes in the design of future studies of this type as well as directions for further research in this area. As previously mentioned, it is felt that the length of each stimulus presentation was too short to recruit and maintain maximum attention from these infants. Thus, a method such as that employed by Kaplan (1969) or Moffitt (1971) where the stimulus is repeated a number of times in succession might seem to be a more appropriate technique. A stimulus period of approximately ten seconds has been used by a number of researchers (e.g., Kaplan, Berg, Moffitt) and may prove more successful in initially recruiting attention. It should be noted, however, that most mothers do not seem to repeat what they have said to their infants. One wonders how similar a group of words repeated several times would be to the environment in which children learn language. The length of stimulus presentation would seem to be an important factor in evaluating the magnitude of cardiac deceleration. No research in this area has been found for infants of this age.
In addition to using cardiac response in measuring discrimination, the magnitude of response might also be used as an index of amount of interest or attention which the stimulus presentation evokes. Unfortunately there are presently no data regarding the relationship between different degrees of cardiac response to different stimuli within the same individual. Such an evaluation might begin first with adults who are able to subjectively report their reactions to stimuli of varying degrees of interest to them. If such a relationship is present, there are clearly implications for its use in understanding the developing breadth and sophistication of the child's schemata.

The use of behavioral observations in this study added little to the understanding of the infant's ability to discriminate between the various stimuli. Many of the infant's behavioral responses to the stimulus were fleeting and quite difficult to interpret by the observer. When engaged in a more extensive study, it would be helpful to have video-tape recordings of the entire experimental session, in an effort to better classify and understand the responses which the infant makes. In addition, the type and length of response might change with a longer period of stimulation.
The apparent time lag between stimulus change and renewed cardiac deceleration which is reported for the 32-week old infants in Group 1 is one of the most interesting findings of this study. Consequently, it is the kind of finding which needs to be replicated using similar stimuli and a larger group of infants of the same age. If such a phenomenon is replicated, it would seem to indicate that some previous studies which have reported no discrimination immediately upon stimulus change might have found such an effect were the second stimulus presented for a longer period of time. Learning and discovering the differences between the two stimuli with repeated stimulus presentation does seem to have taken place for the infants in this study. This phenomenon might also be indicative of a particular stage in the development of the infant's schemata, especially if the infant showed evidence of more immediate discrimination with additional experience (either through training or maturation) with the type of stimuli used. It may also be that such a lag would only appear where the infant could not control the rate of stimulus input or where the differences between the stimuli were fairly small. If the infant is able to inspect the stimulus (such as visually presented figures) for as long as he desires, it seem likely
that if he is able to detect a difference between the stimuli he will do so as soon as the stimulus is changed. Such a time lag phenomenon as reported here would seem more likely to occur when the stimulus is presented rather quickly and the differences in the stimuli are subtle ones. With short periods of presentation, the infant is able to attend to only one part of the stimulus on each presentation and it will therefore take him longer to detect subtle differences between the stimuli.

It will be remembered that the 32-week old infants in group 2b (that is, those who heard the nonsense list and then the English phrase) showed an unusual pattern of cardiac response. Although the magnitude of deceleration to the initial presentation of the stimulus was not large, it increased over the four trial blocks in which the nonsense list was presented. Magnitude of deceleration then decreased (although the decrease was not significant statistically) when the second stimulus was presented. This might be seen as evidence for a sort of reverse discrimination, where the cardiac response pattern is the opposite of that reported by Kagan (1971) and others. In this instance it would seem that the infants were responding to the word list as something new and unusual to them. When
the English phrase was presented to them, it might have been so ordinary and uninteresting that it was not capable of sustaining their attention. Although highly speculative, this explanation would suggest that these infants did, in fact, discriminate between the two stimuli and were responding to them in different ways. It would be important to replicate this sort of response pattern using unusual stimuli such as this nonsense list, as well as attempting to identify other stimuli where this type of pattern might exist. It would also be interesting to determine the number of trials over which the unusual stimulus must be presented before habituation occurs, as well as response to stimulus change when habituation (which did not occur here) is present. There appears to be a developmental pattern in response to the nonsense list among the infants in this study which might be indicative of cognitive growth in these children. It might be that the nonsense list for the 16-week olds was too strange to sustain attention and for the 32-week old Ss was the only really "optimally discrepant stimulus" presented.

