PROSODIC MODIFICATIONS IN INFANT-DIRECTED SPEECH

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Abstract

The purpose of the present study was to compare three prosodic features of IDS with ADS using natural conversation. The three prosodic features examined were duration of stressed content words, duration of unstressed syllables, and rate of speech (both spoken and read). The first objective was to determine the proportion of the slower rate of speech of IDS as compared to ADS that was accounted for by the exaggerated final syllable lengthening in IDS. The second objective was to determine if read IDS is slower than spoken IDS. The third objective was to determine if unstressed function word syllables were shorter in duration than unstressed syllables in content words and if the durations of these unstressed syllables were comparable in IDS and ADS. Two mothers participated in the study. Two 45-minute audio recordings were made for each participant; the first recording session the mother was interacting with her preverbal infant and in the second recording session she was conversing with a familiar female friend.

The results showed that IDS was not significantly slower than ADS when the exaggeratedly lengthened final syllable was excluded from calculations of speech rate. This suggests that non-phrase-final content words are not lengthened in spontaneous IDS as compared to ADS. Previous studies showing lengthening of non-phrase-final content words in IDS as compared to ADS were done using read speech. In this study, speech was read at a slower rate than spontaneous speech, which suggests lengthening of non-phrase-final content words is perhaps an artefact of speech that is read to young children. Durations of unstressed syllables in content words were significantly longer than unstressed syllables in function words in both ADS and IDS. However, there was

considerable variability for both categories of words resulting in a large area of overlap. Apart from the robust finding of exaggerated utterance final syllable lengthening in IDS, these data showed that the other prosodic features examined were not exaggerated in IDS compared to ADS.

Table of Contents

List of Tables

List of Figures

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CHAPTER I

LITERATURE REVEIW

Introduction

Infant-directed speech (IDS) and adult-directed speech (ADS) differ in some of their prosodic features. In general, compared to utterances directed to adults, utterances directed to children include overall higher pitch, greater pitch range, longer between-utterance pauses, shorter length of utterance, and slower overall rate of speech (Fernald & Mazzie, 1991; Fernald & Simon, 1984; Fernald et al., 1989; Garnica, 1977; Grieser & Kuhl, 1988). Over the last 15 years, the role of prosody in providing the infant with acoustic cues to linguistic structure has been explored. The notion that there may be acoustic cues to syntactic structure in the speech stream that could provide language learners with useful bottom-up segmentation information is known as the "prosodic bootstrapping hypothesis" (Gerken, Jusczyk & Mandel, 1994; Kemler Nelson, Hirsh-Pasek, Jusczyk, & Wright Cassidy, 1989). According to the prosodic bootstrapping hypothesis novice language learners can derive rudimentary grammatical information from their perceptual analyses of speech input.

A constellation of prosodic cues marks both linguistic units, such as clauses and phrases, and grammatical categories, such as content or function words (Morgan, Shi, & Allopenna, 1996). In English, prosodic changes such as pausing, pitch changes, and vowel lengthening have been shown to occur at utterance boundaries and even at within-utterance phrase boundaries (Cooper & Paccia-Cooper, 1980). In English, compared to content words, many function words are phonologically reduced, having a minimal syllable complexity, and they are acoustically reduced, having a reduced vowel duration, amplitude, and pitch change (Shi, 1995). The terms content word and function word correspond roughly to the vocabulary classification of open class item and closed class item and at times are used synonymously. The former includes only free forms whereas the latter also encompasses bound forms (Garrett, 1982). A more thorough definition of content word and function word is discussed in a later section regarding vowel durations in function words.

The prosodic bootstrapping hypothesis obviously has both an acoustic component and a perceptual component. The acoustic component depends on evidence that characteristic prosodic features are consistently associated with syntactic boundaries. The perceptual component depends on evidence that prosodic cues influence perception of syntactic boundaries. Four major sources of indirect evidence are typically cited by advocates of the prosodic bootstrapping hypothesis. The first two sources of evidence, involving prosody-to-syntax mapping, are descriptive studies suggesting that characteristic prosodic features are consistently associated with syntactic boundaries in ADS (e.g. Cooper & Sorensen, 1981) and descriptive studies showing that prosodic cues to utterance boundaries are more exaggerated in IDS than in ADS (e.g. Fernald & Mazzie, 1991; Morgan, 1986). The second two sources of evidence, involving perceptual use of these cues, are experimental studies showing that prosodic cues influence adults' perception of syntactic boundaries (e.g. Morgan, Meier, & Newport, 1987) and developmental research suggesting that young infants are sensitive to prosody-syntax relations, even in unfamiliar languages (e.g. Hirsh-Pasek et al., 1987).

The indirect evidence for the prosodic bootstrapping hypothesis is of primary interest for the present investigation (Berstein Ratner, 1996; Fernald & Mazzie, 1991;

Fernald & Simon, 1984; Morgan, 1986; Swanson, Leonard & Gandour, 1992). Three main studies are typically cited as evidence that the prosodic cue of syllable lengthening at utterance and phrase boundaries is more exaggerated in IDS than ADS. Two of these studies involved carefully constructed prepared texts (Morgan, 1986; Swanson et al., 1992). Such materials were necessary because the designs of the studies involved comparing the durations of the same content words in phrase-final and phrase-non-final position in IDS and ADS. However, making conclusions about spontaneous speech based on findings from speech that is read warrants two caveats. First, studies of ADS have shown that read sentences are not necessarily representative of spontaneous conversation (Goldman-Eisler, 1972; Howell & Kadi-Hanifi, 1991). Second, the constructed sentences used in these studies are often longer and more complex than the very short utterances that typify speech directed to young children. The purpose of the present thesis is to compare three prosodic features in IDS and ADS using natural conversation as opposed to speech that is read. In addition, the natural speech samples gathered will include a portion of speech that is read, thereby enabling some comparisons to be made between spontaneous IDS and speech that is read to young children. The three prosodic features to be examined are duration of stressed content words, duration of unstressed syllables in spontaneous speech, and rate of speech (both spontaneous and read).

The studies often cited as evidence that prosodic cues to utterance and phrase boundaries are more exaggerated in IDS are discussed in the following section. Literature concerning rate of speech of IDS and ADS is then reviewed briefly. In the final section of the chapter, studies pertinent to the significance of the duration of unstressed syllables in IDS and ADS are discussed.

Vowel Lengthening in Content Words

Three prosodic cues to phrase boundaries have been noted: pausing, pitch changes, and vowel lengthening. The central topic of the present section of the chapter is vowel lengthening as a prosodic cue to utterance and phrase boundaries. In English, syllables that end utterances, clauses, and phrases tend to be lengthened relative to syllables elsewhere in utterances. Following is a review of the descriptive studies showing that the prosodic cue of syllable-final lengthening is more exaggerated in IDS than in ADS. First, the evidence of utterance-final or pre-pausal vowel lengthening in ADS is established. Second, the evidence of pre-pausal lengthening being exaggerated in IDS as compared to ADS is discussed. Third, studies finding exaggerated phrase-final lengthening in IDS compared to ADS are reviewed. Finally, studies suggesting that content words in general, regardless of phrasal position, are lengthened in IDS compared to ADS are discussed.

Pre-pausal Lengthening in Adult-directed Speech

In ADS the syllable at the end of a sentence is longer than it would be within an utterance (Klatt, 1976). This durational effect has been called "pre-pausal lengthening". Even when there is no physical pause present in the acoustic signal, pre-pausal lengthening has been observed at phrase and clause boundaries (Martin, 1970; Klatt, 1975). Martin (1970) showed that, in spontaneous speech, segments just prior to major constituent boundaries tend to be lengthened. Klatt (1975) measured the durations of all segments in a connected discourse that was read. He observed lengthening at the ends of noun phrases and at the end of conjoined or embedded clauses. Elongation of phrase final words has been noted cross-linguistically to be one of several prosodic cues to phrase boundary in ADS (Cooper & Paccia-Cooper, 1980).

Exaggerated Clause-final Lengthening in Infant-directed Speech

Bernstein Ratner (1986) found that when speaking to infants, mothers used more exaggerated vowel lengthening to mark clause boundaries than when speaking to adults. To examine whether this pre-boundary lengthening was exaggerated in mother-child speech, she recorded play sessions of mothers speaking to their children at three different stages of child language development, the preverbal stage, the one-word stage, and the two-word stage. Each mother was also recorded speaking to an adult (the examiner). Measurements of all nine vowels from a variety of monosyllabic words in clause-medial and clause-final position were made for each adult-adult and adult-child conversation.

The results showed that mothers significantly increased pre-boundary vowel lengthening when speaking to pre-verbal children (ages 9-13 months). In fact, the expected degree of clause-final lengthening in adult-adult speech was almost doubled in speech to pre-verbal children. The mean difference between vowel length in final, as opposed to medial position, was 52.16 ms for adult-adult speech; this differential increased to 100.74 ms for the adult-preverbal child sample. This exaggeration of lengthening became less pronounced in speech to children using single words, in which the clause-final vowels were only 15 ms longer than those observed in adult-adult speech (mean difference of 74.43 ms for child-directed speech versus 59.47 ms for adult-directed speech). Pre-pausal lengthening in speech to children at the two-word stage was much more similar to that observed in ADS (mean difference of 67.22 for child-directed speech and 59.57 for adult-directed speech). Bernstein Ratner concluded that increased pre-boundary lengthening was likely an exaggerated cue to syntactic boundaries, especially for the child who is on the verge of developing expressive language abilities.

Exaggerated utterance-final lengthening in infant-directed speech also extends to utterance-final unstressed syllables. Albin and Echols (1996) examined whether even unstressed word-final syllables were lengthened in utterance-final position in infant-directed versus adult-directed speech. Eight mothers of 6-month-old infants and eight mothers of 9-month-old infants participated in the study. Samples of infant-directed spontaneous speech involving a naming task were compared to samples of the mothers participating in a similar naming task with the examiner. There were significant main effects of addressee for the whole final word duration, the final syllable duration, and for the proportion of the final syllable in relation to the whole word duration. The duration of the utterance-final word was longer in IDS, and this effect was particularly pronounced for the final syllables. Unstressed final syllables accounted for a greater proportion of the duration of an utterance-final word in IDS than in ADS. Whether or not unstressed word-final syllables are also lengthened in IDS versus IDS when they are not in utterance-final position remains to be examined.

Phrase-final Lengthening in Infant-directed Speech

A study by Morgan (1986) investigated whether exaggerated lengthening extended to phrase-final words as well as clause-final words. Thirty-four mother-child dyads participated in the study; in half of the pairs the child was approximately two years old and in the other half, the child was four years old. Seven matched pairs of experimental sentences were constructed and embedded in a 450-word children's story. In one sentence in each experimental pair the target word occurred in phrase-final position (either at the end of an S, a VP, or an NP), whereas in the other sentence the same target word occurred in a phrase-non-final position.

Consistent with the findings reported by Cooper and Paccia-Cooper (1980), target word vowel durations were significantly longer when the words occurred in phrase-final position than when they occurred in phrase-non-final position. However, only three of the seven phrase-final target words showed exaggerated lengthening in IDS when compared with lengthening in ADS. The findings of Cooper and Paccia-Cooper (1980) may be consistent with the results of Bernstein Ratner's (1986) study. It is noteworthy that Morgan's (1986) investigation involved children age two and age four years. The exaggerated pre-pausal lengthening reported by Bernstein Ratner was only negligible for the children at the two-word stage of language development, which is the age of the younger children in Morgan's study. Morgan's study differs from the studies of Copper and Paccia-Cooper in two ways. Read speech rather than spontaneous speech, and phrase-final words versus clause-final words were investigated.

Lengthening of Content Words in Non-final Position

There are conflicting results in the studies reviewed above regarding the duration of phrase-non-final content words. Bernstein Ratner (1986) found no main effect of addressee for the duration of clause-medial stressed vowel durations. Durations of clause-medial vowels remained almost constant across all groups of child and adult listeners (durations ranging from approximately 102 to 119 ms). Morgan (1986), on the other hand, found consistent main effects of addressee with read speech: for all seven words, target word durations, regardless of phrasal position, were significantly longer in child-directed speech than adult-directed. He concluded that the slower speech rate evident in child-directed speech is due in part to lengthening of stressed vowels in content words.

An earlier study by Garnica (1977) also found exaggerated lengthening of medial content words in IDS compared to ADS but a different interpretation of the results was given. In her investigation Garnica measured six prosodic and paralinguistic features of IDS compared to ADS, one of which was duration of content words. Twelve mothers of 2-year-old children and twelve mothers of 5-year-old children participated in the study. The participants were given eight written instructions for solving a puzzle task. They were then recorded (verbally) giving these instructions to their child for the IDS condition and to the examiner for the ADS condition. Each of the eight prepared instructions contained a verb and a colour term. Six of the eight sentences were chosen for the comparison of average duration of content word syllables between the adult listener and child listener sessions.

The results of the study showed that the duration of verbs and colour terms were significantly longer in sentences spoken to the two-year-olds than the comparable sentences spoken to the adult listener. For the sentences spoken to the five-year-olds only the colour terms were significantly longer. The author did not conclude from these results that content words are lengthened in IDS regardless of phrasal position. Rather her interpretation supposed a functional reason for the significantly longer durations of one or both of the target content words. The adult was giving instructions for completing a puzzle task. In the speech to the 5-year-olds the durations of the colour terms could be viewed as a way to highlight contrastive stress. Elongating the duration of the word green in the instruction, "Push in the green piece," emphasized which colour piece to manipulate; the green piece was to be pushed in, rather than the red piece or the blue piece. Garnica had a similar explanation of the longer duration of both the verbs and colour terms in the speech to the 2-year-olds. She suggested that in this condition the verb received emphatic stress and the colour term carried contrastive stress. Simply stated, these were the two key words the two-year-old needed to understand to follow the instructions correctly. This study, like the study of Morgan (1986), involved a set of prepared instructions as opposed to spontaneous speech.

A more recent investigation by Swanson et al. (1992) with children at the holophrastic stage of language development (ages 1:6 –2:4) replicated Morgan's (1986) results that content words, regardless of phrasal position, are consistently lengthened in IDS as opposed to ADS. Fifteen mother-child dyads participated in their study. Similar to the Morgan study, this investigation used prepared text to be read by the mother to her infant and also to the examiner. A set of 90 sentences (24 sentence pairs involving content words plus 42 sentences containing function words) were embedded in five novel children's stories to be read over two, hour-long recording sessions. Phrase-final lengthening was observed for both adult-directed and child-directed speech. The increase in phrase-final lengthening in IDS was, on average, only 11.8 ms longer than phrase-final lengthening in ADS, which is consistent with the degree of exaggerated clause-final lengthening reported by Bernstein Ratner (1986) for this age group. Similar to Morgan, Swanson et al. observed overall longer durations for both medial and phrase-final content words in IDS compared to ADS. The results of their study showed that, on average, content-word durations in phrase-non-final position were 14.7 ms longer in child-directed than adult-directed speech whereas in phrase-final position they were 26.5 ms longer in child-directed than in adult-directed speech.

In contrast, in a study using spontaneous speech Bernstein Ratner (1985), found little observable difference in the durations of vowels in content words spoken to adult and child addressees. She recorded the speech of five mothers of children ranging in age from 17 months to 20 months. The mothers were recorded speaking to both their child and to the examiner. The mother-child and mother-examiner conversations were transcribed and analyzed to locate instances of monosyllabic words used by each woman to both her child and the examiner. The selection of such matched words were subject to contextual constraints. Approximately 430 words addressed to the children and 520 words addressed to the adult were analyzed, of which 60% were content words and 40% were function words in each sample. Importantly, there was little observable difference in the durations of either content or function words across addressee groups. Bernstein Ratner concluded that IDS was not characterized by generally lengthened vowel durations in either content words or function words, "although the shorter utterance length of mother-child speech might have predicted relatively longer segmental durations in this register" (Bernstein Ratner, 1985, pp. 259). The mothers in the study slowed their overall speech rate to their children almost 25% (from 184 wpm to 138 wpm). However, she noted that this "global rate adjustment did not translate directly into longer segmental durations" (Bernstein Ratner, 1985 pp. 262).

There seems to be conflicting results from these studies regarding whether or not medial content words are lengthened in IDS. The studies reporting overall lengthening of content words have been from investigations involving prepared read text and not spontaneous speech. The studies from investigations using spontaneous speech have not reported an overall lengthening of content words but rather similar infant-directed and adult-directed medial content word durations. It is possible the observed lengthening of phrase-non-final content words is an artefact of speech that is read to children.

Slower Rate of Infant-directed Speech

It is well documented that IDS is exemplified by short utterances, especially compared to adult-directed speech (Fernald & Simon, 1984; Fernald et al., 1989; Grieser & Kuhl, 1988). In a cross-linguistic study Fernald et al. (1989), measured 50 randomly selected utterances of IDS and 50 from ADS for five groups of 60 parents differing in terms of language. For all five languages the mean duration of utterances was significantly shorter for IDS than for ADS; for example, the mean utterance duration for the mothers speaking American English to their one-year child was 1345 ms while the mean utterance duration of their ADS was 2345 ms.

It is also often reported that IDS has a slower rate when compared with ADS (Broen, 1972; Drach, 1969; Fernald & Simon, 1984; Sachs, Brown, & Salerno, 1976). During speech production, the typical mean speaking rate for adults is between 3.7 and 6.5 syllables per second (Chermak & Schneiderman, 1986; Pindzola, Jenkinsm & Lokken, 1989; Smith, Wasowicz, & Preton, 1987). Slower and faster fluctuations within speakers are probably no greater than from 15% to 20% of the mean rate (Smith, Sugarman, & Long, 1983). (To say, "Jack be nimble, Jack be quick, Jack jumped over the candlestick" in four seconds would be a speaking rate of four syllables per second).

Sachs et al. (1976) compared the speech rate of five adults (three female and two male) telling a story based on a picture to a 22 month-old child and then to another adult. Two minutes of tape recorded speech were analysed. The rate of speech was calculated in words per minute. The mean rate of speech for the participants was 132 words/min for IDS and 169.6 words/min for ADS. Although IDS has longer between-utterance pauses than ADS, pauses were not excluded from the calculation of rate.

A later study by Fernald and Simon (1984) excluded pauses greater than 300ms from the calculation of speech rate. The study examined the prosodic characteristics of 24 German mothers speaking to their newborns. Mean rate of articulation was defined as the total number of syllables divided by the total speech time exclusive of pauses greater than 300 ms. Mean rate of articulation for a two-minute selection of an IDS sample and an ADS sample were calculated and compared. The mean articulation rate in syllables/second for IDS and ADS was 4.2 and 5.8 respectively.

The slower rate of IDS has been attributed by some researchers to the overall lengthening of stressed syllables in content words regardless of phrasal position (Albin & Echols, 1996; Bernstein Ratner, 1996; Morgan, 1986; Swanson et al., 1992). However, not all research has concluded that stressed vowels in phrase-non-final content words are lengthened in IDS as compared to ADS (Bernstein Ratner, 1984, 1985). In fact, the two most often cited studies supporting the claim that vowels in stressed content words overall are longer in IDS than in ADS involved speech that was read rather than spontaneous speech (Morgan, 1986; Swanson et al., 1992).

Another explanation for the slower rate of speech in IDS compared to ADS should be considered. Utterances are consistently shorter in IDS than in ADS (e.g. Fernald & Simon, 1984) and the final word is exaggeratedly lengthened in IDS compared to ADS (e.g. Bernstein Ratner, 1986); therefore it is possible that the slower rate of infant-directed speech is due in a large part to the disproportionately long final syllable and the occurrence of this syllable in utterances that are typically only a few syllables long. Indeed, it has been noted that any study concerned with the question of whether or not speaking rate changes with word lengthening should take final-syllable lengthening into account (Oller, 1973). To what extent is the slower rate of infant-directed speech accounted for by the exaggerated lengthening of the final word? If the final word were not included in the calculation of rate of speech how would the rate of IDS compare to the rate of ADS?

Since read material can be controlled it is widely used for assessing aspects of speech. Therefore, it is important to investigate the representativeness of read material as a measure of spontaneous speech. Howell and Kadi-Hanifi (1989) compared selected prosodic factors between read and spontaneous speech. The investigators had three participants give spontaneous verbal descriptions of a room of their choice. The descriptions on average lasted five minutes. The material was orthographically transcribed and three months later the same three participants read their own transcriptions and the transcriptions of the two other participants. Two of the prosodic features examined were rate of speech and pauses.

The mean speech rate, averaged over the three speakers, was 4.11 syllables per second for the spontaneous speech, 6.23 syllables per second for reading their own transcriptions, and 5.87 syllables per second for reading the transcriptions of other participants. These data showed reading rate in ADS to be faster than spontaneous speech. The authors noted that a contributing factor was the marked tendency for speakers during reading to drop many of the within-utterance pauses that appeared in spontaneous speech. Conversely, pauses were rare during reading. Some of the other prosodic properties the investigators examined included the position of primary stresses, the number of pauses, and the location of pauses. Howell and Kadi-Hanifi concluded that material that has been read cannot be regarded as representative of spontaneous speech.

If lengthening of medial content words is an artefact of speech read to children then it is predicted that, unlike adult-directed read speech, child-directed read speech should have an even slower rate than spontaneous IDS. However, Morgan (1986), when discussing the result that only three out of seven target words in his study exhibited the expected exaggerated phrase-final lengthening stated, "It is quite clear that the prosody of reading speech is not identical to that of spontaneous speech, though it is difficult to identify the exact differences. Several mothers seemed to read to their children at a faster rate (italics added) and with flatter intonation than they used in simply speaking to them. If this is the case, then only reduced versions of the prosodic exaggerations normally present in speech to children may have been examined here. Further examination of spontaneous speech is required to resolve this question" (Morgan, 1986 pp. 121). It appears that read ADS is faster than spontaneous speech and Morgan suggested it is for IDS as well. Is read speech to children faster or slower than spontaneous speech to children?

The final section of the chapter briefly discusses the work of three previously mentioned researchers, Bernstein Ratner (1984), Morgan (1986), and Swanson et al. (1992), in view of their studies involving the syllable duration of function words in IDS as compared to ADS. Another pertinent investigation by Shi (1995), regarding the duration of syllables in function words in IDS only, is also reviewed.

Vowel Durations in Function Words

The comparisons between IDS and ADS in terms of lengthening in utterance-final, clause-final, and phrase-final position discussed thus far have involved vowels in open class items. A major bifurcation in the lexicon of a language divides so-called open class items from closed class items. As the terms imply, new words can readily be added to the open class, whereas the closed class strongly resists the admission of new members. The terms content word and function word correspond roughly to the vocabulary classification of open class items and closed class items and sometimes are used synonymously. However, the former includes only free forms whereas the latter also encompasses bound forms, such as those for number, tense, and aspect (Garrett, 1982). Three major sources of empirical evidence are given as support of this division: patterns of language acquisition (Brown & Bellugi, 1964; Swanson et al., 1992), accounts of aphasia (Grodzinsky, 1984; Lapointe, 1983), and patterns of spontaneous speech errors (Garrett, 1982). Nevertheless, deriving distinct definitions for content words and function words proves challenging. There are certain elements that have ambiguous status.

The language acquisition literature concerned with the content-function word dichotomy has defined content words to include meaning-related open class words such as nouns, main verbs, adjectives, and adverbs. The definition given for function words has included auxiliary verbs, case or gender markers, complementizers, conjunctions, determiners, prepositions, sentence particles (e.g. question or imperative markers) and pro-forms (Bernstein Ratner, 1984; Kelly, 1992; Morgan, Shi, Allopenna, 1996; Shi, Werker, & Morgan, 1999). These authors point out that the inclusion of prepositions as function words is somewhat controversial. Although prepositions are closed class items, in English there are ways they are similar to open class items. For example, in X-bar theory, in addition to nouns, verbs, and adjectives, prepositions head phrases and similar to nouns, prepositions can be compounded (e.g. in behind, out of).

Certain adjectives, such as intensifiers and class inclusion items, and certain adverbs, such as degree words, are closed class items. The aphasia and spontaneous speech error literature have proposed a more specific restricted definition for content words including only open class items. The content word category outlined in the adult literature includes nouns, main verbs, adjectives (excluding intensifiers and adjectival quantifiers) and derived adverbs (Lapointe, 1983; Caplan, 1992). Therefore, in this body of literature the closed class items of intensifiers, and adjectival and adverbial quantifiers are considered function words, in addition to auxiliary verbs, case or gender markers, complementizers, conjunctions, determiners, prepositions, sentence particles (e.g. question or imperative markers) and pro-forms.

One of the first researchers of IDS to distinguish and separate out vowel durations according to the broad form classes of content words versus function words was Bernstein Ratner (1984). She looked at patterns of vowel modification in IDS compared to ADS, examining the speech of nine mothers to children at three different levels of language development, (preverbal, holophrastic, and combinatorial), and in addition, speech to an adult. From approximately 27 hours of mother-child and adult-adult interaction, she analysed the formant frequency and durations of vowels embedded in 2,406 words found in varying syntactic environments. The classification of function words included determiners, clause introducers, auxiliaries, modals, prepositions, pronouns, and wh-question markers. Most of the vowel durations for both monosyllabic content words and function words were not statistically significantly different across the four addressee conditions. There were two exceptions. The first exception was the high back cardinal vowel /u/ in function words in the speech addressed to the child at the combinatorial level. The vowel /u/ was approximately 50 ms longer in IDS than in ADS. The second exception involved three vowels in function words addressed to the preverbal child. The two low cardinal vowels /ae/ and /o/ each averaged approximately 25 ms longer than in ADS. Similar to the speech addressed to the child at the combinatorial level, the high back cardinal vowel /u/ also averaged approximately 50 ms longer in speech to the preverbal infant compared to ADS. Apart from these exceptions, she concluded that the durations of function word vowels do not seem to differ consistently as a function of addressee.

Morgan (1986), in a study of the prosodic encoding of structural information in input to children, did not systematically identify and measure the durations of vowels in function words. He did, however, measure a "few" (Morgan, 1986, p. 118) function word vowel durations in speech of mothers reading to their 2- and 4-year-old children and also to an adult. The particular function words selected for measurement were not listed. The measurements showed no difference in the length of such vowels depending on addressee.

A systematic investigation was conducted by Swanson et al. (1992). Seven function words (a, the, should, could, is, to, of) were written into a set of 42 sentences that were then embedded in five novel children's stories. All seven function words shared the acoustic characteristics of being monosyllabic, unstressed, and phonologically reduced. Fifteen mothers were recorded reading the stories to their child (age ranged from 1:6 – 2:4) and to the examiner. On average, function-word vowels were only 3.9 ms longer in child-directed than in adult-directed speech. Word-by-word analyses of variance showed no significant main effects for addressee for any of the seven function-word vowels used. The difference between function-word vowel durations in IDS and ADS was not significant.

To re-cap, in contrast to the findings of exaggerated lengthening of content words in clause-final and some phrase-final positions, for the most part, the duration of function word vowels was not lengthened in IDS as compared to ADS (Berstein Ratner, 1984; Morgan, 1986; Swanson et al., 1992). It has been hypothesized by some researchers (who espouse the "prosodic bootstrapping hypothesis") that the disproportionate lengthening of content words versus function words could potentially allow the child to use vowel durations within words to identify form class membership (Bernstein Ratner, 1996; Morgan, 1986).

In a later study, Shi (1995) tested the hypothesis that the form of function words, as opposed to content words, is universally reduced in the speech stream. She hypothesised that the manifestation of the reduced form would vary with respect to specific languages. The investigation looked at three typographically different languages, English, Mandarin Chinese, and Turkish. For each of the three languages, distributional, phonological, and acoustic characteristics of function words and content words were analysed in order to determine whether these properties in combination would reliably predict the two classes of words.

Each of two English-speaking mothers was recorded interacting with her 12-month-old infant for 40 minutes. Both infants were at the preverbal stage of language development. For each participant, 100 content words and 100 function words were randomly chosen for analysis. The total number of content words analysed was 200, of which 143 were monosyllabic and 57 were disyllabic. The total number of function words analysed was also 200, of which 192 were monosyllabic and 8 were disyllabic. Average vowel durations were calculated from the durations of the stressed and unstressed syllable for disyllabic words. For Participant 1, the mean vowel duration was 178.32 ms for content words and 93.37 for function word vowels. However, the standard deviation was approximately 120 ms for content words and 60 ms for function words. The vowel duration results of Participant 2 were similar to those for Participant 1. The mean duration was 134.83 ms for content words (standard deviation of approximately 85 ms) and mean duration was 91.13 ms for function words (standard deviation of approximately 80 ms).

The large degree of variability resulted in a sizeable degree of overlap between the durations of syllables from content words versus the same from syllables from function words. Such variability was expected because the data were randomly chosen from natural speech, with no control for factors such as position of a word in an utterance, number of words in an utterance, or speech rate. Due to the large degree of overlap, duration alone cannot be sufficient as a cue for separating the two classes of words. However, a multivariate discriminant analysis and unsupervised self-organizing neural network model were used to support the conclusion that vowel duration in combination with distributional, phonological, and other acoustic properties could yield classifications of words into content and function categories with accuracies ranging from 83 to 91 percent.

In most studies cited, vowel length in content words has referred to stressed syllables and the vowel length in function words has referred to unstressed monosyllables (Berstein Ratner, 1984, 1985, 1986; Garnica, 1977; Morgan, 1986; Swanson et al., 1992). The only exception to this is the work of Shi (1995), in which both disyllabic content and function words were measured, although vowel length over the stressed and unstressed syllables was averaged. To determine whether vowel duration is sufficient to provide a helpful acoustic cue to the form class membership of individual words then the strength of the cue should hold when considering the duration of unstressed syllables in content words with the duration of unstressed function word syllables. Are unstressed syllables in function words shorter than unstressed syllables in content words? If there is a durational difference between the two types of unstressed syllables is the difference exaggerated in IDS as compared to ADS?

Considerations in Comparing Unstressed Content-word Syllables with Unstressed Function-word Syllables

Typically, monosyllabic content words are stressed syllables whereas monosyllabic function words are unstressed syllables. Unstressed syllables in content words are not actual words on their own but rather they occur in multi-syllabic content words. In contrast, unstressed syllables in function words are very often unstressed monosyllabic words such as determiners, prepositions, auxiliaries, modals, conjunctions, and pronouns. In order to compare unstressed syllables in content words with unstressed function word syllables it is necessary to identify and measure unstressed or reduced syllables that are not actual words on their own but rather syllables that occur in multi-syllabic content words or to compare disyllabic content and function words. Therefore, comparing an unstressed function-word syllable with an unstressed content-word syllable will involve comparing a monosyllabic word with a syllable that is part of a word.

Comparing the duration of an unstressed monosyllabic word (function syllable) with the duration of an unstressed syllable that is part of a word (content syllable) raises three issues. The first issue concerns the validity of comparing a syllable that is a word with a syllable that is part of a word. The second issue is similar and concerns comparing a syllable that is preceded and followed by a word or syntactic boundary with a syllable that is preceded by a syllable or morpheme boundary. The third issue involves considering the inter-stress interval in which the unstressed syllables occur. Each of these concerns is addressed individually in the following section.

Infants' Speech Processing

There is considerable evidence from research on infant speech processing that the syllable is a unit processed and represented by very young infants. This suggests that comparing the duration of a syllable that is an independent word with a syllable that is a part of a word in IDS is a reasonable proposition. Bertoncini and Mehler (1981) investigated the role of the syllable in the processing of speech of very young infants. Using an habituation-dishabituation paradigm, infants less than 2 months of age were presented with three kinds of stimuli: syllabic (CVC), non-syllabic (CCC), and the non-syllabic sequence imbedded in a syllabic-synthetic (VCCCV). The infants were better able to discriminate change in the syllable-like stimuli than in the non-syllable like stimuli even though the physical change from the habituation to the non-habituation stimuli was always the same. The results showed that infants can process units like the syllable at a very early age and provide evidence that the syllable is the natural speech-processing unit.

More recent studies have confirmed that syllables are a unit processed and represented by very young infants. Bijeljac-Babic, Bertoncini, and Mehler (1993) assessed 4-day old French infants' ability to discriminate between bi-syllabic CV sequences such as "baku or rifo" and tri-syllabic ones such as "mazopu or rekivu". Infants were habituated to either a list of bi-syllabic or tri-syllabic items. In the post-shift phase infants in the control condition heard a list with the same number of syllables as the list heard in the habituation phase, whereas infants in the experimental condition heard a list that differed from the list heard in the habituation phase in terms of the number of syllables. The infants in the experimental condition discriminated the change in syllable number. The investigators used a speech compression/extension algorithm to prove that the infants' discrimination performance was not due to the durational differences between the sets of stimuli. The infants behaved as if they had represented the number of CVs per item. The researchers concluded that neonates may be sensitive to the number of syllabic components.

A study carried out by Bertocini, Floccia, Nazzi, and Mehler (1995) demonstrated that infants were not similarly sensitive to the number of moras. Bertocini et al. used the same experimental design as above (Bijeljac-Babic et al., 1993) to assess 3-day old French infants' ability to discriminate between bi-moraic bi-syllabic items and tri-moraic syllabic items. Infants in this experiment failed to react to a change in the number of moras during the post-shift phase. The authors proposed that for infants the bi-moraic bi-syllables were represented like the tri-moraic bi-syllables. The crucial unit of representation for the neonate was possibly number of syllables.

A later study by van Ooyen, Bertoncini, Sansavini, and Mehler (1997) provides further evidence that the syllabic unit is what predominately counts for newborns. Using the non-nutritive high-amplitude sucking paradigm the authors examined the role of weak syllables in neonate perceptual representation. Twenty 2-day old French infants were tested on their ability to discriminate various stressed vowels versus reduced vowel schwa in natural, isolated English words. Unlike earlier experiments that have used simple CV sequences, phonetically highly varied words were used. The first condition tested infants' ability to discriminate a list of monosyllabic words containing one strong vowel (e.g. nose, dream, etc.) versus bi-syllabic words with a weak-strong stress pattern (e.g. belief, control, etc.). The second condition tested infants' ability to discriminate a list of words with a weak-strong stress pattern (e.g. belief, suspense, etc.) versus words with a strong-strong stress pattern (e.g. volume, rhubarb, etc.).

The results of the first condition showed that neonates reliably distinguished weak-strong (two-syllable) words from strong (monosyllabic) words. The results of the second condition showed that the infants did not apparently detect a change between words with a weak-strong stress pattern and words with a strong-strong stress pattern. The authors interpreted these findings as indicating that for neonates a weak, reduced vowel was equivalent to a strong, full vowel. For the infants both types of vowels counted as syllabic nuclei. The neonate's representation of syllables containing a vocalic nucleus extended even to reduced vowels. While the neonate could attend to weak vowel information, the difference between weak and strong vowel information was apparently not noticed.

Infants' ability to discriminate between weak and strong vowel information has developed by 9 months of age. In an investigation by Jusczky, Cutler, and Redanz (1993), American infants showed a sensitivity to stressed and unstressed syllables by 9 months of age. In fact, by 9 months of age the infants actually showed a preference for the strong-weak stress pattern characteristic of English words. In the experiment, 9-month-old infants listened significantly longer to words with a strong-weak stress pattern than to words with a weak-strong stress pattern. This preference was not demonstrated by the 6-month old infants in the experiment.

The alteration between consonant and vowel is an essential part of the structure of words of all natural languages (Chomsky & Halle, 1968; Newman & Gerstman, 1952). Words consisting of three consonant sequences (CCC) structure are very rare (Bertoncini & Mehler, 1981). Evidence supports the special status of the syllable as a primary unit for speech processing of infants. Based on these findings it was deemed reasonable to investigate unstressed syllable durations in IDS as compared to ADS even though the content syllables were part of multi-syllabic words and the function syllables were primarily monosyllabic words.

Comparison of Morpheme Boundaries with Word and Syntactic Boundaries

A second issue to be discussed concerns comparing a syllable that is preceded and followed by a word or syntactic boundary with a syllable that is preceded by a syllable or morpheme boundary. A study by Lehiste (1972) provides evidence that a morpheme boundary and syntactic boundary are temporally indistinguishable. Lehiste looked at the effect of morphological and syntactic boundaries on the temporal structure of spoken utterances. She measured the length of three sets of words consisting of a monosyllabic base form (speed), and then disyllabic (speeding) and tri-syllabic (speediness) words derived from the base by the addition of suffixes. These syllable durations were compared with durational measurements of the same monosyllabic base form within three short sentences (e.g. The speed increased.) in which the base form was followed by a syntactic boundary.

Lehiste hypothesised that syntactic boundaries and word boundaries would have temporal effects distinct from those of morpheme boundaries; however, the effects of morpheme boundaries and the effects of syntactic boundaries could not be separated from each other on the basis of duration. Even when syllables shared the same phonemic structure, the syllable durations of di-syllabic words consisting of the base plus suffix (shad-ing) were indistinguishable from those of di-syllabic sequences taken from sentences in which the base word was followed by an unstressed syllable over a syntactic boundary (the shade in-creased).

The number of syllables rather than the number of segments or the presence of boundaries determined the durational structure of an utterance. For example, in a two-syllable sentence like speed kills, syllable durations were similar to di-syllabic bimorphemic words such as speedy. There was an absence of any clear differences between the effects of morpheme boundaries and syntactic or word boundaries. Rather, the temporal structure of an utterance depended most on its syllabic structure. A sentence like the speed increased resembled most words like speediness, with an unstressed short syllable followed by a relatively long syllable. Based on these findings it was deemed reasonable to measure and compare unstressed syllables from multisyllabic content words preceded by syllable or morpheme boundaries with unstressed monosyllabic function words preceded by word or syntactic boundaries.

Isochronous Inter-stressed Pulse in English

In different languages different elements appear to recur at regular intervals, thereby establishing a temporal organization. In English, stresses appear to recur at somewhat regular intervals. Utterances may be considered as being divided by the isochronous pulse into groups of approximately even length. Each group starts with a stress and contains everything that follows that stress up to, but not including, the next stress. Specifically, it has been shown that the duration of inter-stress intervals in English is directly proportional to the number of syllables in the interval (Bolinger, 1965). Conversely, the quantity or duration of any syllable is a proportion of the total length of the interval within which the syllable occurs, and its duration is relative to the quantity of any other syllable in the interval (Abercrombie, 1964). Therefore, the duration of inter-stress intervals is affected by the number of syllables they contain and in turn the number of syllables in a given inter-stress interval has an effect on the duration of each syllable. In other words, the number of syllables in a given inter-stress interval has an effect on both the overall duration of the inter-stress interval and the duration of each syllable within that inter-stress interval. Therefore the number of syllables in an inter-stress interval is an important factor to consider when measuring and comparing the durations of unstressed syllables.

Summary and Hypotheses

The following section contains key findings of the studies reviewed are summarized and the list of hypotheses that have been generated for the present study.

IDS versus ADS Difference in Utterance-final Syllable Duration

In the 1970s, there was a considerable amount of research on the durations of speech segments as well as the durations and positions of pauses in ADS. In studies using both spontaneous speech (e.g. Martin, 1970) and read text (e.g. Klatt, 1975) a consistent finding was that segments occurring just prior to major grammatical constituent boundaries tend to be lengthened. Later studies compared the lengthening in ADS with the lengthening in IDS. A consistent finding from these studies, using both spontaneous speech (e.g. Bernstein Ratner, 1985) and read text (e.g. Morgan, 1986; Swanson et al., 1992), was a significant exaggeration of utterance-final or pre-pausal lengthening in IDS compared to ADS. Attempting to replicate this finding, in the present study the following null and alternate hypotheses are proposed.

Null Hypothesis 1. The utterance-final syllable duration in IDS is not significantly different from the utterance-final syllable duration in ADS.

Alternative Hypothesis 1. The utterance-final syllable duration in IDS is greater than the utterance-final syllable duration in ADS.

IDS versus ADS Difference in Rate of Speech

Another consistent finding from research comparing prosodic features of IDS with ADS was an overall slower rate of speech in IDS (Broen, 1972; Drach, 1969; Fernald & Simon, 1984; Sachs, Brown, & Salerno, 1976). For example, a study by Fernald and Simon (1984) calculated and compared the mean rate of articulation for a two-minute selection of IDS and ADS of 24 German-speaking mothers. Mean rate of articulation was defined as the total number of syllables divided by the total speech time exclusive of pauses greater than 300 ms. The mean articulation rates for IDS and ADS were 4.2 and 5.8 syllables/second respectively. Attempting to replicate this finding in English, in the present study the following null and alternate hypotheses are proposed.

Null Hypothesis 2. The rate of speech in IDS is not significantly different than the rate of speech in ADS.

Alternative Hypothesis 2. The rate of speech in IDS is slower than the rate of speech in ADS.

IDS versus ADS Difference in Speech Rate when Utterance-final Syllable is Excluded

The slower rate of IDS has been attributed by some researchers to the overall lengthening of stressed syllables in content words regardless of phrasal position (Albin & Echols, 1996; Bernstein Ratner, 1996; Morgan, 1986; Swanson et al., 1992). However, not all research has concluded that stressed vowels in phrase-non-final content words are lengthened in IDS as compared to ADS (Bernstein Ratner, 1984, 1985). In fact, the two most often cited studies supporting the claim that vowels in stressed content words are longer in IDS than in ADS involved speech that was read rather than spontaneous speech. Another explanation for the slower rate of speech in IDS compared to ADS should be considered. Utterances are consistently shorter in IDS than in ADS (e.g. Fernald & Simon, 1984) and the utterance-final word is exaggeratedly lengthened in IDS compared to ADS (e.g. Bernstein Ratner, 1986); therefore it is possible that the slower rate of IDS is due in large part to disproportionately long final syllables and the occurrence of these syllables in utterances that are typically only a few syllables long. Indeed, it has been noted that any study concerned with the question of whether or not speaking rate changes with word lengthening should take utterance-final syllable lengthening into account (Oller, 1973). To what extent is the slower rate of IDS accounted for by the exaggerated lengthening of the utterance-final word? If the utterance-final word were not included in a calculation of rate of speech how would the rate of IDS compare to the rate of ADS? In the present study the following null and alternative hypotheses are proposed.

Null Hypothesis 3. When the final syllable is excluded from the calculation of rate, the rate of speech of IDS and ADS will not be significantly different.

Alternative Hypothesis 3. When the final syllable is excluded from the calculation of rate, the rate of IDS will still be significantly slower than the rate of ADS.

Read versus Spontaneous Speech Rate in IDS

There were conflicting results from the studies reviewed as to whether or not utterance-medial content words are lengthened in IDS. The studies reporting overall lengthening of content words were from investigations involving prepared read text and not spontaneous speech (e.g. Morgan, 1986; Swanson et al., 1992). The studies from investigations using spontaneous speech did not report an overall lengthening of content words but rather similar utterance-medial content word durations in IDS and ADS (e.g. Bernstein Ratner, 1985). If the lengthening of phrase-non-final content words observed in speech that is read to children is not observed in spontaneous speech, then it is possible that speech read to infants has a slower rate than spontaneous IDS. In the present study the following null and alternative hypotheses are proposed.