As well as a means of measuring discrimination, indicative of schematic growth, in normal infants this technique might also be useful in the study of handicapped children who have both physical and language
disabilities. For these children, who are unable to communicate through meaningful written or spoken language, this paradigm for assessing attention and discrimination might be an especially appropriate one. It would be one method by which the cognitive development of these infants might be assessed in particular areas of visual or auditory experience. If particular areas of deficit could be pinpointed, as inferred by the inability of the infant to make discriminations as measured by physiological responses, training or added experience in the particular area might lead to added growth and development. This technique does seem to have potential in the assessment of cognitive development in infants and non-verbal individuals.
CHAPTER 6
SUMMARY AND CONCLUSIONS

This study attempted to determine the ability of 16-week and 32-week old female infants to discriminate between English and nonsense words, when the two stimuli were an English phrase and a nonsense--word phrase (the only differences between the stimuli were in the words used) and when the stimuli were an English phrase and a nonsense-word list (there were differences in intonation, stress and rhythm, as well as in the words used). The paradigm of habituation and dishabituation of cardiac response to stimulus change constituted the major response measure. Behavioral responses, specifically quieting, orienting, vocalizing and smiling, were also recorded and analyzed.

All infants responded with cardiac deceleration to the initial language stimulus; the deceleration response of the 16-week olds, and of the 32-week olds in the phrase/list group, did not habituate during the four trial blocks of the initial stimulus. Habituation was obtained in the phrase/phrase group of 32-week olds by
trial block four. The analysis of the behavioral responses added little to the understanding of stimulus discrimination as deduced from the pattern of cardiac response.

The 32-week olds in the phrase/phrase comparison group responded with dishabituation to stimulus change. This response did not appear immediately following stimulus change but occurred instead during the second trial block of the new stimulus. Although this evidence for dishabituation, after several trials of the second stimulus, is strong it is not unequivocal. It is suggested that this reported response lag results from a rather poorly developed schema for English language and speech and fairly subtle changes in the stimulus.

Of the infants in the phrase/list and list/phrase comparison groups, the 16-week olds responded with continued deceleration through trial block five. As the infants in this group continued a decelerative response over a longer period of time than the 16-week old infants in the phrase/phrase group, it is suggested that this comparison may have been sufficient to elicit and maintain a greater amount of attention. For the 32-week olds in the phrase/list group, there was graphic evidence of deceleration to the initial language stimulus
Graphic evidence for those 32-week olds infants in the list/phrase group suggests a different and rather unusual pattern of response to the stimuli. In this group, the deceleratory response to the initial language stimulus (the nonsense list) was rather small but increased in magnitude over the four trial blocks. The magnitude of deceleration seemed to decrease upon stimulus change. Because these infants did not seem to show cardiac response habituation by TB 4, it was not possible to find discrimination of the two stimuli, as measured by cardiac deceleration, on TB 5. It may be that these infants did, in fact, discriminate between the two stimuli, as magnitude of cardiac response appeared to change upon introduction of the second stimulus (the English phrase).

The paradigm of habituation and dishabituation of cardiac response seems an appropriate and useful one for studying the abilities of young infants to discriminate between auditory stimuli. Future research might focus on the effects of length of stimulus presentation, order effects in comparison between unusual stimuli and the occurrence of a lag between stimulus change and
response in those cases where there are very subtle
differences between the stimuli offered for
comparison.
APPENDIX A

Speech of Mothers to their Four Month Old Infants

**Infant # 1**  (Male, second born)

During feeding, mother to child:

Come on, pinkie.
Come on.
There you are, pinkie.
There you go.
Come on.

**Infant # 2**  (Female, second born)

During feeding, mother to child:

Here honey.
That's a girl.
Come on.
Come on, Kristie.
Come on, here's your fruit.
(with bottle)
That better?
That good? That ok?
That all you want, hmmm?
That's it! That's the bottom.
Infant # 3 (Female, first born)

During feeding, mother to child:

Is it good?
Ummm boy?
Wanna be mommy's helper, don't you?
Here.
Yeah.
That feel better?
That's a pretty smile.
What's the matter?
You happier now?
You hungry?
Look at the big girl.
You stinker!