Null Hypothesis 4. The rate of speech read to infants does not differ significantly from the rate of spontaneous IDS.

Alternative Hypothesis 4. Speech is read to infants at a slower rate than spontaneous IDS.

Duration of Unstressed Syllables in Function versus Content Words in IDS and ADS

In addition to the prosodic cues to utterance and phrase boundaries being exaggerated in IDS, the prosodic bootstrapping hypothesis suggests that the speech stream also contains information sufficient for the naive language learner to assign individual words to two major grammatical categories, which closely correspond to content words and function words (Morgan et al., 1996). The bootstrapping information in the speech stream consists of a constellation of overlapping, partially predictive cues, one of which is vowel duration. In English, many function words, in contrast to content words, are phonologically reduced, having a minimal syllable complexity, and many are also acoustically reduced, having a reduced vowel duration, amplitude, and pitch change (Shi, 1994). Many function words are shorter than content words in both IDS and ADS (e.g. Shi et al., 1998; Swanson et al., 1992). However, in all of the studies reviewed in this chapter, the vowel length in content words always referred to stressed syllables and the vowel length in function words always referred to unstressed syllables. The only exception to this was the work of Shi (1994), in which both disyllabic content and function words were measured; however, an average vowel length over the stressed and unstressed syllables was calculated. To determine whether vowel duration may provide a helpful acoustic cue to the form class membership of individual words it is important to compare durations of unstressed syllables in content words with durations of unstressed function word syllables. Are unstressed syllables in function words shorter than unstressed syllables in content words? If there is a durational difference between the two types of unstressed syllables then is the difference exaggerated in IDS as compared to ADS? In the present study the following null and alternative hypotheses are proposed.

Null Hypothesis 5. In ADS unstressed syllables in function words are not significantly shorter than unstressed syllables in content words.

Alternative Hypothesis 5. In ADS unstressed syllables in function words are significantly shorter than unstressed syllables in content words.

Null Hypothesis 6. In IDS unstressed syllables in function words are not significantly shorter than unstressed syllables in content words.

Alternative Hypothesis 6. In IDS unstressed syllables in function words are significantly shorter than unstressed syllables in content words.

Null Hypothesis 7. The durations of unstressed syllables in function words in IDS are not significantly different from those in ADS.

Alternative Hypothesis 7. The durations of unstressed syllables in function words in IDS are significantly longer than those in ADS.

Null Hypothesis 8. The durations of unstressed syllables in content words in IDS are not significantly different from those in ADS.

Alternative Hypothesis 8. The durations of unstressed syllables in content words in IDS are significantly longer than those in ADS.

CHAPTER II

METHODS

Objectives

The first objective of the present study was to determine the extend to which the slower rate of speech in IDS as compared to ADS is a result of the exaggerated utterance-final syllable lengthening in IDS. The second objective was to determine whether read IDS is slower than spontaneous IDS. The third objective was to determine whether unstressed syllables in function words are shorter in duration than unstressed syllables in content words and whether the durations of these unstressed syllables are comparable in IDS and ADS. The study was designed using natural conversations to examine these prosodic features of IDS and ADS empirically. The following sections describe the study.

Study Design

Two mothers participated in the study. Two 45-minute audio recordings were made for each participant; in the first recording session the mother was interacting with her preverbal infant and in the second recording session she was conversing with a familiar female friend. The following sections describe in detail the participants, recording procedures, transcription procedures, data selection procedure, stress analysis, measurement procedure, measurement reliability, and procedures for the calculation of speech rates.

Participants

Two monolingual English-speaking mothers served as participants. Both mothers were between the ages of 30 to 35 and were the primary caregivers of their children. The mothers were both white middle-class speakers of standard Canadian English. Both mothers had children who were at the preverbal stage of language development, one aged 8 ½ months and one aged 11 months. The infants were both male and had no siblings. Both mothers had friends who agreed to participate in recorded conversations. The friends were native speakers of standard Canadian English and were female peers of the mothers.

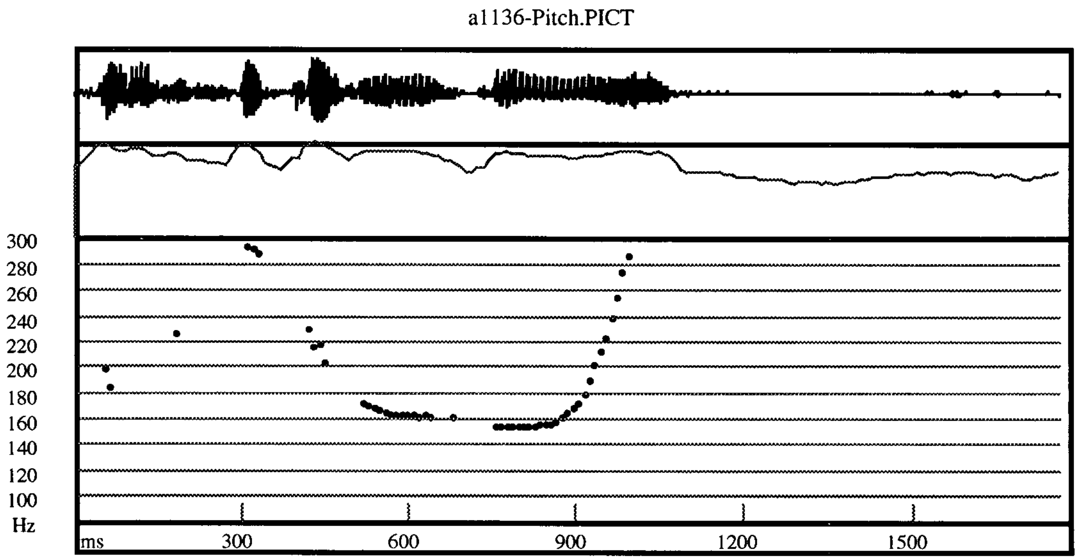
Recording Procedure

Each participant participated in two 45-minute recording sessions. The first recording session involved the participant and her child. The second session involved the participant and an adult female friend. The recording sessions with the mother-child dyads were made an hour after the infant had awoken in an attempt to ensure that the infant as alert but well rested. The sessions were held in the homes of the participants in an attempt to record as natural an interaction as possible. Because one objective of the study was to compare rate of speech for spontaneous utterances with speech rate for read utterances, the investigator brought some quiet toys to the session and two or three children's books. Each mother was instructed to interact with her child as naturally as possible. Each was also asked to read the books to her child when it seemed appropriate. The recording sessions with the adult female friend were held at the home of the friend without any children present. The participants were instructed to have a natural conversation and, at some point, to read the same children's books that they had read to their child. They were asked to read the book as they might to an adult, for example, as if they were considering purchasing it for a child. For all four recordings the investigator was nearby but not in the same room.

Audio recordings were made on a Marantz tape recorder model number PMD420, using a VHF wireless receiver and transmitter, and a Lavalier microphone. The microphone was clipped to the mother's collar. The transmitter was small enough to be put into her pocket. These procedures and the recording environment made it possible to obtain high-quality recordings while allowing the mother and child to move around easily.

Transcription Procedures

From the four audiotapes, the primary investigator made orthographic transcriptions of each utterance spoken by the mothers. An utterance was defined acoustically, rather than linguistically, as a section of speech bounded by pauses greater than 300 ms. (Jaffe & Feldstein, 1970; Fernald & Simon, 1984). Utterances were coded as spontaneous or read. In addition, utterances were coded as statements or questions. Utterances were coded as questions if they had a question syntactic form or a statement syntactic form spoken with a rising intonation. Figure 1 shows an example of an utterance spoken with a rising intonation.



“That’s ag ood li ttle g uy.”

Figure 1. Utterance spoken with a rising intonation. The top tracing is the speech time waveform. The middle tracing is intensity and the bottom tracing is pitch.

A second listener with extensive experience in phonetic transcription listened to the audiotapes with the transcripts to assess the reliability of the transcripts. Because the mothers’ speech was being only orthographically transcribed, accuracy was over 99%, with only four out of a total of 413 utterances identified differently by the two listeners.

Data Selection Procedure

In order to examine the effect of exaggerated utterance-final syllable lengthening in IDS on rate of speech, utterances ending in a stressed syllable were of primary interest. Also of interest were unstressed content-word and function-word syllables that were in comparable utterance positions. It was decided to measure and compare penultimate unstressed syllables. Therefore, from the orthographic transcripts, utterances that ended with an unstressed syllable followed by a stressed monosyllabic content word were identified and coded. This weak-strong stress pattern occurred in three different conditions, one including a function word and two not including a function word. The first condition (Condition 1: Fun/Con) involved an unstressed function word followed by a stressed monosyllabic content word [1](e.g. in BED, the CAR, with MOM, etc.). The second condition (Condition 2: Con/Con T) involved an unstressed word-final syllable of a content word followed by a stressed monosyllabic content word (li-ttle BOY, identi-fy THINGS, o-ther NIGHT, etc.). The third condition (Condition 3: ConCon I) involved utterances ending with an iambic content word (e.g. ba-LLOON, ex-PLORE, etc.).

A total of 413 utterances ending in a weak-strong stress pattern were identified and included in the analysis. In addition, 13 utterances of read speech ending in a monosyllabic content word were identified and coded even though they did not end with a weak-strong stress pattern but rather with a secondary-strong stress pattern (Condition 4: ReadCon). They were used in the speech rate component of the analysis because the final syllables of the utterances were stressed monosyllabic content words (e.g. in the GREAT GREEN ROOM, there was a YOUNG MOUSE). Following is a breakdown of the number of utterances per participant, addressee, and condition.

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[1] Capitalization indicates the stressed syllable.

Table 1. A breakdown of the number of utterances per participant, addressee, and condition.

Participant	Addressee	Total # of Utterances in 45 min.	# of Utterances Identified and coded	Fun/Con e.g. in BED	Con/ConT e.g. ha-ppy BOY	ConCon I e.g. ma-CHINE	Read/Con e.g. GREEN ROOM
1	IDS	480	94 spoken	53 spoken	34 spoken	7 spoken	Na
			22 read				
			116 Total	15 read	4 read	3 read	1 read
1	ADS	430	75 spoken	37 spoken	25 spoken	13 spoken	Na
			16 read				
			91 Total	11 read	4 read	1 read	0 read
2	IDS	470	91 spoken	52 spoken	27 spoken	12 spoken	Na
			20 read				
			111 Total	7 read	6 read	3 read	7 read
2	ADS	386	79 spoken	44 spoken	22 spoken	13 spoken	Na
			16 read				
			95 Total	9 read	4 read	3 read	5 read

The following closed class categories were considered function words in this study: determiners, prepositions, auxiliaries, modals, complementizers, pronouns, and conjunctions. A full list of the function words is presented in Appendix A and B.

Stress Analysis

The number of syllables in a given inter-stress interval has an effect on both the overall duration of the inter-stress interval and the duration of each syllable within that inter-stress interval. Therefore the number of syllables in an inter-stress interval was an important factor to consider when measuring and comparing the durations of unstressed syllables. As previously stated, an inter-stress interval starts with a stress and contains everything that follows that stress up to, but not including, the next stress. The final stressed syllable in all selected utterances was considered to be in the final stressed interval. The penultimate unstressed syllable was considered to belong to the penultimate inter-stress interval. It was necessary to establish the stressed syllable on which the penultimate inter-stress interval began in order to know how many syllables that inter-stress interval contained. Three different patterns were observed. The penultimate inter-stress syllable could be followed by one unstressed syllable (e.g. PULL the WEEDS, LIving ROOM, etc.), two unstressed syllables (e.g. COUple of BOOKS, SLEPT through the NIGHT, etc.), or three unstressed syllables (e.g. BEing in the CRIB, PUT it in your MOUTH, etc.).

Before analysing the final two inter-stress intervals for the selected utterances some decisions had to be made. An acoustic definition of stress has been notoriously elusive (Hayes, 1985; Lehiste, 1970). For the purposes of the present study stress was conceived as the relative prominence or emphasis placed on syllables in words or phrases. Such prominence could be phonetically signalled in a variety of ways. Typically, phonetic cues for stress include duration, pitch, amplitude, and vowel quality. Different languages use different combinations of these cues to indicate stress. English makes use of all four of these cues such that a stressed syllable is distinguished by one or more of the following: greater duration; higher fundamental frequency, or pitch; higher amplitude, or loudness; and non-reduced vowel quality (Lehiste, 1970). However, it is crucial to realize that stress perception is based on relative rather than absolute acoustic measurements of these four parameters. In the present analysis a syllable was perceived as stressed in relation to adjacent syllables. All four of the phonetic cues were used by two separate listeners for an initial perceptual stress analysis of the syllables contained in the final two inter-stress intervals of each selected utterance.

In stress-timed languages, such as English, unstressed syllables often have a vowel that is reduced to schwa. It was therefore unequivocal to say that English has at least two levels of stress, stressed syllables and unstressed syllables. What has been debated among phoneticians is just how many levels of stress there are beyond these basic two. Some phoneticians have described two levels, which would be the presence or absence of stress (Ladefoged, 1975), while others have described three levels (Bronstein, 1960; Shriberg & Kent, 1982), four levels (Tiffany & Carrell, 1977), and even up to six levels (Pulleyblank, 1998). Since only the final two inter-stress intervals were being analysed in the present study and not the entire utterance, an analysis incorporating primary stress, secondary stress and tertiary or weak stress was considered adequate.

Both expert listeners separately listened to the four audiotapes to analyse the final two inter-stress intervals for each selected utterance perceptually. The analysis involved identifying the penultimate inter-stress interval and coding it as either a primary stress (1) or a secondary stress (2). The following one, two, or three unstressed syllables were coded as such. Finally, a decision was made as to whether the final stressed syllable received primary or secondary stress. This analysis was done perceptually based on the relative prominence of the syllables in question.

Stress Analysis Reliability

The average agreement obtained by comparing the analyses of the two examiners was 82%. The range was r = .79 for the analysis of Participant 2 IDS to r = .84 for Participant 1 both IDS and ADS. Most disagreements involved assigning primary or secondary stress for a phrase. There were only four instances when there was a disagreement because a syllable was assigned secondary stress versus tertiary stress. Acoustic measures of amplitude were used to resolve discrepancies in the perceptual judgements of the two listeners. There were instances in which the primary and secondary stress of the final two inter-stress intervals were perceptually ambiguous. Figure 2 illustrates one such instance in which acoustic amplitude measurements clarified that the primary stress was on the penultimate inter-stress interval.

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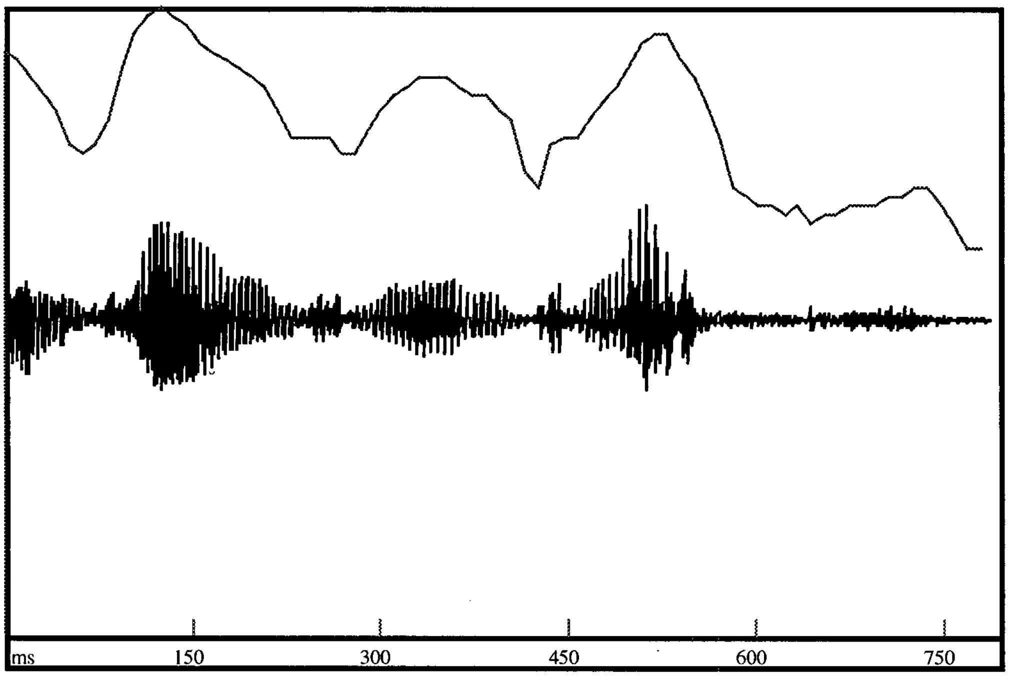


“d r in k i ng c u p”

Figure 2. Amplitude measurements used to assign stress codes. Top tracing is the amplitude envelope of the speech time waveform shown in the bottom tracing.

Measurement Procedure

A series of durational measurements were made on each selected utterance. The first measurement was the total time (in milliseconds) of the utterance; the second measurement was the duration (in milliseconds) of the penultimate unstressed syllable; the third measurement was the duration (in milliseconds) of the final stressed syllable. The procedure to obtain these measurements first involved digitizing the whole utterance, then syllabifying the penultimate unstressed syllable if it was part of a content word, and finally making segmentation judgements. These procedures are outlined in the following sections.

Digitization

Since an utterance was defined acoustically, rather then linguistically, as a section of speech bound by pauses greater than 300 ms, there were no between-utterance segmentation difficulties. From the audiotapes each selected utterance was digitized at 22.050 kHz (16 bits) using the SoundEdit 16 version 2 program (copyright 1996) on a Macintosh computer. Individual soundfiles (AAIF) were created for each utterance. For each soundfile, Macquirer version 6.0 (copyright 2000), a speech analysis package, was used to produce a spectrogram of the waveform, with a bandwidth of 344 Hz and a frequency range of 6000 Hz. Durational measurements were then made from the waveforms and wideband spectrograms.

Syllabification

Decisions of syllabification were based on principles of well-formed syllables outlined by Pulleyblank (1998). When a consonant occurred intervocalically it was joined to the following vowel as an onset (e.g. ha-ppy boy, mo-mmy's toast, li-ttle pie, rea-lly big, etc.). The sonority sequencing principle was applied to ambiguous cases where more than one consonant occurred intervocalically (e.g. slip-ry fish, in-side, some-thing else, slen-der one). There were two instances when a glide was inserted intervocalically and it was syllabified as an onset with the following vowel (e.g. thee yair, thee yend).

Segmentation

Three durational measurements were obtained from each digitized utterance. The first measurement was the total time (in milliseconds) of the utterance, which involved determining the start and end points of each utterance. The second measurement was the duration (in milliseconds) of the penultimate unstressed syllable, which involved segmentation decisions. The third measurement was the duration (in milliseconds) of the final stressed syllable, which also involved segmentation decisions. Segmentation decisions for durational measurements were made using information from the waveform and the spectrogram. The criteria used for making these decisions are outlined in the following sections, beginning with the easiest decisions and progressing to more difficult decisions.

Beginning of utterance.

Over 90% of the utterances from the four audiotapes began with a voiced segment and so onset of phonation was a reliable cue marking the beginning of the utterance. The exceptions to this were utterances beginning with either a voiceless fricative or a voiceless stop. Only the latter category was problematic. Utterances beginning with an initial voiceless fricative (e.g. she, should, shall, so, see) registered considerable friction noise on both the waveform and the spectrogram, which was taken to mark a beginning point. There were seven such utterances for Participant 1 (6 ADS and 1 IDS) and ten such utterances for Participant 2 (6 ADS and 4 IDS). There was no cue to indicate the beginning point of an utterance-initial voiceless stop and so the stop closure was not included in the measurement (e.g. put, people, take, can, cause, kind). For these utterances the onset of phonation of the following vowel was used as the beginning point. There were ten such utterances for Participant 1 (4 ADS and 6 IDS) and eleven such utterances for Participant 2 (4 ADS and 7 IDS).

End of utterance.

Determining the end of the utterance was more variable and proved more difficult than determining its utterance. Generally, for voiced segments the waveform was primarily used to determine cessation of pitch pulses. The exceptions to this were voiced fricatives, for which the spectrogram was used to determine cessation of friction energy. Cessation of fricative energy on the spectrogram was also used to decide ending points of voiceless fricatives. To determine the terminal boundary for the release of a stop the first step was to establish the presence or absence of a release burst and frication noise. This was done visually by identifying friction noise on the waveform and the spectrogram. Isolating and listening to a 30-40 ms section of the speech signal was done to confirm that the friction noise on the waveform and spectrogram was due to a release burst and not random background noise. The cessation of friction energy on the spectrogram was taken as the indication of the terminal boundary for voiced stops with a voiced release (e.g. crib, ride, dog, etc.) and voiceless stops with a voiceless release burst (e.g. flap, boat, think, etc.). The cessation of pitch pulses on the waveform was taken as the indication of the terminal boundary for unreleased voiced stops (e.g. bed, egg, etc.). For unreleased voiceless stops, the point of closure for the stop was used to mark the terminal boundary for the syllable (e.g. night, milk, etc.).

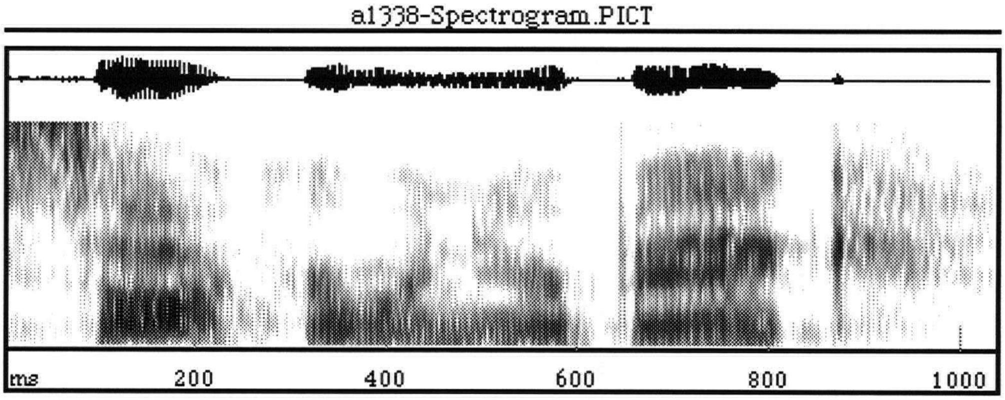
Segmentation of syllables.

The delineation of successive syllables was challenging because of the way speech is produced. Speech is produced more like a continuous succession of gradually varying and overlapping patterns than it is like a sequence of discrete units with distinct boundaries joined together as beads on a string (Fant, 1962). In speech production, the articulators are moving continuously, which means that the shapes for the preceding and following phonemes influence the shape of the vocal tract for each intended phoneme. The continuous movement of the articulators is the source of coarticulation, the overlapping of features or smearing among neighbouring phonemes. Therefore, acoustic features for phonemes widely vary as a function of different phonetic contexts. The influence of phonetic context is so great that the invariant units of speech perception, phonemes, do not correspond to invariant acoustic segments in the signal. This acoustic-phonetic invariance makes segmentation of the successive segments in connected speech a challenge.

There were some instances in which the beginning and end of a syllable was relatively unambiguous. However, in many instances the transitions between segments occurring at syllable boundaries involved an overlapping of cues due to coarticulation. Another segmentation difficulty involved instances in which the same segment or acoustically indistinguishable segments occurred on either side of a syllable boundary. Criteria used for segmentation decisions in these latter two conditions follow.

A descriptive analysis of the acoustic aspects of speech in which spectrographic correlates were mapped to phonetic cues and categories was outlined by Fant (1962) and served as a basis for segmentation decisions in this study. The procedure Fant described involved decomposing phonemes into sound segments. Sound segment boundaries would quite often display as distinct boundaries in spectrograms and as waveform properties related to switching events in the speech production mechanism. He noted that sound segment boundaries should not be confused with phoneme boundaries. For example, a stop could contain at least two sound segments, the occlusion and the burst. If the stop were voiceless then the burst could be further subdivided; the burst could contain an explosion transient and a short fricative. According to this procedure, the number of successive sound segments within a speech sample can be greater than the number of phonemes. It then became necessary to decide which sound segments would be assigned to which phonemes.

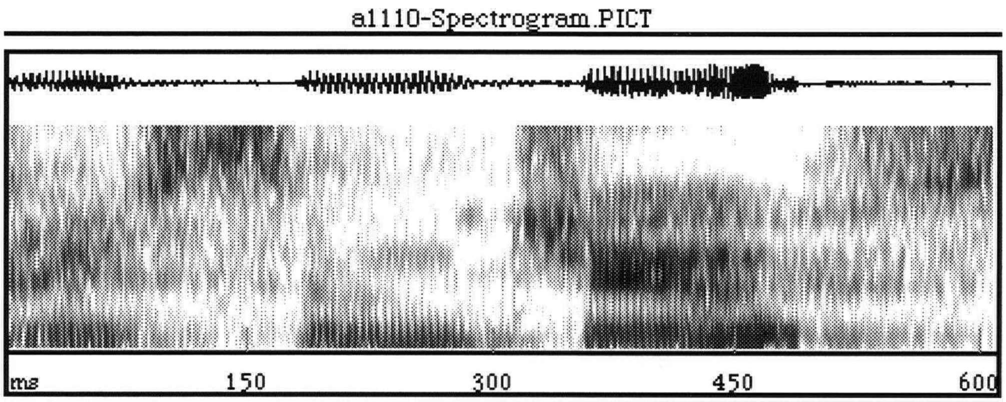
If the syllable began with a stop, for both voiced and voiceless stops, there was an obvious amplitude cue in the waveform reflecting the closure in the speech mechanism. This point was consistently chosen as the beginning point of the syllable. If a syllable ended with a stop, the transient burst and frication noise, if present, were considered part of the stop and therefore part of the preceding syllable. Figure 3 shows the transient burst and friction noise of the final voiced stop for the monosyllabic content word "big".



"s o cc er wh e n y ourb i g"

Figure 3. Transient burst and friction noise of final voiced stop /g/. Top trace is the speech time waveform and the bottom trace is the spectrogram.

If a syllable began with a fricative then the beginning point of friction noise seen on the waveform and the spectrogram were taken as the beginning point of the syllable. Figure 4 shows a syllable that begins with a voiceless fricative. Even though the beginning of friction noise on the waveform and spectrogram overlapped with the voicing of the preceding vowel, the start of frication was clearly identifiable and taken as the syllable boundary.



"y ou s o me j ui ce"

Figure 4. Overlap of pitch pulses and friction noise for voiceless fricative /s/. Top trace is the speech time waveform and the bottom trace is the spectrogram.

A syllable beginning with a nasal showed on the spectrogram as a marked discontinuity between the formants of the adjacent sounds and the formants of the nasal. This often coincided with the beginning of a slow varying waveform.

A syllable beginning with a liquid or a glide was more challenging to segment because there were no formant discontinuities in the transitions from the previous vowels to the following vowels. A similar situation happened if a syllable boundary occurred between two vowels. In both these instances, the initiation of the formant transitions was considered to be the beginning of the syllable.

There were several instances in which the same segment occurred at syllable boundaries (e.g. her-ROOM or BAS-ket-TOO, etc.). In these situations, the total time (in milliseconds) of the boundary segment was measured. The total time for the segment was then divided in half and the halfway point was considered the syllable boundary. The same procedure was used in the few instances where acoustically indistinguishable segments occurred at syllable boundaries (e.g. two voiceless fricatives, such as sort of-thing, or two voiceless stops, such as that-can go).

The measurement procedure described above primarily used the initiation of co-articulation (e.g. beginning of friction noise, beginning of formant transitions, etc.) between adjacent segments as the indication of a syllable boundary. Using the halfway point in the portion of co-articulation is another possible approach (Klatt, 1975). However, for these data the beginning point of co-articulation was consistently clearer than the ending point, especially for formant transitions. For this reason the beginning point of co-articulation was chosen as the boundary for segmentation. For 10 randomly selected utterances, a second expert examiner confirmed consistent use of this procedure.

Measurement Intra-Examiner Reliability

To assess reliability, recordings of 40 utterances were randomly selected, 10 from each audiotape. For intra-judge reliability, the primary investigator re-calculated the durations of the total utterance, the unstressed syllable, and the stressed syllable for each of the randomly selected utterances. The re-calculations were made on three separate occasions over a three-month period. For decisions regarding the beginning of utterances, the absolute mean error of measurement was found to be 3.4 ms (range = 0-6 ms). For unstressed syllables, the absolute mean error of measurement was found to be 9.7 ms (range = 0-19 ms). End of utterances had the largest absolute mean error of measurement. In many instances it was the challenging to determine the end of utterance due to low amplitudes, especially of release bursts. Absolute mean error of measurement for end of utterance was 20.6 ms (range = 3-37 ms).

Calculations of Rate

Two calculations of rate of speech were computed. The first rate (Rate 1) was computed by counting the number of syllables for each utterance and dividing it by the utterance's total duration. In order to determine the extent to which the slower rate of IDS was accounted for by the exaggerated utterance-final syllable, a second calculation of rate was made excluding the duration of the final stressed syllable. This second calculation of rate was computed by dividing the total number of syllables minus one in each utterance by the total utterance duration minus the duration of the final syllable (Rate 2).

CHAPTER III

RESULTS

Introduction

In this chapter, the results of duration measurements and speech rate calculations are described. In the section that follows, the duration of stressed monosyllabic utterance-final content words in ADS is compared to findings for IDS. The results of speech rate calculations in ADS and IDS, including and excluding the final syllable are then discussed. The results of reading rate calculations in IDS are also described. Finally, the remaining sections discuss the findings for the duration measurements for penultimate unstressed content-word and function-word syllables in ADS and IDS.

Durations of Utterance-final Syllables in ADS and IDS

Table 2 lists for each participant the mean durations and standard deviations (in milliseconds) of the utterance-final stressed syllables for the selected utterances.

Table 2. Mean final stressed syllable durations for each participant and addressee condition.

Participant	Addressee	# of Utterances	Mean Syllable Duration (ms)	Standard Deviation (ms)
1	ADS	75 spontaneous	386.3	112.9
		16 read	459.0	124.8
1	IDS	94 spontaneous	586.1	165.1
		22 read	631.1	180.4
2	ADS	79 spontaneous	385.9	115.7
		16 read	502.3	91.3
2	IDS	91 spontaneous	489.1	154.7
		20 read	636.4	139.9

For both participants in both ADS and IDS, the duration of the utterance-final syllables were longer when reading than when speaking spontaneously. For spontaneous speech, the duration of the utterance-final stressed syllable in ADS was similar for each participant. The duration of the utterance-final stressed syllable was longer for each participant in IDS compared to ADS, although Participant 1 showed greater utterance-final syllable lengthening in IDS than did Participant 2. Two one-way ANOVAs analysis of variance for spontaneous speech showed the difference in final syllable duration across addressee was significant for both participants [$F(1,167)=79.993$, $p<0.01$ for Participant 1; $F(1,168)=23.663$, $p<0.01$ for Participant 2].

Figure 5 shows the difference in utterance-final syllable durations (in milliseconds) between spontaneous ADS and IDS for both participants.

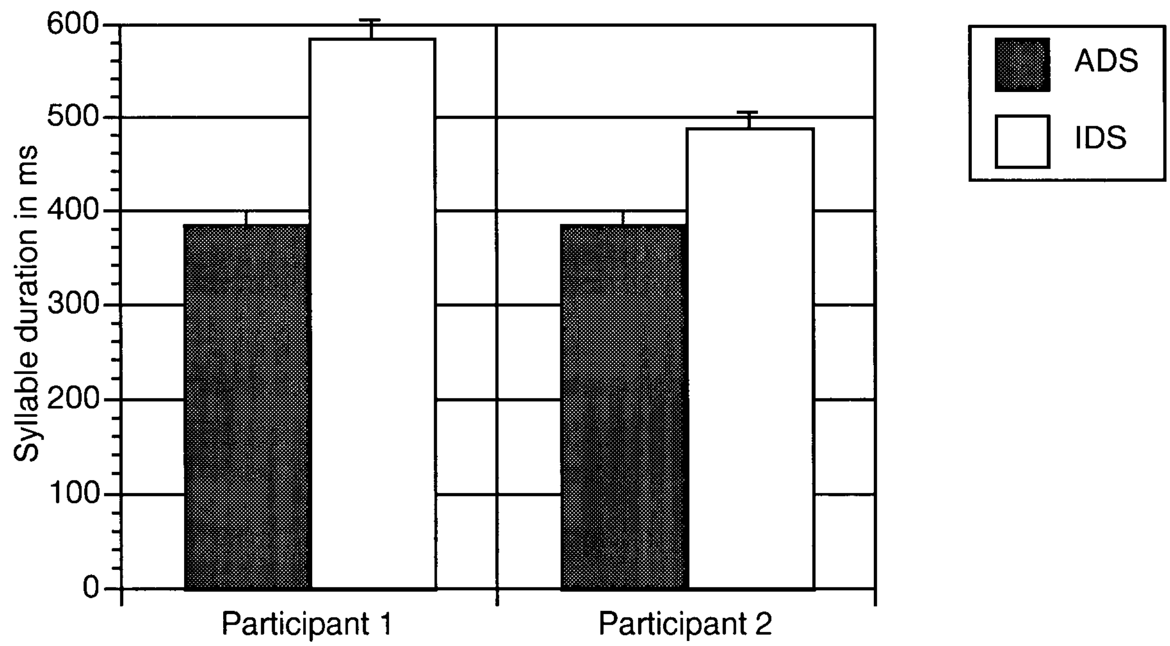


Figure 5. Mean utterance-final stressed syllable durations for both participants and addressee conditions.

The selected utterances ended with either a primary or secondary stress. Table 3 lists the mean duration and standard deviation (in milliseconds) of the utterance-final stressed syllables in the spontaneous utterances listed in Table 2. The utterances ending with a primary stress have been separated from the utterances ending with a secondary stress.

Table 3. Mean primary and secondary utterance-final stressed syllable durations for each participant and addressee condition.

Participant	Addressee	# of Utterances	Mean syllable Duration (ms)	Standard Deviation (ms)
1	ADS	48 PS (primary stress)	406.3 ms	111.2
1	ADS	27 SS (secondary stress)	350.8 ms	108.8
1	IDS	88 PS	592.1 ms	165.8
1	IDS	6 SS	498.1 ms	137.5
2	ADS	43 PS	438.4 ms	100.9
2	ADS	36 SS	323.3 ms	100.9
2	IDS	75 PS	498.4 ms	157.8
2	IDS	16 SS	445.6 ms	134.7

The duration of utterance-final syllables with primary stress was longer than the duration of utterance-final syllables with secondary stress for both participants across both addressee conditions. There were more instances of utterances ending with a secondary stress than with a primary stress in ADS compared to IDS. In ADS, over a third of the selected utterances ended with a secondary stress for Participant 1 and almost half did so for Participant 2. In IDS, only 6 out of the possible 94 spontaneous utterances ended with a secondary stress for Participant 1 and 16 out of the possible 91 spontaneous utterances did so for Participant 2.

Calculations of Rate for Spontaneous Speech

Two different speech rate calculations were made. The first calculation (Rate 1) was the total duration of each utterance divided by the total number of syllables. The second calculation was the total duration of each utterance excluding the duration of the final syllable and divided by the total number of syllables minus one. Table 4 lists the two different speech rates in syllables per second for spontaneous ADS and IDS for each participant.

Table 4. Mean rates and standard deviations in syllables/sec for ADS and IDS with the utterance-final syllable included (Rate 1) and excluded (Rate 2).

Participant	Addressee	[2]Rate	# of Utterances	Mean (Syllables/sec.)	Standard Deviation
1	ADS	1	75	5.30	1.28
1	ADS	2	75	6.37	1.81
1	IDS	1	94	4.14	0.94
1	IDS	2	94	6.03	1.85
2	ADS	1	79	5.92	1.20
2	ADS	2	79	7.63	2.20
2	IDS	1	91	5.25	1.29
2	IDS	2	91	7.87	2.06

[2] Rate 1 was calculated including the duration of the utterance-final syllable whereas rate 2 was calculated excluding the duration of the final syllable.

Both participants' spontaneous speech rates were slower in IDS than in ADS. Two one-way ANOVAs analysis of variance showed the difference in Rate 1 between IDS and ADS was significant for both participants [$F(1,167)=45.309$, $p<0.01$ for Participant 1; $F(1,168)=11.925$, $p<0.01$ for Participant 2].

Figure 6 shows the mean Rate 1 measures (in syllables/sec), which includes the duration of the final syllable, for ADS and IDS for both participants.

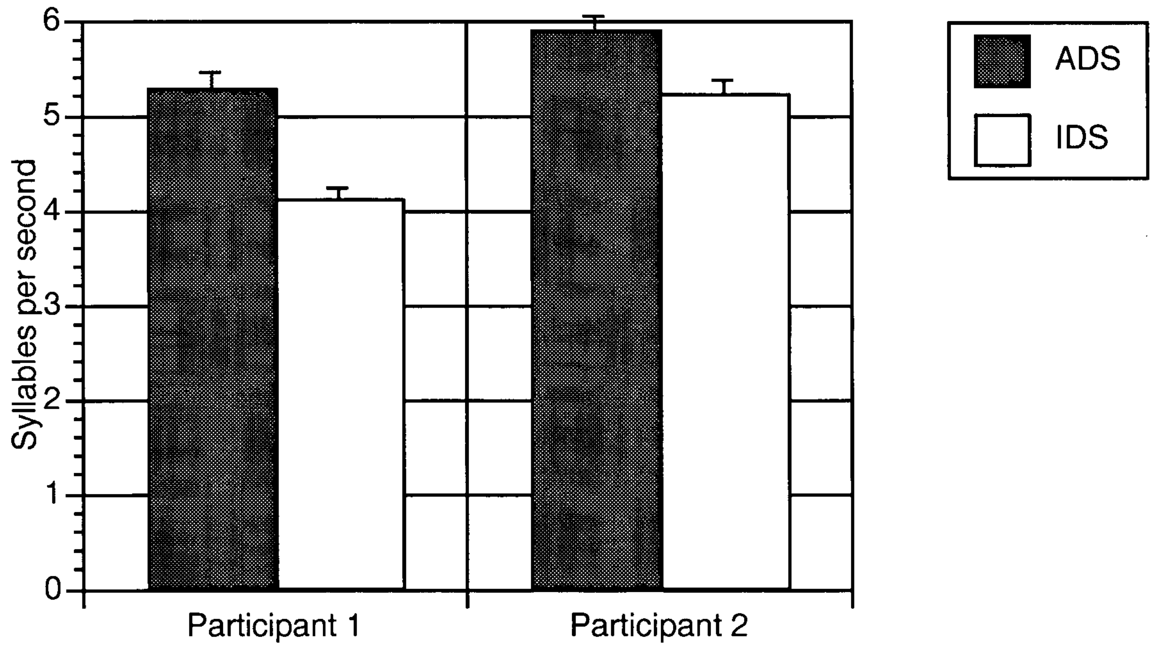


Figure 6. Mean speech rates including the utterance-final syllable (in syllables/sec) for both participants and addressee conditions.

When the calculation of speech rate excluded the duration of the final syllable two one-way ANOVAs showed there was not a significant difference between speech rates for IDS and ADS for either participant [$F(1,167)=1.478$, $p=0.226$ for Participant 1; $F(1,168)=0.539$, $p=0.464$].

Figure 7 shows mean Rate 2 measures (in syllables/sec), which excludes the duration of the final syllable, for both participants and addressee conditions.

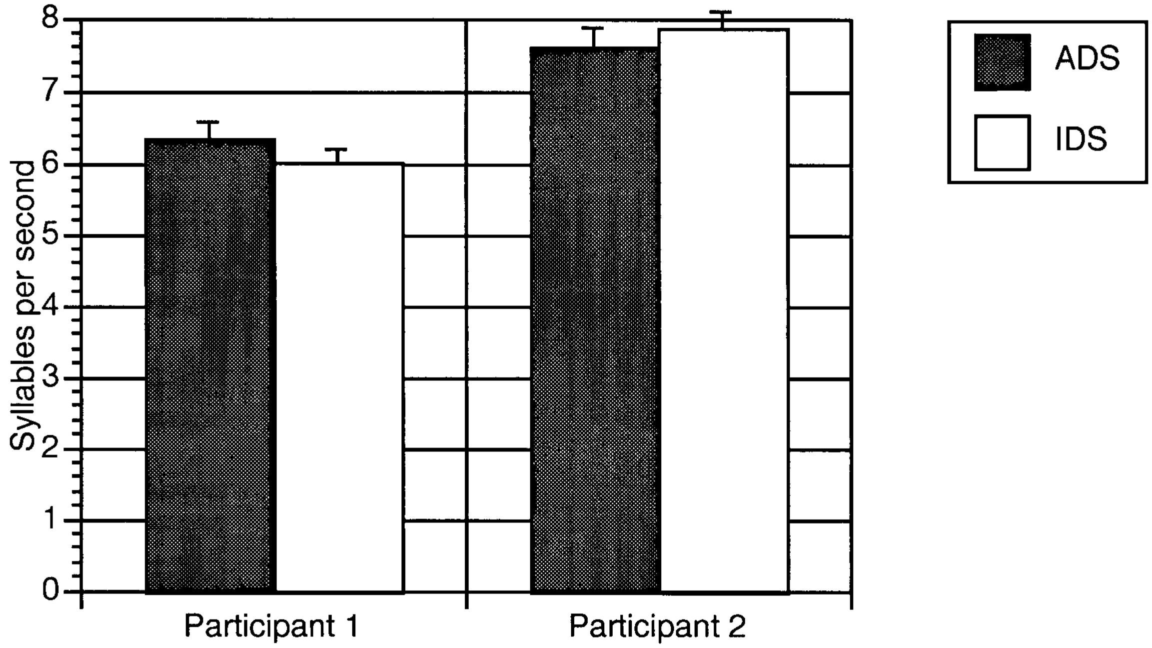


Figure 7. Mean speech rates excluding the utterance-final syllable (in syllables/sec) for both participants and addressee conditions.

Calculation of Rate of Speech Read to Infants

Table 5 lists the means and standard deviations for the rates (Rate 1) spontaneous IDS and speech read to the infants for both participants.

Table 5. Means and standard deviations of speech rates (in syllables/sec) for spontaneous and read utterances in IDS for each participant using the Rate 1 calculation.

Participant	Speech Type	# of Utterances	Mean rate in Syllables/sec	Standard Deviation
1	Spontaneous	94	4.14	0.94
1	Read	22	3.31	0.79
2	Spontaneous	91	5.25	1.28
2	Read	20	3.47	0.71

The rate of speech that was read to the infants was slower than the rate of spontaneous IDS for both participants using the Rate 1 calculation. Two one-way ANOVAs analysis of variance showed the difference in the two rates was significant for both participants [$F(1,114)=14.468$, $p<0.0005$ for Participant 1; $F(1,109)=35.812$, $p<0.0005$ for Participant 2].