Infant # 4 (Male, second born)

That's all right.
You little stinker. Yes you are.
What's the trouble?
It's not coming fast enough for you?
You sleepy? Hmm?
Oh. Just a minute
Those drips get under your fat little neck. Yes.
What?
Wake up.
Oh, I know.
We don't like being up today, do we?
You stinker you.
You're a stinker? Yes?
OK, I won't talk to you.
That's it bud.
Oh, just so comfortable.
You pick my flowers (mother was wearing flowered blouse)
Hmmm?
You see it but you're not sure what it is.
Infant # 5 (Male, second born)

During feeding, mother to child:

Come on.
You want this?
Know what this is?
Yes, you were hungry.
Hi.
There it goes.
You're a mess. You are so.
You can have more.
Hi.
Come on.
What's wrong.
There you go.
Is that okay?
Okay, I'll give you some more?
What's wrong?
Well, what's wrong?
You want to play.
You're heavy.
I don't think you're all that hungry right now.
Wait a minute. Oh, gosh.
Hi.

Infant # 6 (Female, first born)

During feeding, mother to child:

Let's see. Get the other hand up here.
Is that okay Alison?
You're getting better at it now.
Hold it by yourself.
You don't want to do that now.
Ah, there - almost.
Okay, ready for a scream?
Good girl; that was beautiful, Alison.
Hold on. Come on now, hold on.
You're doing good, too, Alison.
Is that it? No.
Is that it? Nope. Just a little more.
Okay, that's it kid. Let's have a good burp.
Get your hands away from your mouth.
That's a little one. You give me a big one?
I'll do that for you, honey. Okay?
Infant # 7 (Male, first born)

During feeding, mother to child:

Oh.
That a boy. Those are good.
Oh, isn't that good?
Hey there.
You look at those pretty girls?
Oh.
There are those yummy carrots again.
You'll be a big boy.
Oh. Here comes some more, don't worry.
What are you trying to say?
Are you trying to say more food?
Oh, Jonathan. Oh no, no.
Oh, what did we do? Oh, sweetie?
Oh is our boy starved? Is he starved?
Okay. One more. Is that okay?

Okay. Let's try some milk.
Here come the yummies.
Say we sure love our daddy.
What would we do without him?
Yeah, we play fingers until you're all finished.
Yeah, think you might like that, huh?
Those eyes; they look like they might be closing.
Yes, you just get very tired.
Not bad, huh?
Hi there. Hi there.
Have you had enough?
Oh. Are you full, huh?
Hi there. You like all this attention, don't you?
Infant #8 (Male, second born)

During feeding, mother to child:

Oh, Matthew.
Wanna try this?
Gonna show her your double dimples, huh?
Isn't this good? Oh, carrots are so good.
Don't think you're really too hung on this.
Hi, Matthew.
Isn't that good?
Ummm. Good carrots.
Hi. How are those?
Is that good? Do you like that?
Is that okay?
There you go. There you are.
How's that?
Such a chubby little rascal you are.
There you go.
How 'bout that?
Not so good. Yes.
Where you going? You gonna hop right out of that seat pretty soon, aren't you?
You just love your thumb don't you?
Yeah, say you would.
Well, really.
Okay, how's that?
See if you got a burp in there, Huh?
Got a burp, huh?
No burps.
Want some more?
Hi, how's that?
There it was, we got it.
Want some more?
Yeah, lot of dimples.
Hi, how are you?
Oh, my goodness.
Do you like that, do you?
There we go. Whatcha doing there?
Hi, is that better?
Such a big boy, aren't you?
Oh, boy. Say, "oh that's fun to stand up."
Yes it is.
Infant # 9 (Female, first born)

During feeding, mother to child:

We aren't crazy about that, huh?
That's cereal, yes.
MmmHmm.
Everybody watching you, huh?
What do you feel like eating? Hmm?
What about those, huh?
No. You're so big, yes.
Oh, what're you saying, huh?
Watcha saying?
You're saying, "give me the bananas."
You're doing good with the peas, though.
What? You tell me how each bit tastes.
I wish I knew what you were saying.
Yes.
But you're a good baby. Yes you are.
Aren't you getting full?
You're running out of food.
You like that, huh?
There, all done. That okay?
There we are.
Who is that?
You know somebody's watching you, huh?
You should be used to people watching you, hmm.
Say, "I want to play. I want to play with the people."
Yes. There we are. Yes.
Maybe we should go put our 'jamas on.
Maybe we should do that, hmm?
Yes, Yes.
Done?
We take a long time with our bottle.
Oh! Did somebody scare you?
Yeah.
Where you going? Oh, poor baby.
Yes, there you go.
Got any more?
# APPENDIX B

## BEHAVIORAL CHECKLIST

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## APPENDIX C

**CORRELATION BETWEEN PRE-STIMULUS LEVEL AND MAGNITUDE OF RESPONSE**

### Mean Scores

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### Lowest Beat Scores

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* *p < .05
*# *p < .10
BIBLIOGRAPHY