Figure 8 shows the mean speech rates (in syllables/sec) for spontaneous and read utterances in IDS for both participants using the Rate 1 calculation.

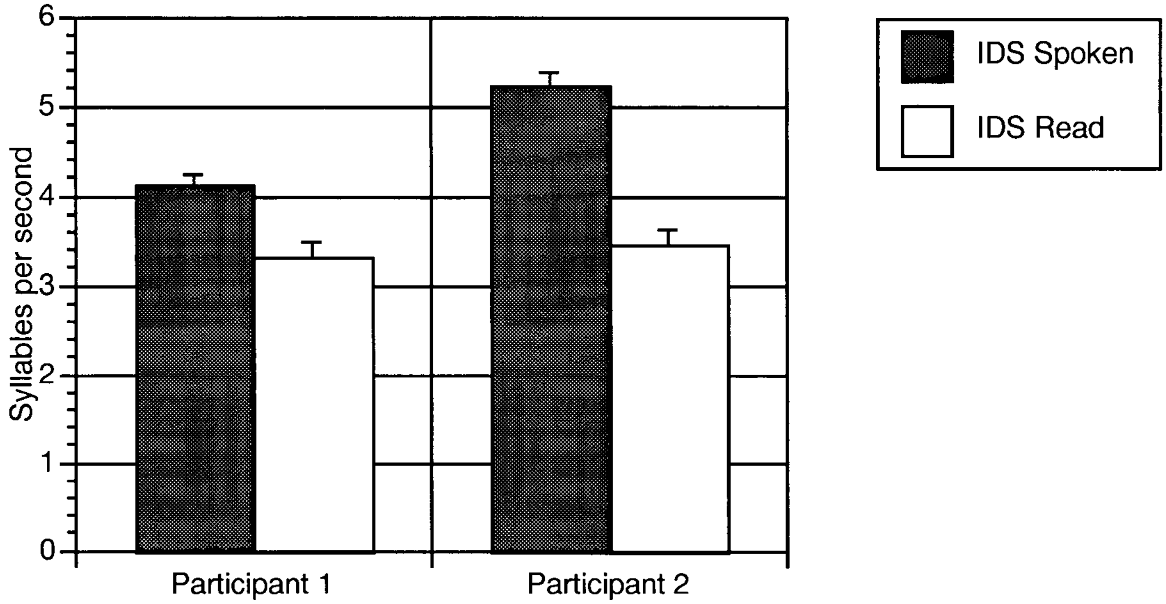


Figure 8. Mean speech rates, including the utterance-final syllable, for spontaneous and read utterances in IDS for both participants.

Even when the final syllable was excluded from the calculation of rate, using the Rate 2 calculation, the rate of speech read to the infants was still slower than the rate of spontaneous IDS for both participants. Two one-way ANOVAs analysis of variance showed the difference in the two rates was significant for both participants [$F(1,114)=6.571$, $p<0.01$ for Participant 1; $F(1,109)=38.710$, $p<0.01$ for Participant 2].

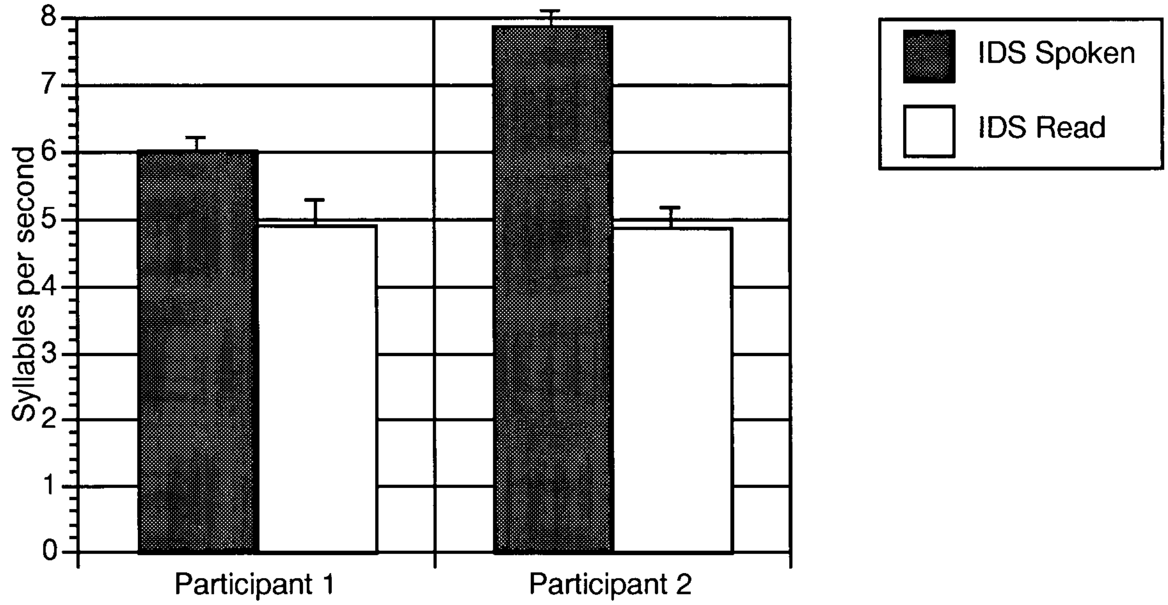


Figure 9. Mean speech rates, excluding the utterance-final syllable, for spontaneous and read utterances in IDS for both participants.

Durations of Unstressed Penultimate Syllables in IDS and ADS

The penultimate unstressed syllable was either a function word (Fun/Con; e.g. the of the BOOK) or part of a content word. If the unstressed syllable was part of a content word, it was either a word-final syllable followed by a monosyllabic stressed content word (Con/Con T; e.g. the –ttle of li-ttle BOY, the – bel of re-bel GROUP, etc.) or an initial syllable of an iambic content word (Con/Con I; e.g. the ma of ma-CHINE). Table 6 lists the means and standard deviations for syllable duration (in milliseconds) for the three types of unstressed penultimate syllables in spontaneous ADS for both participants.

Table 6. Means and standard deviations of the durations of unstressed penultimate syllables in ADS.

Participant	Types of Unstressed syllables.	# of Utterances	Mean Syllable Duration (ms)	Standard Deviation (ms)
1	Fun/Con (e.g. in BED)	37	89.6	37.8
1	Con/Con T (Trochaic) (e.g. ve-ry GOOD)	25	142.2	61.1
1	ConCon I (Iambic) (e.g. to-DAY)	13	98.6	36.5
2	Fun/Con	44	82.2	33.3
2	Con/Con T	22	130.3	51.4
2	ConCon I	13	71.4	26.6

Figure 10 shows the mean durations of function word syllables (Fun/Con) and the word-final content syllables (Con/Con T) in ADS for both participants.

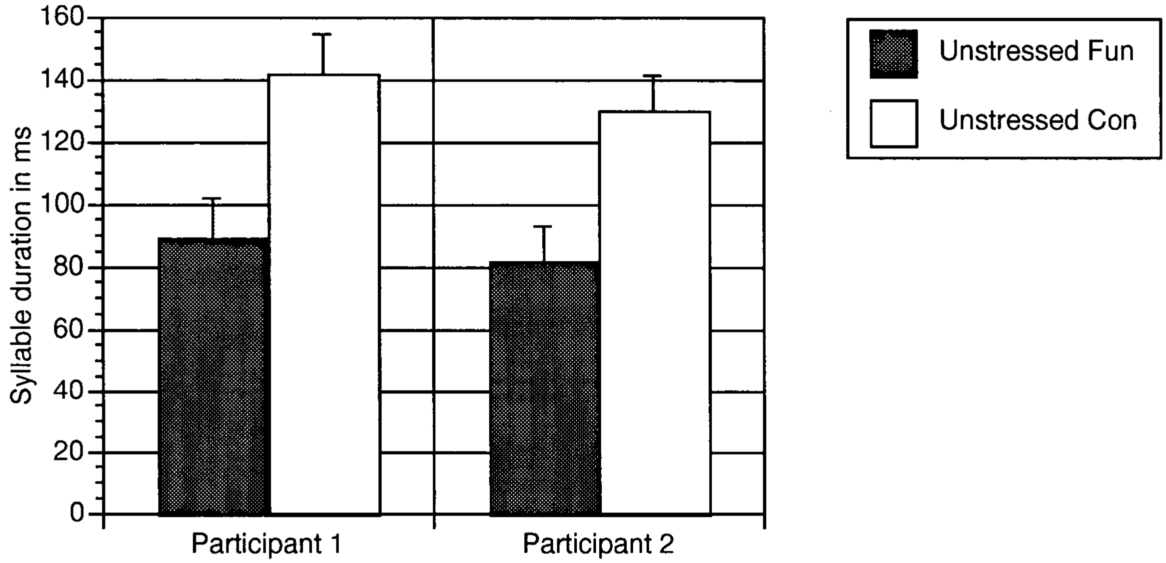


Figure 10. Mean durations of unstressed function and content syllables in ADS for both participants.

Table 7 lists the means and standard deviations for the durations (in milliseconds) types of unstressed penultimate syllables in spontaneous IDS for both participants.

Table 7. Means and standard deviations for durations of unstressed penultimate syllables in IDS.

Participant	Type of Unstressed syllable.	# of Utterances	Mean Syllable Duration (ms)	Standard Deviation (ms)
1	Fun/Con (e.g. in BED)	53	97.4	42.1
1	Con/Con T (Trochaic) (e.g. ve-ry GOOD)	34	158.7	41.1
1	ConCon I (Iambic) (e.g. to-DAY)	7	142.0	81.4
2	Fun/Con	52	72.9	23.4
2	Con/Con T	27	138.9	39.9
2	ConCon I	12	102.0	24.4

Figure 11 shows the mean durations of function word syllables (Fun/Con) and word-final content syllables (Con/Con T) in IDS for both participants.

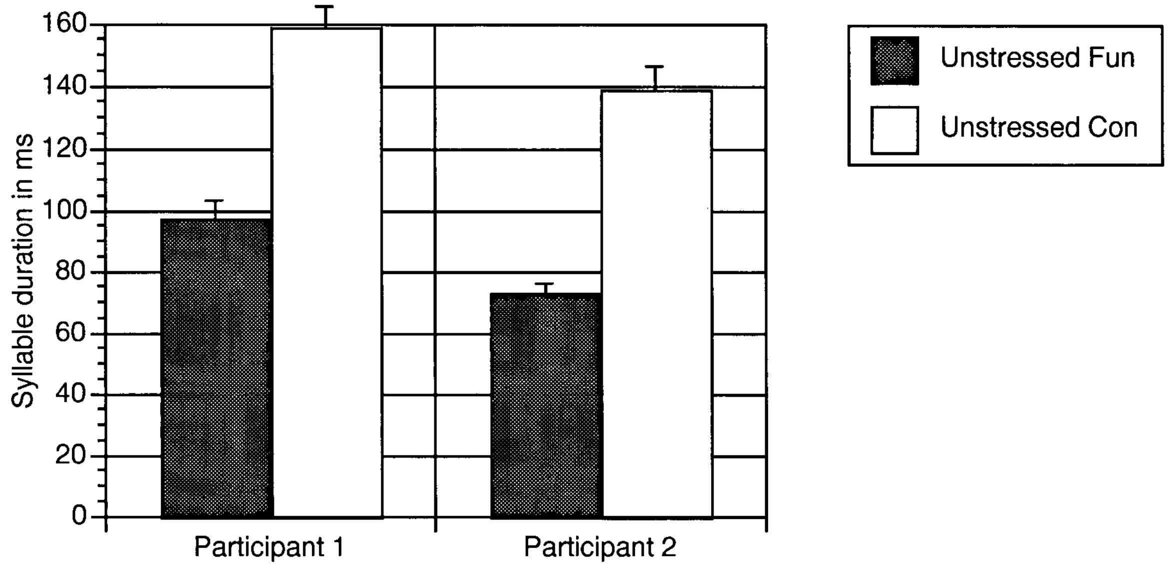


Figure 11. Mean durations of unstressed function and content syllables in IDS for both participants.

As expected in natural conversation, for both participants, there were few instances of iambic content words. Two two-way ANOVAs with syllable type (Fun/Con versus Con/Con T) and addressee (ADS versus IDS) as within subject factors were obtained, one for each participant. For both participants, there was a clear main effect of syllable type [F(1,24)=35.513, p<.0005 for Participant 1; F(1,21)=43.951, p<.0005 for Participant 2]. For both participants the effect of addressee was not significant [F(1,24)=.209,p=.652 for Participant 1; F(1,21)=.000,p=.993 for Participant 2]. Furthermore, there was no significant interaction of syllable type x addressee [F(1,24)=.668,p=.422 for Participant 1; F(1,21)=2.312, p=.143 for Participant 2]. A Student-Newman-Keuls test of multiple comparisons also confirmed (p< .05) that durations for unstressed syllables in function words (Fun/Con) did not differ according to addressee and durations for unstressed syllables in content words (Con/Con T) did not differ according to addressee; however, durations for Fun/Con were significantly shorter than durations for Con/Con T.

Figure 12 shows the mean durations (in milliseconds) for function word syllables in ADS and IDS for both participants.

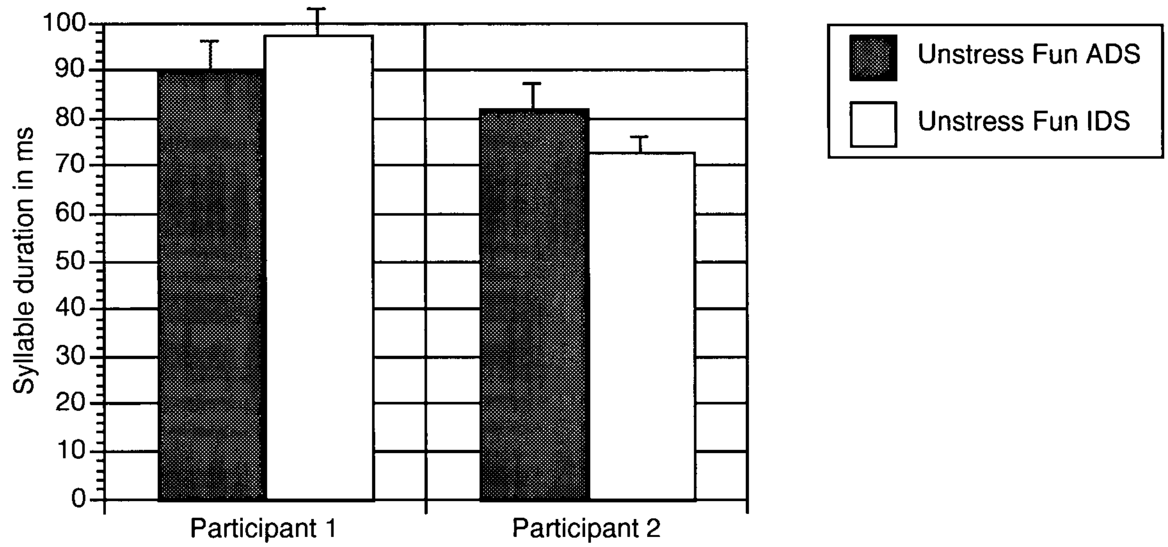


Figure 12. Mean durations of unstressed function word syllables in ADS and IDS for both participants.

Figure 13 shows the mean duration (in milliseconds) for word-final content syllables in ADS and IDS for both participants.

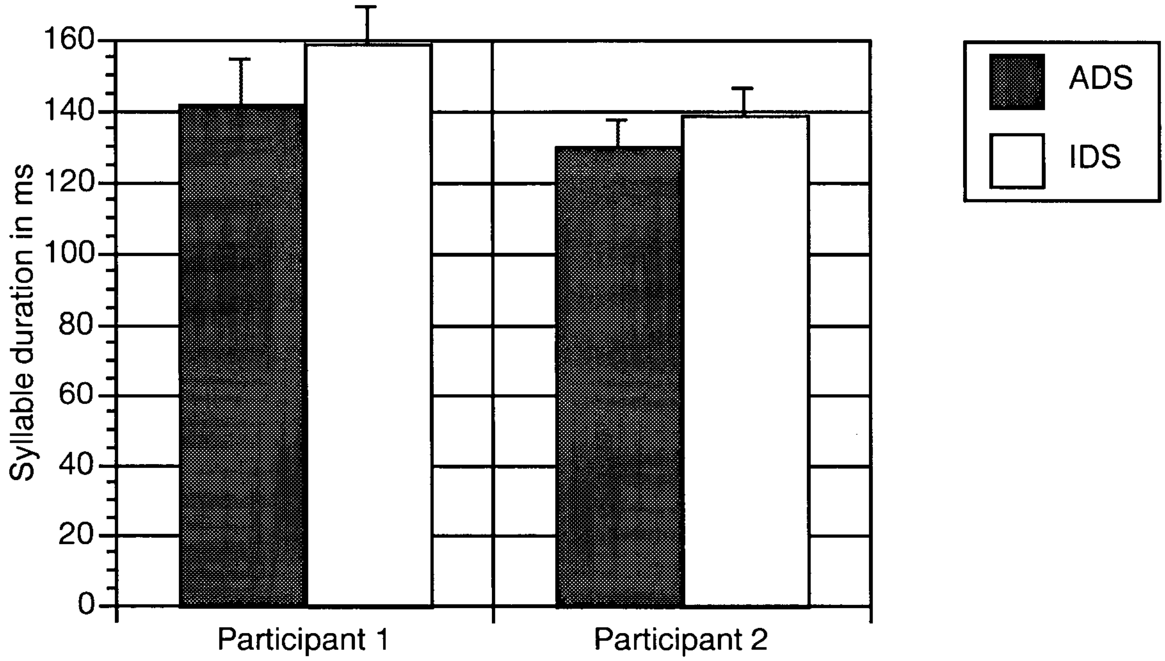


Figure 13. Mean durations of unstressed content word syllables in ADS and IDS for each participant.

The number of syllables in a given inter-stress interval was expected to have an effect on the duration of each syllable within that inter-stress interval. The penultimate unstressed syllable was at times the only unstressed syllable in the inter-stress interval in which it occurred (e.g. PULL the WEEDS, LIving ROOM, etc.). There were instances in which the penultimate unstressed syllable was preceded by another unstressed syllable (e.g. COUple of BOOKS, SLEPT through the NIGHT, etc.). Finally, there were instances in which the penultimate unstressed syllable was preceded by two unstressed syllables (e.g. BEing in the CRIB, PUT it in your MOUTH, etc.). Table 8 lists the mean duration of the penultimate unstressed function-word syllables and word-final content syllables according to the number of unstressed syllables in the respective penultimate inter-stress intervals for both participants in ADS.

Table 8. Mean unstressed syllable durations in ADS according to the number of unstressed syllables in the penultimate inter-stress interval.

Participant	Type of Unstressed syllable	# of Unstressed Syllables in inter-stress interval	# of Utterances	Mean Syllable Duration (ms)	Standard Deviation (ms)
1	Fun/Con (e.g. in BED)	1 (e.g. READ the BOOK)	21	99.9	36.5
1	Fun/Con	2 (e.g. TEA in a MUG)	10	75.9	40.5
1	Fun/Con	3 (e.g. LY-ing on the BED	6	75.8	31.1
1	Con/Con (e.g. ve-ry GOOD)	1 (e.g. CER-tain TIME)	21	133.0	56.1
1	Con/Con	2 (e.g. HER-oin THING)	4	190.1	72.1
2	Fun/Con	1	21	91.1	35.1
2	Fun/Con	2	17	78.4	32.9
2	Fun/Con	3	6	62.1	16.2
2	Con/Con	1	18	129.3	55.6
2	Con/Con	2	4	134.8	30.6

Table 9 lists the mean durations of the penultimate unstressed function word syllables and word-final content syllables according to the number of unstressed syllables in the respective penultimate inter-stress intervals for both participants in IDS.

Table 9. Mean unstressed syllable durations in IDS according to the number of unstressed syllables in the penultimate inter-stress interval.

Participant	Type of Unstressed syllable	# of Unstressed Syllables in inter-stress interval	# of Utterances	Mean Syllable Duration (ms)	Standard Deviation (ms)
1	Fun/Con (e.g. in BED)	1 (e.g. READ the BOOK)	28	101.2	49.9
1	Fun/Con	2 (e.g. TEA in a MUG)	22	94.1	33.5
1	Fun/Con	3 (e.g. LY-ing on the BED	3	86.6	6.1
1	Con/Con (e.g. ve-ry GOOD)	1 (e.g. LI-ttle GUY	30	156.2	38.1
1	Con/Con	2 (e.g. MAR-velous DAD	4	170.3	75.7
2	Fun/Con	1	33	74.6	24.1
2	Fun/Con	2	14	69.4	24.6
2	Fun/Con	3	5	70.1	17.7
2	Con/Con	1	24	136.7	38.9
2	Con/Con	2	3	156.3	53.7

There were more instances of inter-stress intervals containing only one unstressed syllable, either a function or content word, for both participants across both addressee conditions. There were very few instances in which a word-final unstressed content syllable was preceded by another unstressed syllable and no instances in which it was preceded by two unstressed syllables. Except for Participant 2 in IDS, function word syllables became progressively shorter in duration as the number of unstressed syllables in the inter-stress interval increased. Although the sample number was small, content-word syllables showed the opposite pattern. Word-final content syllables that occurred in inter-stress intervals with two unstressed syllables were longer in duration than ones in inter-stress intervals that contained only one unstressed syllable. Both participants showed this pattern for both addressee conditions.

CHAPTER IV

DISCUSSION

Review of Hypotheses

The present study was designed to compare IDS and ADS in terms of three prosodic features using natural conversation. In addition, the natural speech samples included a portion of speech that was read, thereby enabling some comparisons to be made between spontaneous IDS and speech that was read to young children. The three prosodic features examined were the duration of stressed content words and the duration of unstressed syllables (in both content and function words) in spontaneous speech, and rate of speech (both spontaneous and read).

The following null hypotheses were tested:

1) The utterance-final syllable duration in IDS is not significantly different from the utterance-final syllable duration in ADS.

2) The rate of speech in IDS is not significantly different from the rate of speech in ADS.

3) When the utterance-final syllable is excluded from the calculation of rates, the rate of speech in IDS and ADS are not significantly different.

4) The rate of speech read to infants does not differ significantly from the rate of spontaneous IDS.

5) In ADS, unstressed syllables in function words are not significantly shorter than unstressed syllables in content words.

6) In IDS, unstressed syllables in function words are not significantly shorter than unstressed syllables in content words.

7) The durations of unstressed syllables in function words in IDS are not significantly different from those in ADS.

8) The durations of unstressed syllables in content words in IDS are not significantly different from those in ADS.

Summary of Results

The following sections discuss whether the findings of the present study appear to support or refute the eight null hypotheses.

Null Hypothesis 1: IDS versus ADS Difference in Utterance-final Syllable Duration

It was hypothesized that the utterance-final syllable duration in IDS would not be significantly different from the utterance-final syllable duration in ADS. However, the mean utterance-final syllable duration was significantly longer in IDS than in ADS for both participants. These results are consistent with those of Bernstein Ratner (1986), who found that mothers significantly increase pre-pausal vowel lengthening when speaking to pre-verbal children (ages 9-13 months). In fact, a study of spontaneous speech by Albin & Echols (1996) has shown that the exaggerated utterance-final lengthening of stressed syllables even extended to utterance-final unstressed syllables in IDS addressed to 6 to 9-month-old infants.

Research indicating that exaggerated pre-pausal lengthening occurs in IDS addressed to children beyond the preverbal stage of language development has used prepared texts that were read to young children (Morgan, 1986; Swanson et al., 1992). However, research using spontaneous speech found that exaggeration of lengthening became less pronounced in speech to children who used single words and negligible in speech to children at the two-word stage (Bernstein Ratner, 1986).

The robust finding of accentuated pre-pausal or utterance-final lengthening in IDS compared to ADS in spontaneous speech has come from studies involving mothers addressing preverbal infants. The advocates of the prosodic bootstrapping hypothesis suggest that the more extreme pre-pausal lengthening in IDS compared to ADS may serve as an accentuated acoustic marker of utterance boundaries. However, considering the language development stage of the addressee it is possible that the heightened durational cue serves more a global role of eliciting and maintaining the preverbal infant's attention. The exaggerated lengthening of the utterance-final word or syllable in IDS to preverbal infants could be merely a word teaching strategy since 9-13 month-old infants are just on the verge of producing single words. Two previous investigations support such an interpretation.

Woodward and Aslin (1990) investigated the strategies used by mothers in their speech when attempting to teach their 12-month-old infants new words. In the study, 19 English-speaking mothers were instructed to teach their infants three novel English words (lips, wrist, lobe). The mothers were instructed to teach their infant two of the three target words using any strategy they felt appropriate, even though it was clear that they were unlikely to elicit word productions from their infant. While some mothers used the target-words in isolation as a word-teaching strategy, many did not. Nevertheless, placing the target-word in utterance-final position was a strategy used by all 19 mothers in the study. Such utterance-final positioning occurred an average of 89% of the time (range: 76%-100%) that the target-word was presented in a multiword utterance. The authors hypothesized that mothers have tacit knowledge that infants can better attend to and remember words placed in utterance-final position.

Fernald and Mazzie (1991) obtained similar results in their investigation of mothers' use of prosodic emphasis to mark focused words in speech to infants compared to speech to adults. In their experiment, 18 English-speaking mothers told a story to their 14 month-old infants and to an adult using a picture book with no written text. In the story, six items had been identified as target words to be the focus of attention. In IDS the mothers consistently positioned target words on exaggerated pitch peaks in utterance-final position, whereas in ADS, prosodic emphasis of target words was more variable.

Placing novel or target words in utterance-final position appears to be a word-teaching strategy used by mothers of preverbal infants. In addition, mothers use exaggerated utterance-final lengthening in IDS addressed to preverbal infants. However, it is unclear whether this cue serves more than the general role of eliciting and maintaining the infant's attention and perhaps focusing it on a portion of the utterance. Since utterance-final positioning and lengthening occurs in IDS addressed to preverbal infants perhaps it is more a word segmentation cue than a phrase segmentation cue. Advocates of the prosodic bootstrapping hypothesis propose that vowel lengthening as the prosodic cue to utterance boundaries is more exaggerated in IDS than ADS. Presumably it would be children in the holophrastic and combinatorial stages of language development, more than preverbal infants, who would use exaggerated utterance-final lengthening as a phrasal segmentation cue. Thus far research from spontaneous speech addressed to children in the one-word and two-word stages of language development has not shown exaggerated utterance-final lengthening in IDS compared to ADS at that stage of development. Further research showing accentuated utterance-final lengthening in spontaneous speech addressed to children in the holophrastic and combinatorial stages of language development is needed to support the claim that the duration cue to phrase boundaries is exaggerated in spontaneous IDS compared to ADS.

Of course, it is possible that the exaggerated length of the final syllable also helps facilitates comprehension of phrases for the preverbal infant. In general, comprehension precedes production, and thus, parents may be trying to facilitate comprehension. Once children appear to understand utterances, at the holophrastic and combinatorial stages, perhaps the need for exaggerated utterance-final lengthening diminishes. Perhaps some preverbal infant and toddler perception and comprehension studies, with and without exaggerated utterance-final lengthening, are needed to augment the literature.

In the present study, an utterance was defined acoustically, rather than linguistically, as a section of speech bounded by pauses greater than 300 ms. Interestingly, a pause does not necessarily represent an intended stop following a prosodic unit in ADS. Within-sentence hesitations can account for up to half of the observed pauses in spontaneous ADS (Goldman-Eisler, 1972; Fernald & McRoberts, 1996), whereas long pauses in IDS are nearly always at the ends of sentences or phrases used in isolation (Broen, 1972; Fernald & Simon, 1984). Given the very high correspondence between pauses and the boundaries of grammatical units in IDS, the exaggerated lengthening of the pre-pausal syllable is not only an accentuated cue to a grammatical boundary, it is a more consistent cue in IDS than ADS.

Null Hypothesis 2: IDS versus ADS Difference in Rate of Speech

It was hypothesized that the rate of speech in IDS would not be not significantly different than the rate of speech in ADS. The present study, consistent with previous research (e.g. Fernald & Simon, 1984; Sachs et al., 1976), showed the rate of speech in IDS to be significantly slower than the rate of speech in ADS. Earlier studies from the 1970s comparing rate of speech in IDS to ADS were calculated in words per minute. Between-utterance pauses were not excluded from these calculations of rate. However, the between-utterance pauses would account for some of the slower rate of speech in IDS compared to ADS because in IDS pauses are longer and more frequent (Fernald & Mazzie, 1991; Fernald & Simon, 1984; Garnica, 1977; Grieser & Kuhl, 1988). Studies in the 1980s, as in the present study, calculated the rate of speech in syllables per second excluding pauses over 300 ms (e.g. Fernald & Simon, 1984). This calculation is a more accurate depiction of the rate of articulation because the confounding difference in length and frequency of between-utterance pauses in IDS compared to ADS has been eliminated. However, differences due to length and frequency of the utterance-final syllable in IDS compared to ADS are still confounded. Perhaps a more accurate portrayal of the rate of articulation in IDS compared to ADS involves a calculation of rate in which both the between-utterance pauses and the duration of the final syllable are excluded.

Null Hypothesis 3: IDS versus ADS Difference in Speech Rate when Utterance-final Syllable is Excluded

It was hypothesized that when the utterance-final syllable was excluded from the calculation of rate, the rate of speech in IDS and ADS would not be significantly different.

of the present study support this null hypothesis. When the final syllable is excluded from the calculation, the rate of speech in IDS is not significantly different from the rate of speech in ADS. The articulation rate of the syllables in utterances preceding the final syllable was found to be similar in IDS and ADS.

Some researchers have attributed the slower rate of IDS to the overall lengthening of stressed syllables in content words regardless of phrasal position (Albin & Echols, 1996; Morgan, 1986; Swanson et al., 1992). However, as noted in the literature review, there seem to be conflicting results as to whether or not utterance-medial content words are lengthened in IDS. The studies reporting overall lengthening of content words have been from investigations involving prepared read text and not spontaneous speech. The studies from investigations using spontaneous speech have not reported an overall lengthening of content words but rather similar infant-directed and adult-directed utterance-medial content word durations. In the present study, the articulation rate of the syllables preceding the final syllable was similar in spontaneous IDS and ADS. These results are consistent with previous research using spontaneous speech and suggest that utterance-medial content word durations are similar in IDS and ADS.

Bernstein Ratner (1996) also attributed the slower rate of IDS to the overall lengthening of stressed syllables in content words regardless of phrasal position. However, ten years earlier, when discussing the results of her own research using spontaneous speech she had concluded that IDS was not characterized by generally lengthened vowel durations in either content words or function words, "although the shorter utterance length of mother-child speech might have predicted relatively longer segmental durations in this register" (Bernstein Ratner, 1985, pp. 259). When reflecting on the observed slower rate of IDS compared to ADS in her study, she noted that the "global rate adjustment did not translate directly into longer segmental durations" (Bernstein Ratner, 1985 pp. 262). Despite these observations she does not offer an explanation for the observed slower rate in spontaneous IDS compared to ADS. If there are not longer segmental durations in spontaneous IDS compared to ADS then what is the source of the consistently reported slower rate of IDS? The results of the present study suggest that the slower rate of speech in IDS compared to ADS can be attributed in a large part to the disproportionately long final syllable in combination with it being in an utterance that is typically only a few syllables long.

Null Hypothesis 4: Read versus Spontaneous Speech Rate in IDS

It was hypothesized that the rate of speech that is read to infants would not differ significantly from the rate of spontaneous IDS. The data from the present study show that speech is read to infants at a slower rate than it is spoken spontaneously to them. Howell and Kadi-Hanifi (1989) obtained contrary results when they compared the rate of speech read to adults with the speech rate of ADS. Their data showed the reading rate in ADS to be faster than the rate of spontaneous speech.

A methodological difference between the two studies may account for some of the divergent results. In the Howell and Kadi-Hanifi study, rate calculations were made for tone-units. A tone-unit is usually a sentence or a phrase within a sentence made up of words carrying primary, secondary and unstressed syllables. To identify tone-units in their study, a set of guidelines for a stress analysis outlined by Crystal (1969) was followed. According to the analysis, pauses longer than 300 ms could occur as within-utterance pauses. Howell and Kadi-Hanifi noted a marked tendency for readers to drop many of the within-utterance pauses that had appeared in their spontaneous speech. The elimination of these pauses in read speech compared to spontaneous speech contributed to the faster reading rate in ADS. Conversely, there was a low incidence of adding pauses during reading. In the present study, an utterance was defined acoustically, rather than linguistically, with the criteria being that an utterance was deemed to be a section of speech bounded by pauses greater than 300 ms. Consequently pauses longer than 300 ms were, by definition, between-utterances pauses and never within-utterance pauses. Despite this methodological difference, the results of the two studies were contradictory. In the Howell and Kadi-Hanifi study, the mean rate of read ADS was approximately two syllables per second faster than spontaneous ADS (6.05 vs 4.11 syllables/sec). In the present study, the mean rate of read IDS was approximately one syllable per second slower than the rate of spontaneous IDS (3.3 vs 4.2 syllables/sec for Participant 1; 3.5 vs 5.25 syllables/sec for Participant 2). Taken together, the results of the two studies suggest that, whereas speech is read to adults at a faster rate than spontaneous ADS, possibly speech is read to infants at a slower rate than spontaneous IDS. However, in the present study the spontaneous and read speech rates were calculated for only two participants. Further research comparing the spontaneous and read speech rates in IDS using more participants would be prudent to confirm these results.

The utterance-final syllable was longer in speech read to infants than in spontaneous IDS. These data suggest that the utterance-final syllable lengthening in ADS, which is exaggerated in spontaneous speech to preverbal infants, is additionally exaggerated in speech that is read to infants. Excluding the utterance-final syllable from rate calculations for spontaneous IDS and ADS resulted in similar speech rates. However, even when the utterance-final syllable was excluded from rate calculations for read and spontaneous IDS, speech was still read to infants at a significantly slower rate than spontaneous IDS. A corollary of the slower rate of read IDS is that the rate of articulation of the syllables preceding the final syllable in the read utterances was at a slower rate than those in the spontaneous utterances. The slower rate of the syllables preceding the final syllable in the read speech is attributable to longer segmental durations in read IDS compared with spontaneous IDS.

These results are consistent with the observed overall exaggerated lengthening of content words (phrase-final and non-phrase-final) in studies of read IDS (Morgan, 1986; Swanson et al., 1992). From their studies with read speech, both Morgan (1986) and Swanson et al. (1992) reported longer utterance-medial content word vowel durations in IDS compared to ADS. These researchers proposed that the observed vowel lengthening was due to the addressee condition; i.e., that the speech was IDS versus ADS. Morgan stated, "Thus, as expected, the slower speech rate evident in child-directed speech is due in part to the lengthening of at least stressed vowels in content words" (Morgan, 1986 pp 118). The results of the present study provide further evidence of vowel lengthening in utterance-medial content words but only in speech that is read to infants and not in spontaneous IDS. In spontaneous speech, the articulation rate of the syllables preceding the final syllable was found to be similar in IDS and ADS, suggesting that the utterance-medial content word durations are similar in the two types of speech. The present investigator proposes that the vowel lengthening in utterance-medial content words observed in these two previous studies may be due, at least in part, to the type of speech (read versus spontaneous) as opposed to addressee of the speech (IDS versus ADS). Rather than the observed vowel lengthening in content words being a result of speech that is child-directed, it may be a result of speech that is read to young children. Both Morgan (1986) and Swanson et al. (1992) acknowledged that the read speech in their studies might not be fully representative of spontaneous speech. However, neither discussed the possibility that the type of speech (read vs spontaneous) might be the source of the differences in medial vowel durations and the related differences in rate they observed. When Howell and Kadi-Hanifi compared the two types of ADS (read vs spontaneous) they concluded from their findings that material that has been read could not be regarded as representative of spontaneous speech. Further research comparing speech rates of read and spontaneous IDS and ADS is required to resolve this apparent confound.

Null Hypothesis 5: In ADS, Durations of Unstressed Syllables in Function Words versus those in Content Words

It was hypothesized that in ADS unstressed syllables in function words would not be significantly shorter than unstressed syllables in content words. In ADS, the mean duration of unstressed syllables in function words was, however, significantly shorter than the mean duration of unstressed syllables in content words (89.6 versus 142.2 ms, respectively, for Participant 1; 82.2 versus 130.3 ms, respectively, for Participant 2).

It is noteworthy that there was considerable variability for both categories of words. The variability was expected since there are several factors that interact and influence the duration of a syllable. The factors influencing syllable duration could include stress, phonemic content, number of syllables in an inter-stress interval, number of syllables in a word, and speech rate.

Because comparisons in these data were between durations of unstressed syllables, syllable stress, a potentially major source of variability, was eliminated. The phonemic content of a syllable impacts its duration. Each phonetic segment has its own intrinsic or inherent phonological duration (Klatt, 1976). In English, there are substantial differences in the intrinsic durations associated with different vowel categories (Peterson & Lehiste, 1960). Vowels can be inherently long or short. When an unstressed vowel is reduced to schwa, it takes on an even shorter inherent duration (Klatt, 1976). In addition, most of a syllable's duration is contained in the syllable nucleus, namely the vowel (Peterson & Lehiste, 1960). In a factor analysis of stressed vowel duration, Klatt (1976) found that 56% of the variance in syllable duration was accounted for by differences in the inherent durations of vowels. Similarly, in the present study of unstressed syllables, whether or not the syllable was reduced to schwa greatly influenced its duration. Fully 80% (56/69) of the syllables in ADS shorter than 100 ms contained schwa. More function word syllables than content word syllables contained schwa. Specifically, 79% (66/82) of the function word syllables contained a schwa, whereas only 25% (12/47) of the content word syllables contained a schwa. Accordingly, more function word syllables than content word syllables had durations shorter than 100 ms. Specifically, 79% (55/69) of the syllables shorter than 100 ms were function-word syllables, whereas only 21% (14/69) were content word syllables. To some extent, the likely concurrence of vowel reduction to schwa and function form class membership explains the significantly shorter durations of the unstressed function versus content syllables.

As expected, the number of unstressed syllables in an inter-stress interval influenced syllable duration. However, this factor affected the duration of unstressed syllables to a lesser degree than did their phonemic content. The number of syllables in a given inter-stress interval had an effect on the duration of each function word syllable within that inter-stress interval. Function word syllables become progressively shorter in duration as the number of unstressed syllables in the inter-stress interval increases. Although the sample number was small, content word syllables showed the opposite pattern. There were four instances for each participant in which word-final content syllables occurred in inter-stress intervals with two unstressed syllables. In each instance the unstressed word-final content syllable was longer in duration than ones that occurred in inter-stress intervals that contained only one unstressed syllable. The content syllables in these instances were always part of a multi-syllabic word [3](e.g. i-DEN-ti-fy, TY-pi-fy, MAR-ve-lous). The word-final syllable maintained a full vowel and was not reduced to schwa and hence did not have the extremely short duration typical of schwa. Instead, the word-medial syllable in these instances was reduced to schwa and it was presumably very short in duration.

In addition, the rate of articulation of an utterance affected the duration of the penultimate unstressed syllables that were measured in ADS. Considering normal speech range is between four to seven syllables/sec (Chermak & Schneiderman, 1986; Smith et al., 1987) a coding system was devised in which speech uttered at a rate slower than 4.0 syllables/sec was coded as slow; speech ranging from 4.1 – 6.49 syllables/sec was coded as typical and speech faster than 6.5 syllables/sec was considered fast. Using this coding system, 35 out of 129 utterances spoken by the two participants in ADS were at a rate faster than 6.5 syllables/sec. Of the 35 fast utterances, 28 had a penultimate syllable with a duration shorter than 100 ms, whereas only seven had a penultimate syllable longer than 100 ms.

There was still variability in these data despite accounting for a syllable's phonemic content, the number of syllables in an inter-stress interval, and the rate of speech. In one instance Participant 2 uttered, "him PLAY", and in a second instance she said "him DOWN". In both instances "him" was the only unstressed syllable in the inter-stress interval and the utterance was spoken at a medium speech rate. However, in the first

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[3] The syllable for which the duration was measured is underlined. Capitalization represents stressed syllable.

instance "him" was only 96.2 ms, whereas in the second instance "him" was 138.5 ms. Conversely, there were instances in which syllables, from comparable inter stress intervals and speech rates, had similar durations, yet one syllable contained a reduced vowel and the other did not. For example, Participant 1 said "an HOUR" and ""-ry GOOD". The unstressed syllable "an", with the reduced vowel, was 66.2 ms whereas the unstressed "ry", with the long vowel, was 70.3 ms.

The influence of the phonemic content, the number of syllables in an inter-stress interval, and the rate of speech on a syllable's duration in ADS can be seen in Appendix A.

Null Hypothesis 6: In IDS, Duration of Unstressed Syllables in Function Words versus those in Content Words

It was hypothesized that, in IDS, unstressed syllables in function words would not be significantly shorter than unstressed syllables in content words. As in ADS, in IDS the mean duration of unstressed syllables in function words was significantly shorter than the mean duration of unstressed syllables in content words. Thus the null hypothesis was rejected. As in the ADS data, there was considerable variability for both categories of words. The variability in IDS was due to the same factors that interacted and influenced the unstressed syllable durations in ADS.

Whether or not the syllable was reduced to schwa greatly influenced its duration. Fully 90% (74/82) of the syllables shorter than 100 ms contained schwa. More function word syllables than content word syllables contained schwa. Specifically, 88% (92/105) of the function word syllables contained a schwa, whereas only 32.5% (14/43) of the content word syllables contained a schwa, which is similar to the distribution in ADS. More function word syllables than content word syllables had durations shorter than 100 ms. Specifically, 95% (78/82) of the syllables shorter than 100 ms were function-word syllables whereas only 5% (4/82) were content word syllables. To some extent, the likely concurrence of vowel reduction to schwa and function form class membership explains the shorter durations of the unstressed function versus content syllables.

There was still variability in these data despite accounting for a syllable's phonemic content, the number of syllables in an inter-stress interval, and the rate of speech. In one instance Participant 1 uttered, "li-ttle BOY", and in a second instance she said "for MOM". In both instances the inter-stress interval contained only one unstressed syllable and the utterance was spoken at a medium speech rate. However, in the first instance the unstressed content-word syllable "-ttle" was only 82.6 ms, whereas in the second instance the unstressed function-word syllable with the reduced vowel "for" was considerable longer, 144.4 ms. Conversely, there were instances in which syllables, from comparable inter stress intervals and speech rates, had similar durations, yet one syllable contained a reduced vowel and the other did not. For example, Participant 2 said "for SURE" and "fu-nny RINGS". The unstressed syllable "for" with the reduced vowel was 126.0 ms and the unstressed "-nny" with the long vowel was 125.1 ms.

Again, as in the ADS data, the number of syllables in an inter-stress interval and the rate of speech influenced the duration of unstressed syllables in IDS. The influence of these factors on a syllable's duration can be seen in Appendix B.

Some researchers have proposed that vowel duration could provide a helpful acoustic cue to the form class membership of individual words (Bernstein Ratner, 1996; Morgan, 1986; Swanson et al., 1992). This proposal has been supported by measures of vowel lengths in stressed syllables in content words compared to unstressed syllables in function words (Bernstein Ratner, 1984, 1985; Morgan, 1986; Swanson, et al., 1992; Shi, 1995). The only exception to this pattern is the work of Shi (1995), in which both di-syllabic content and function words were measured; however, average vowel length was calculated over the stressed and unstressed syllables. Thus far, no research has compared the durations of unstressed syllables in function words to those in content words. The results of the present study suggest that, even when the syllables are restricted to those in unstressed content words, there is a durational difference between the syllables durations in content versus function words. These results support the notion that vowel duration could provide a helpful acoustic cue to the form class membership of individual words.

However, in the present study the classification of content versus function words was made in accordance with the definitions proposed in the acquisition literature of the 1990s. Therefore, all adjectives and adverbs, including closed class items, such as intensifiers and quantifiers were classified as content words. In addition, closed class affixes that were attached to content words were classified as unstressed content-word syllables. Because intensifiers, quantifiers, and affixes are all closed class items an argument could be made to classify these unstressed syllables as function-word syllables. The items in question include many syllables containing unreduced vowels (e.g. so, more, ve-ry, -ly, -ing). Therefore the classification criteria used may have unduly shortened the average duration of function-word syllables. The durational difference between unstressed content-word and function-word syllables found in the present study may be diminished by a re-classification from content to function-word syllables of the closed class items mentioned. Perhaps in future work, a three-way classification would need to be attempted, in which a clitic and non-clitic division within the closed class was recognized. The three-way classification could include clitic closed class, non-clitic closed class, and open class.

Null Hypotheses 7 & 8: Duration of Unstressed Syllables in Function and Content Words in ADS compared with IDS

It was hypothesized that the difference in the durations of unstressed syllables in function and content words in ADS would not be significantly different from those in IDS. The results of the present study do not refute this null hypothesis. The difference between the mean duration of unstressed function word and content word syllables was similar in ADS and IDS.

The present data indicate that the duration of unstressed syllables in function words is not disproportionately lengthened in IDS compared to ADS. This result is consistent with previous research (Bernstein Ratner, 1984, 1985; Morgan, 1986; Swanson et al., 1992). In the present study it was the penultimate unstressed syllable that was measured. Considering the exaggerated utterance-final lengthening in IDS compared to ADS, it is conceivable that the penultimate syllable in IDS also might demonstrate lengthening. However, the present data indicate that the exaggerated utterance final lengthening in IDS is localized and does not extend to the penultimate unstressed syllable.

Regardless of the form class membership of the unstressed syllables, half of the utterances in ADS and IDS contained schwa. Considering the exaggerated utterance-final lengthening in IDS, the infant often hears a short, phonetically insubstantial syllable followed by an exaggeratedly lengthened one, followed by a pause. This scenario is reminiscent of a rhythmical cadence in a musical phrase (i.e. "ta dah"). The localized, accentuated, long final syllable preceded by the short syllable in IDS perhaps enhances the rhythmic aspects of phonological phrases in English for the benefit of the infant as learner.

Summary and Conclusions

In summary, the results of the present study show that in spontaneous speech addressed to preverbal infants there was exaggerated lengthening of the utterance-final syllable and an overall slower rate of speech compared to ADS. These two findings replicated previous research. Importantly, it was hypothesized that the disproportionately long final syllable in the typically short utterances of IDS would account for the observed slower rate of speech in IDS compared to ADS. Indeed, when the final syllable was excluded from the calculation, the rate of speech in IDS was not significantly different from the rate of speech in ADS. The articulation rate of the syllables in utterances preceding the final syllable was similar in IDS and ADS. In addition, the data from the present study indicate that speech was read to infants at a slower rate than spontaneous speech to infants.

In ADS and in IDS, the mean duration of unstressed syllables in function words was significantly shorter than the mean duration of unstressed syllables in content words. However, the difference in the mean duration of unstressed function word and content word syllables was similar in ADS and IDS. While duration could provide a helpful acoustic cue to the form class membership of individual words, the difference in duration of unstressed function word and content word syllables in ADS was not exaggerated in IDS.

In conclusion, in the present study, the acoustic boundary marker of pre-pausal lengthening was found to be exaggerated in the spontaneous speech of two North American mothers to preverbal infants compared to that found in ADS. Thus far, research from spontaneous speech addressed to children in the one-word and two-word stages of language development has not shown exaggerated utterance-final lengthening in IDS compared to

ADS. It is unclear whether this durational cue in spontaneous speech to preverbal infants serves more than a global role of eliciting and maintaining the infant's attention and perhaps focusing it on a portion of the utterance as a possible support or enhancement to utterance comprehension or word learning.

It has been suggested that due to the exaggerated prosodic features of IDS, a prosody-to-syntax mapping is more distinctive and reliable in speech directed to children versus adults. The notion that acoustic cues to syntactic structure are accentuated in IDS compared to ADS is given as indirect evidence to support the prosodic bootstrapping hypothesis. Apart from the robust finding of exaggerated utterance-final syllable lengthening in IDS, the present findings show that other prosodic features were not exaggerated in IDS compared to ADS.

Future Directions for Research

Advocates of the prosodic bootstrapping hypothesis propose that vowel lengthening as a prosodic cue to utterance boundaries is more exaggerated in IDS than in ADS. However, research indicating that this exaggerated pre-pausal lengthening occurs in IDS addressed to children beyond the preverbal stage of language development has used prepared texts that were read to young children (Morgan, 1986; Swanson et al., 1992). Research using spontaneous speech found such exaggeration of lengthening to be less pronounced in speech to children who were using single words and they found it to be negligible in speech to children at the two-word stage (Bernstein Ratner, 1986). Further research showing accentuated utterance-final lengthening in spontaneous speech addressed to children in the holophrastic and combinatorial stages of language development is needed to support the claim that the duration cue to phrase boundaries is exaggerated in spontaneous IDS compared to ADS. In addition, infant and toddler perception and comprehension studies are also needed comparing various rates of speech and degrees of utterance-final lengthening.

The results of the present study suggest that the slower rate of speech in IDS compared to ADS can be attributed in large part to disproportionately long final syllables and utterances typically being only a few syllables long. However, the speech rates in the present study were calculated for only two participants. Studies of more participants for whom rate of speech, with and without the exaggerated final syllable, is calculated are necessary to confirm the preliminary results of the present study. In addition, the two participants in the present study were mothers of preverbal infants. Studies of speech to children at different ages and stages of language development would be interesting. In addition, examining the effect of varying types of input for children with language and hearing impairments might be productive.

Previous researchers have concluded that the observed vowel lengthening in content words is a result of speech being child-directed (Berstein Ratner, 1996; Morgan, 1986; Swanson et al., 1992). The present investigator proposes that the vowel lengthening in utterance-medial content words observed in previous studies is more likely due to the type of speech (read versus spontaneous) as opposed to addressee of the speech (IDS versus ADS). When Howell and Kadi-Hanifi compared the two types of ADS (read versus spontaneous), they concluded from their findings that material that has been read could not be regarded as representative of spontaneous speech. Further research comparing speech rates of read and spontaneous IDS and ADS is required to resolve this.

In the present study the classification of content versus function words was made in accordance with the definitions proposed in the acquisition literature of the 1990s. This classification criterion may have unduly shortened the average duration of function-word syllables. In future work, a three-way classification would need to be attempted, in which a clitic and non-clitic division within the closed class was recognized. The three-way classification could include clitic closed class, non-clitic closed class, and open class.

Clinical Implications

The results of the present study, consistent with previous research, suggests that IDS provides minimal prosodic assistance in the acquisition of English function words. Relative to content words, function words seem to have little phonetic substance, at least in terms of duration, in either ADS or IDS. The diminutive phonetic substance of function words may impede their acquisition in English. English-speaking children's early word combinations typically contain content words, but lack function words (e.g. articles, prepositions, pronouns) and inflections (e.g. –s, -ed). Some children use filler syllables, mimicking what they have possibly learned about prosodic phrasing (see, for example, Bernhardt & Johnson, 1997). The acquisition of these structures is very often a challenge for the child with language learning difficulties. A course of treatment in such instances might need to involve teaching prosodic phrasing or, finding ways to give natural emphasis (i.e. contrastive stress) to function words. Such an approach would provide both prosodic and semantic bootstrapping to the acquisition of otherwise phonetically insubstantial but important details of morphology and syntax.

The low phonetic substance of function words also has implications for the deaf and hard of hearing population or for children with normal hearing who are listening in non-ideal noisy situations. These words are often omitted in the natural speech of such individuals during development. After teaching, it might be the case that unstressed syllables become overstressed (B. Bernhardt, personal communication, January 2002), which is one source of the unnaturalness of their speech. Rather than focusing only on the use and meaning of function words and unstressed grammatical morphemes, rhythmic approaches to speech production are promising.

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APPENDIX A

Listing for each utterance of the number of syllables in an inter-stress interval, the rate of speech, form class membership of unstressed syllables, durations of measured syllables in milliseconds, and the words. Durations of unstressed syllables are listed in ascending order from shortest to longest.

Participant 1 ADS

# of Syllables in an inter-stress interval	Rate Syllables per sec.	Rate coded: fast/ med/ slow	F=function C=content	Unstressed penultimate syllable duration in ms	Final two syllables in the utterance	Stressed final syllable duration in ms
2	6.1	Med	F	29.2	a drive	485.2
1	7.21	Fast	F	34.9	a cat	228.2
2	5.5	Med	F	38.4	a walk	270.9
3	6.34	Med	F	39.4	the road	410.9
1	5.34	Med	F	39.9	a bit	237.2
3	6.63	Fast	F	40.3	a drive	481
2	9.31	Fast	F	43.4	the book	241.7
2	5.18	Med	F	50.7	the books	339.1
1	3.34	Slow	F	52.1	a grey	637
1	4.21	Med	C	64.2	ver spoke	531.5
1	4.89	Med	F	64.3	of cute	292.8
1	6.61	Fast	F	66.2	an hour	352.9
1	4.64	Med	F	66.9	a bridge	492.7
1	6.63	Fast	C	70.3	ry good	174.5
3	5.93	Med	F	70.8	the day	209.7
2	6.56	Fast	F	73.9	the ball	348.5
2	4.71	Med	F	76.1	ya think	298.7
1	8.2	Fast	C	77.6	ther night	304.9
1	3.16	Slow	F	78.6	the beach	537.7
1	4.28	Med	C	79.7	ry nice	438.2
2	6.06	Fast	F	80	the bed	388.4
2	4.22	Med	F	80.7	the scales	587.6
1	6.19	Med	C	84.5	ther day	265
1	5.17	Med	C	84.7	ly does	389.5
2	7.22	Fast	C	86.4	be done	146.6
3	5.04	Med	F	92.8	an hour	309.1
3	4.31	Slow	F	97.2	the crib	528.9
1	5.02	Med	C	99.5	n time	234
1	8.3	Fast	C	99.7	ther night	272.7
1	4.75	Med	F	100	to say	244.4
1	4.94	Med	F	101.6	he looked	281.3
1	4.56	Med	F	101.7	to sleep	450.3
1	2.79	Slow	F	102.5	the same	537.9
1	6.13	Med	C	103.2	so much	337.1
1	7.03	Fast	F	105.6	I read	469.1
1	6.46	Med	C	105.9	der one	312.3
1	6.23	Med	F	109.4	it rhymes	510.8
1	4.48	Slow	F	109.5	the crib	364.5
1	6.3	Med	F	110.3	it rhymed	427.8
3	5.13	Med	F	114.6	his crib	389.9

# of Syllables in an inter-stress interval	Rate Syllables per sec.	Rate coded: fast/ med/ slow	F=function C=content	Unstressed penultimate syllable duration in ms	Final two syllables in the utterance	Stressed final syllable duration in ms
1	6.5	Fast	C	118.4	ther day	354.6
1	4.4	Med	F	122.4	to sleep	461.6
1	3.63	Slow	C	126.4	man Pat	417.6
2	4.04	Med	F	132.3	of mom	336.1
1	3.79	Slow	F	133.5	at all	478.6
1	4.27	Med	F	135.4	thee end	307.2
1	4.79	Med	C	146.4	thing else	371.8
1	4.91	Med	C	146.7	ty guy	428.9
1	3.56	Slow	F	148.1	with cats	398.6
1	4.9	Med	F	150.2	to sleep	447
2	4.55	Med	F	155.1	(h)is own	377.2
1	3.54	Slow	C	155.6	so quaint	353.2
1	4.19	Med	C	162.3	ly likes	425.6
1	5.56	Med	F	166.7	to sleep	430.5
1	5.74	Med	C	175.7	thing else	416.8
2	5.94	Med	C	196.3	fy those	327.1
1	5.68	Med	C	196.6	more times	394.5
1	4.04	Med	C	197	sing cat	508.9
1	4.05	Med	C	229.5	son beach	380.8
2	3.87	Slow	C	233.9	so much	533.1
2	4.62	Med	C	243.8	fies cat	360.6

Participant 2 ADS

# of Syllables in an inter-stress interval	Rate Syllables per sec.	Rate coded: fast/ med/ slow	F=function C=content	Unstressed penultimate syllable duration in ms	Final two syllables in the utterance	Stressed final syllable duration in ms
2	6.24	Med	F	27.2	uh books	492.1
2	5.37	Med	F	30	a break	598.6
2	7.05	Fast	F	33.5	a lot	178.4
1	6.47	Med	F	36.1	of just	247.6
3	6.69	Fast	F	41.5	a big	259.4
1	6.09	Med	F	46	a plant	514.8
2	5.31	Med	F	46.8	uh toys	557.6
2	6.12	Med	F	50.8	the way	307.6
3	6.45	Med	F	52.6	a kid	338.3
3	6.94	Fast	F	53.6	of time	422.9
1	5.42	Med	F	55.7	a lot	272.6
1	7.02	Fast	F	56	ya know	209.9
1	6.43	Med	C	57.1	ty bored	325.9
1	6.86	Fast	F	57.8	of neat	279.9
1	6.55	Fast	F	62.4	don't mind	266.5
2	7.6	Fast	F	62.8	a lean	331.9
3	5.49	Med	F	63.3	a plant	613.4
1	4.17	Med	F	63.7	n stuff	396.3
2	7.51	Fast	F	66.7	your pack	403.2
1	7.03	Fast	F	72.7	the king	356.8
1	5.33	Med	F	76.1	I guess	362.5
3	5.42	Med	F	77.7	I guess	463.7
1	6.52	Fast	C	78.5	ly good	436.6
1	8.54	Fast	C	79.5	by blues	484.9
1	6.19	Med	C	80.1	rite toy	320.2
2	5.99	Med	F	80.5	n stuff	429.7
3	6.92	Fast	F	84	my books	443.8
1	6.21	Med	F	84.9	in Rome	288.9
1	6.34	Med	C	87	ry safe	430.5
2	3.53	Slow	F	89.7	the cars	627.5
2	6.58	Fast	F	90.2	n talk	601.6
2	7.71	Fast	F	91.6	her room	301.5
1	5.37	Med	F	96.2	him play	454.9
1	6.25	Med	C	97.3	cer ball	254.8
2	7.23	Fast	F	97.4	his height	386.7
1	4.67	Med	F	98.3	is good	418.7
2	5.49	Med	F	98.4	a war	425.6
1	5.25	Med	F	99.9	of thing	240.6
2	5.16	Med	F	100.2	ave died	450.3
1	5.5	Med	C	100.3	by books	349.9
1	6.87	Fast	F	106.7	in next	518.6
1	3.91	Slow	F	107.7	the kids	331.8
2	5.47	Med	F	109.6	to do	292.4
2	5.2	Med	F	110.4	his crib	455
1	2.46	Slow	F	110.9	it sucks	540.1
1	4.02	Med	C	115.7	den blocks	629.1

# of Syllables in an inter-stress interval	Rate Syllables per sec.	Rate coded: fast/ med/ slow	F=function C=content	Unstressed penultimate syllable duration in ms	Final two syllables in the utterance	Stressed final syllable duration in ms
1	6.6	Fast	C	117.9	ty flight	384.5
1	5.14	Med	F	118.7	him down	358.2
1	5.15	Med	C	119.5	by food	279.4
1	4.37	Med	F	122.2	to look	522.4
1	5.05	Med	C	123.3	ny day	416.7
1	4.96	Med	C	124.6	tain off	448.2
1	5.22	Med	F	125	is work	319.5
1	8.37	Fast	C	126.8	ving room	246.7
2	4.91	Med	C	136.9	so much	466.2
2	4.91	Med	C	136.9	so much	466.2
1	4.81	Med	F	138.5	him down	576.9
2	6.86	Fast	C	143.9	so weird	226.4
2	4.02	Med	F	146.4	I guess	446.7
1	4.34	Med	C	154.2	tic heads	445.1
2	5.83	Med	C	165.7	ine thing	380
1	5.69	Med	F	178.4	was hard	423.8
1	7.13	Fast	C	188.5	so much	427.2
1	5.12	Med	C	198.8	bel group	501.4
1	5.47	Med	C	203.8	n's room	261.1
1	4.17	Med	C	275.1	pies out	415

APPENDIX B

Listing for each spoken utterance of the number of syllables in an inter-stress interval, the rate of speech, form class membership of unstressed syllables, durations of measured syllables in milliseconds, and the words. Durations of unstressed syllables are listed in ascending order from shortest to longest.

Participant 1 IDS

# of Syllables in an inter-stress interval	Rate Syllables per sec.	Rate coded: fast/ med/ slow	F=function C=content	Unstressed penultimate syllable duration in ms	Final two syllables in the utterance	Stressed final syllable duration in ms
1	4.7	Med	F	38.9	the book	402.1
2	6.63	Fast	F	44.5	the book	382.6
1	4.44	Slow	F	47.1	a car	594.4
2	4.14	Slow	F	51.8	the move	432.6
2	4.73	Med	F	52.8	a ride	562.1
2	4.58	Med	F	54.1	a mug	387.8
1	4.44	Slow	F	55.9	the page	545.4
1	4.63	Med	F	55.9	the book	397.8
1	6.15	Fast	F	56.6	the page	484.3
2	4.78	Med	F	56.8	a book	429
1	4.63	Med	F	59.2	a ball	662.1
1	5.46	Med	F	59.7	the page	450.5
2	4.65	Med	F	64.2	a ride	660.5
1	3.49	Slow	F	65.8	it go	535.7
1	5.28	Med	F	71.1	the page	438.7
1	3.97	Slow	F	72.2	a dog	698.7
1	5.53	Med	F	72.5	the dog	608.8
2	4.51	Med	F	72.6	ya think	541
1	3.98	Slow	F	75	the page	672.1
1	2.92	Slow	F	75.5	a car	712.9
2	4.11	Slow	F	77.2	the move	540
3	6.4	Fast	F	82.2	the book	408.4
1	5	Med	C	82.6	dle boy	495.6
1	4.01	Slow	F	83	a spoon	677
3	3.49	Slow	F	84	the train	701.4
1	3.72	Slow	F	85.9	the page	513.8
1	4.49	Slow	F	86	the crib	751
2	3.12	Slow	F	88	the chair	681
2	5.31	Med	F	92.5	the crib	568.9
2	5.11	Med	F	92.7	your mouth	419.3
3	4.48	Med	F	93.6	the train	533.5
1	4.06	Med	F	94.7	the bed	599
2	3.85	Slow	F	97.3	the van	508.3
2	4.51	Med	F	97.4	the car	609.3
1	3.44	Slow	F	102.1	na climb	629.3
2	4.12	Med	F	102.5	the flap	672.8
1	4.11	Med	F	102.8	a spoon	599.3
2	5.1	Med	F	104.5	to read	396.9
1	4.93	Med	C	105.6	dle pie	481.1
2	2.95	Slow	F	107.9	n Hope	621.8

# of Syllables in an inter-stress interval	Rate Syllables per sec.	Rate coded: fast/ med/ slow	F=function C=content	Unstressed penultimate syllable duration in ms	Final two syllables in the utterance	Stressed final syllable duration in ms
2	4.2	Med	F	111.1	in bed	558.4
1	3.93	Slow	C	113.1	dle man	637
1	2.66	Slow	F	114.2	the cat	714.4
2	4.11	Med	C	115.2	n't go	507.5
1	5.17	Med	C	117.5	dle car	574.7
1	5.34	Med	C	118.7	dle boy	486
2	5.16	Med	F	121.9	the park	614.5
2	4.14	Med	F	122.2	an egg	460.5
1	4.05	Med	C	125.7	rey fish	604.6
1	4.08	Med	F	126.1	the flap	577.1
1	3.77	Slow	C	127.1	dle bit	399.8
1	5.98	Med	C	127.3	ther day	476.8
1	4	Med	C	130.3	dle bit	538
1	4.33	Med	C	137	dle pie	671.1
2	3.44	Slow	F	137.2	in bed	713
2	4.55	Med	C	139.1	ty neat	332.6
1	3.29	Slow	C	139.9	els look	482.1
1	4.11	Med	F	144.4	for mom	389.4
1	3.92	Slow	C	145.5	mmy boy	553.4
1	4.67	Med	C	146	dle man	608.7
1	3.86	Slow	C	147.1	ty neat	522.6
1	3.51	Slow	C	147.9	dle pie	804.9
1	4.6	Med	C	149.3	dle pie	596.2
2	3.41	Slow	F	153	and Claire	697.5
1	2.45	Slow	C	154.2	ny one	502.9
1	4.08	Med	F	156.9	his tail	593.1
1	3.87	Slow	C	160.5	ther night	631.2
1	3.03	Slow	C	160.7	ry well	436
1	3.77	Slow	C	160.9	dle man	434.4
1	2.51	Slow	F	165.1	nd soft	1110.7
2	4.51	Med	F	167.8	with mom	586.2
1	3.9	Slow	F	168.6	that fun	484.2
1	2.51	Slow	F	170.5	some books	755.9
1	3.61	Slow	C	170.5	ny one	553.5
1	2.9	Slow	C	172.3	dle boy	1142.1
1	3.43	Slow	C	172.6	py cat	668.3
1	3.98	Slow	C	189.7	dle snooze	888.7
1	3.05	Slow	C	191.8	dle pie	668.3
1	5.33	Med	C	192	oes back	386.8
3	3.62	Slow	C	197.2	be there	644
1	5.58	Med	C	204	dle hug	519.3
1	3.59	Slow	F	205	with me	429.1
1	2.69	Slow	C	213.6	ver boy	1013.5
1	2.58	Slow	F	223.5	has stripes	909.7
1	2.43	Slow	C	224.5	ting hurts	806.7
2	3.86	Slow	C	256.7	nil car	524.1
1	2.78	Slow	C	258.2	ing down	753.5

Participant 2 IDS

# of Syllables in an inter-stress interval	Rate Syllables per sec.	Rate coded: fast/ med/ slow	F=function C=content	Unstressed penultimate syllable duration in ms	Final two syllables in the utterance	Stressed final syllable duration in ms
2	7.17	Fast	F	35.7	a change	583.1
1	7.67	Fast	F	39	the ball	410.6
2	3.64	Slow	F	43.2	the bag	726.8
1	4.66	Med	F	44	uh toys	741.7
1	5.75	Med	F	47.1	the ball	355
1	5.55	Med	F	47.7	your mouth	358.1
2	3.05	Slow	F	48.9	of blocks	828.1
1	5.82	Med	F	51.2	the ball	358.8
3	5.12	Med	F	51.7	your mouth	282.1
2	6.57	Fast	F	52	the floor	422.9
1	5.94	Med	F	52.5	your mouth	346.5
2	4.98	Med	F	52.9	the blocks	664.6
1	4.88	Med	F	55.8	the ball	511.8
1	4.9	Med	F	56	the floor	570.9
1	5.34	Med	F	56.2	the page	433.7
3	5.65	Med	F	59.5	the blocks	639
2	6.46	Med	F	59.7	the air	391
2	5.38	Med	F	59.8	the ball	453.1
1	4.05	Med	F	62.9	a mess	597
1	6.08	Med	F	63.2	it goes	299.3
1	6.72	Fast	F	63.8	n down	391.9
1	5.06	Med	F	64.4	uh fun	507
1	4.75	Med	F	65	it goes	443.9
1	5.92	Med	C	66.6	ry much	492.3
3	8	Fast	F	66.7	your mouth	301.1
2	4.93	Med	F	67.8	of books	653.2
1	4.08	Med	F	67.9	the sky	584.9
2	7.7	Fast	F	70	your mouth	413.3
1	6.73	Fast	F	71	the spoon	465
1	6.49	Med	F	71	the ball	383.9
1	4.08	Med	F	73.6	your hands	659
1	7.5	Fast	F	73.8	n down	256.2
1	4.76	Med	F	75.5	it goes	458.1
2	5.13	Med	F	77.1	the ball	594.8
1	4.53	Med	F	77.4	we made	436.6
1	5.94	Med	F	78	it out	308
1	6.45	Med	F	79.2	of fun	331.6
1	2.27	Slow	F	79.5	your face	671.1
1	2.58	Slow	F	79.7	your bus	880.4
3	6.63	Fast	F	80.5	your hands	480.5
1	6.03	Med	F	82.1	it goes	487
2	7.48	Fast	F	84	yourself	314.7
1	5.63	Med	C	87	dle boy	280.6
1	3.72	Slow	F	90.3	the book	588.5
1	5.43	Med	F	94.3	it out	491
2	4.27	Med	F	95.8	to touch	490.4
3	7.18	Fast	F	96.4	your big	435.5

# of Syllables in an inter-stress interval	Rate Syllables per sec.	Rate coded: fast/ med/ slow	F=function C=content	Unstressed penultimate syllable duration in ms	Final two syllables in the utterance	Stressed final syllable duration in ms
1	4.77	Med	C	98.4	ry page	691.5
2	5.27	Med	C	100.2	dle guy	504.2
1	6.74	Fast	F	100.3	your head	370.8
1	5.91	Med	C	104.1	ther balls	435.9
2	4.57	Med	F	104.2	thee air	520.1
1	4.55	Med	F	108	the weeds	759.2
1	6.05	Fast	C	108.6	tty neat	395.3
2	3.67	Slow	F	121	the ball	594.7
1	4.88	Med	C	123.2	ppy toes	518.6
1	4.87	Med	C	125.1	ny rings	464
1	4.05	Med	F	126	for sure	385.1
1	5.03	Med	C	127.4	den blocks	514.2
1	5.54	Med	C	127.9	zy ball	468.1
1	4.79	Med	C	128.2	n't bounce	526.2
1	6.2	Med	C	129.2	gry boy	432
1	2.38	Slow	F	129.2	the blocks	1009.4
1	6.16	Med	C	130.2	ther things	481.1
1	4.01	Med	C	131	ther blocks	652.6
1	5.41	Med	C	132.2	ty noise	535.9
1	5.95	Med	C	132.6	zy ball	531.7
1	3.28	Slow	F	137.6	it rolls	656.2
1	4.98	Med	C	138.7	ving room	278.9
1	6.72	Fast	C	143.4	ket too	298.2
1	6.7	Fast	C	148.7	my's toast	461.5
1	3.5	Slow	C	155.5	ting fast	734.3
1	6.89	Fast	C	160	na too	363.8
2	5.92	Med	C	161.3	so bad	385
1	2.64	Slow	C	166.5	low square	882.8
1	5.05	Med	C	170.6	my's mouth	268.3
1	5.35	Med	C	171.5	king cup	361.9
2	5.34	Med	C	207.3	some juice	370.5
1	5.07	Med	C	274.6	fast bud	350.6

APPENDIX C

Participant 1 IDS: The beginning of a 45-minute interaction with her 11-month-old son. Only Participant 1's utterances have been transcribed.

1 M., yeah it was different this morning, hey.
2 Yeah, were you watching mommy in bed?
3 Were you watching mommy in bed?
4 Yeah, little M. put himself all to sleep by himself.
5 What did you think of that M. ?
6 What did you think about going to sleep by yourself?
7 You didn't get lonely cause mommy was right there, right?
8 Yeah, you watched mommy and mommy was lying on the bed.
9 And little M. was in the crib.
10 Yeah that's a little man.
12 That's a little man in the crib.
13 Yeah that's a little man.
14 And then you had a little snooze.
15 Yeah, cried a little bit.
16 Cried a little bit.
17 And then you kind of wondered how come mommy didn't wake up right, yeah?
18 It was hard for mommy.
19 Did you know that?
20 Was a little bit hard for mommy.
21 Yeah, didn't want little man to be lonely.
22 Ah, you see.
23 You see a car.
24 Is that your little car?
25 Is that your little car?
26 Oh, see look.
27 (?) You go backwards.
28 It goes forward see.
29 (?) Yes, it goes forward.
30 Whoa, did you do that?
31 Did you make it go?
32 'Gain, let's make it go.
33 M. push.
34 Let's push, yeah.
35 Do you know what kind of car that is M. ?
36 That's a Volkswagon.
37 Black Volkswagon, yeah.
38 Lets move these cause this is dad's catalogue.
39 Yeah, a little worse for wear.
40 Yeah, we'll move this.
41 And mom'll move this.
42 Have you got the hiccups little pie?

43 Have you got the hiccups little boy?
44 Have you?
45 What? What?
46 Mommy's gonna have some tea.
47 Mmh, nice tea in a mug.
48 Yeah, so do you think tomorrow maybe we'll sleep like that again M. ?
49 What do you think?
50 Mommy'll be there,
51 And M. 'll be in the crib.
52 By himself like a big boy.
53 And M. 'll be in the crib
54 Yeah, that's a microphone, yeah.
55 What shall we do that tomorrow?
56 Oh, do you see some books that Robyn brought?
57 What do you see?
58 Oh, there's some books.
59 What's that?
60 That's called Let's Try.
61 Yeah you notice the microphone.
62 That's where Robyn listens.
63 Should we read a story, dya think?
64 Oh look, there's a baby.
65 Little baby.
66 Baby called Pickle.
67 And what's that?
68 Is that a ball?
69 It's a ball.
70 Baby and the ball.
71 And what else, oh look.
72 Let's have a look at this one.
73 Ah, look...
74 It's a dog.
75 Jack, he's called Jack, Jack the dog
76 Yeah, let's look.
77 It's called, It's Bathtime.
78 Oh look, hi Jack.
79 Let's get ready.
80 Jack needs his yellow duck!
81 Look.
82 Jack needs his yellow,
83 Can M. lift the flap?
84 Can M. lift the flap?
85 Jack needs his yellow quack, quack, quack.
86 Who's that?
87 Duck!
88 It's duck.

89 Little wing, see a little wing.
90 Duck's little eye.
91 M. turn the page.
92 M. turn the page.
93 Good job.
94 Jack needs his red...boat!
95 Look a boat!
96 Just like the one daddy's building, boat.
97 What does it say, it says
98 "It's a boat to play with, says Jack."
99 Look, yeah, can you open it again.
100 There's a red...boat.
101 It's a sail boat.
102 Yeah, daddy's making M. a sailboat to sail in.
103 Shall we see what's on the next page?
104 Okay Mom turn the page.
105 Mom turn the page.
106 My...oh no, no don't touch that OK M. ,
107 No, that's not for play, OK.
108 That a boy.
109 That a boy.
110 Jack needs his blue...
111 Can M. open the flap?
112 Yeah, you open.
113 You can open it.
114 Here, maybe if we sit that's easier.
115 Jack needs his blue...
116 M. open.
117 "Fish, splish splash, says Jack."
118 Slippery fish, slippery fish, swimming in the water.
119 Slippery fish, slippery fish, gulp, gulp, gulp.
120 Oh no, it's gotten eaten by a...
121 Fish! Little blue fish.
122 Yeah, that's like in the song Slippery Fish.
123 Senook.
124 There's Jack and he's got his boat,
125 And his duck.
126 Oh, your very squirrely boy, aren't you?
127 Very squirmy boy.
128 Yeah, I read book only if I can move.
129 Jack, are you going to clap, oh that's nice.
130 You clapping M. ?
131 You doing a little clap,
132 What's out there?
133 What did you see, the wind?
134 Yeah, the windy swish, windy in the trees.

APPENDIX D

Participant 2 IDS: The beginning of a 45-minute interaction with her 8 ½-month-old son. Only Participant 2's utterances have been transcribed.

1 Oh, my goodness, you don't like the bib, do you?
2 You don't like the bib very much.
3 Mhh, yummy oatmeal.
4 Want some juice, too?
5 Mommy give you some juice, hm?
6 Wow, that makes a pretty cool noise, doesn't it?
7 It makes a pretty nifty noise.
8 Yeah, mango and orange juice.
9 Oh boy, that's exciting, isn't it?
10 You like your drinking cup.
11 I guess I can give you some of this banana, too
12 What a great breakfast bud.
13 What a great breakfast.
14 Huh, is that good?
15 That's a good little guy.
16 Oh, you're looking at my toast.
17 Are you looking at mommy's toast?
18 Oh, what's up?
19 You don't like oatmeal this morning?
20 Or you just want to eat it off your hands?
21 Ah, yum, there you go.
22 Yeah, I was looking at some pictures this morning of you and I.
23 Yes I was.
24 I've got to get them together and send them off to your G.
25 To your aunt J.
26 Cause they can't wait to see pictures of you.
27 Some video tape, too.
28 All your cousins want to see you crawling, A.,
29 All your cousins want to see you crawling.
30 Mhh, good eater.
31 You're a good little eater.
32 There ya go.
33 There ya go.
34 I can't wait to see this bag of toys, huh?
35 All new toys for you to look at.
36 That's gonna be so exciting.
37 Yeah, you're probably getting kind of bored of your old toys.
38 Like your bus,
39 And your truck book,

40 And your caterpillar, yeah
41 And your blocks,
42 Getting a little bored with those?
43 Like your bus
44 It's nice to have a bit of a change, mh?
45 Oh, yeah, really?
46 And what else happened?
47 Okay, ready?
48 In your mouth.
49 In your mouth.
50 That's what you do when it's on the spoon
51 In your mouth, A..
52 That's what you do, you hold it in your hand and you,
53 Put it in your mouth.
54 You can put it in mommy's mouth, too, hm?
55 Are you going to put it in mommy's mouth?
56 Mmh, thank you.
57 Kay, we'll use this spoon then.
58 It was fun outside yesterday, wasn't it, crawling around in the back yard?
59 On that wet grass?
60 And helping mommy pull the weeds,
61 Out of the garden.
62 You're gonna be a good little helper when you get bigger.
63 Oh, that's not the place for the spoon, bud.
64 Now it's on the floor.
65 Oh, boy, it's a messy breakfast.
66 Is it a messy breakfast today?
67 Do ya want a bit of banana?
68 You can pick that up.
69 Can you pick that up?
70 Put it in your mouth, hm?
71 Or do you want me to do that?
72 Mhh, banana.
73 You want to pick up that piece?
74 There ya go.
75 There ya go.
76 Pick it up by yourself.
77 Is that good?
78 That yummy?
79 You were pretty hungry, weren't ya?
80 You're just a hungry boy.
81 So your grandma W.'s coming over this weekend.
82 She hasn't seen you in a long time.
83 Yeah, Grandma W.'s coming.

84 She's gonna be excited to see you.
85 That's for sure.
86 Yeah, we'll probably go to Vandusen Gardens.
87 Take a walk through the garden.
88 You liked that, didn't you, when we went last time.
89 You liked that.
90 Oh boy, you ready.
91 Oh, dear, here, why don't you hold on to that spoon.
92 Why don't you hold on to that spoon, A.?
93 Always good to have your own spoon to hang on to.
94 There ya go.
95 Did you spit it out, don't spit it out.
96 Kay, almost done.
97 Two more bites.
98 Two more bites, A..
99 Open up, there ya go.
100 Kay last one, spit it out.
101 You're going to sit up a little bit?
102 There we go.
103 That's better.
104 We'll go and check out these toys.
105 See what R. brought us.
106 Hm, there ya go.
107 There ya go.
108 Good boy.
109 Dya want another bit of banana?
110 That good?
111 What a mess what a mess.
112 What a mess we made.
113 All over your shirt, oh yuck!
114 Okay, I'm gonna wash your face.
115 You ready?
116 I'm gonna wash your face.
117 Oh, I know you hate that.
118 I know
119 There ya go, oh.
120 Nkay, wash your hands.
121 Wash your hands.
122 We gotta wash your hands, yeah
123 Okay, there ya go,
124 That wasn't so bad, was it?
125 That wasn't so bad.
126 Okay, let's go check out these toys.
127 You want some juice?

APPENDIX E

Participant 1 ADS: The beginning of a 45-minute interaction with an adult female friend. Only Participant 1's utterances have been transcribed.

1 Good, you're getting levels.

2 This is so bright, K.,

3 It's just so lovely.

4 So we're, we're here at K.'s, um, music making machine

5 K., are you, are you, um, doing much practicing at the moment?

6 Short answer!

7 Okay great.

8 No, we're just at some point we're going to read and it, work in the books, but, um.

9 Actually I already had a, this is quite comfy but I had a little nap with M. this afternoon.

10 I did yes, little man had to sleep, and

11 he slept for all of um,

12 mmh, bout 15 minutes this morning.

13 And then we tried the rocking him, and then ah,

14 And then ah, that didn't work, and then I, you know, and then I the sort of lie him down in bed, cause he will sleep when he's with us right but.

15 Yeah why were we so late last night, oh, cause S. had to work late.

16 Um, yeah he didn't he was probably asleep at um,

17 About ten after eleven or something like that,

18 Yeah it was kind of, it was late last night.

19 But um, he was okay he actually slept through the night.

20 But we been, um we've been trying um, and this is one of the things that I talked to M. about when R. did the first taping, that um,

21 We, um, I've been trying this new sleeping approach.

22 I don't know if I've told you about that, but,

23 Well basically it's just kind of getting to the point where it's, it's kind of it kind of frustrating that, you know, he ah, he won't,

24 What are you smiling about?

25 You're watching this are you?

26 K. would you like to touch it?

27 Okay, I'll put it underneath my shirt.

28 This should be really easy for R., it'll just be like one monologue to transcribe.

29 She had a really quiet friend.

30 She never spoke.

31 She made some good eats though.

32 0h I never, I never find that with you.

33 What was I saying, you know our friend M.?

34 Our friend M. D.?

35 0h he is, he is so bad for that.

36 We went out for, um, it was really nice, we went out for dinner with J. and M. and L., on last Friday.

36 Which was really nice, we just haven't seen those guys so much.

37 And um, but M. is like, oh my God, he's just,
38 he, he, he, he cannot, cannot not interrupt.
39 No, it's almost like pathological,
40 And the funny thing is, it's because he's, he's this really witty guy
41 And so, so he's always got just with one more, funny thing to say
42 It's gotten to the point almost where I know that when I start saying the sentence I'm going to be interrupted.
43 It's really odd, you know, like I sort of,
44 So I never find that with you.
45 0h S. always accuses of me of that actually.
46 Well exactly as long as it's mutual.
47 I was actually fairly on time tonight.
48 I was only about maybe four minutes late.
49 Anyway, oh, I know, what, what I was saying to you, um.
50 Yeah, no, with M. and sleeping it's just um, we've always held him so much.
51 And, you know, held him in a sling, and it's just, it's been,
52 I mean, it's been, such a, it's been magic, it's been so easy, but um,
53 At some point, you know, he's gotta,
54 He has to learn how to, um,
55 Put himself to sleep, you know, or to be able to sort of be, be put down when he's still kind of just drowsy but awake, and be able to kind of,
56 Do that on his own, so
57 Well, I know, yeah, but in some ways it's like oh, but maybe we should have been doing this months ago.
58 I don't know.
59 But anyways, it's funny because we've sort out been thinking about that for awhile, and
60 Periodically try really unsuccessful things like,
61 You know, leaving him in the crib and then walking away.
62 So I've tried this different thing the other day, I actually, I, I, he was like sort of rocked him a bit, and he was kind of drowsy, but I put him in his crib.
63 And, ah, you know, put the blanket over him and kinda said you know it's nap time now M..
64 You know, and then, and then of course the minute I walk away from him,
65 And he's like standing up there, you know, standing up by the rungs going ha, ha,
66 Even though he's like almost asleep.
67 So I just actually lay down on the bed.
68 And, um, didn't look at him.
69 I kind of played dead.
70 And I thought, you know, I know he's tired, I just know that he needs it.
71 I did yeah, yes, yes maybe that's a bit morbid.
72 I played asleep
73 I played asleep.
74 No, but if I had really been playing asleep I guess I should have been snoring.
75 Actually I was lying on my back going, Goddamn it when are you going to go to sleep.
76 And it took him three quarters of an hour.

77 But he finally went to sleep.
78 No, a lot of the time,
79 Well actually he was, at one point I know he was, he was standing at the end of the crib watching me and I could hear the teeth going...
80 Oh, the whole, the whole edge of the crib has these little like, these whole chunks of paint out of it.
81 Okay, is there lead in it, no
82 No actually I mean that's one thing they don't, they make, um
83 I think they make pretty safe things for kids these days.
84 Oh, it's hilarious.
85 He just um, he, he eventually, he eventually just exhausted himself, but he didn't cry the whole, he cried a little towards the end.
86 When I guess he was finally realizing I wasn't going to pay attention but, um
87 Oh, it was just, it was really an exercise in patience, you know, I was thinking, this, you know, okay, half an hour.
88 And he just would roam around the crib and then I surreptitiously steal a glance and he'd be,
89 You know, he'd be down there at the end kind of,
90 You know, looking at, looking at one of his toys and then he'd bind up and he'd come back to my end and he'd go, ah, ah.
91 Trying to get my attention.
92 Hey, mom.
93 So, so that was the day that R. came over so we, um
94 So that's one of the things I talked to M. about I said, so,
95 You know, what did you think about going to sleep all by yourself?
96 Anyway I've tried it a few more times, I
97 And it's taken him,
98 I've tried it maybe two or three more times, and
99 I didn't, I, I decided it was way too boring trying to sit and play asleep so I read.
100 Well what I really want to do is to bring projects in and I thought well I can work on my quilt and I thought no,
101 The quilt will be way to visually stimulating watching me when, you know, so
102 Book is not as interesting, so,
103 So, I mean I, I don't know.
104 My theory is that maybe he'll get sort of get more use to just being in the crib
105 And being with his stuffed toys, and, you know.
106 Well the theory I don't know, I mean, it's all about, it's theories isn't it, but, um,
107 I do know, I, I, I do have friends, that um,
108 That you know, that simply when the baby's sort of getting kind of sleepy when they're still awake they just go and put them down and the baby
109 Actually falls to sleep.
110 Yeah I know.

APPENDIX F

Participant 2 ADS: The beginning of a 45-minute interaction with an adult female friend. Only Participant 2's utterances have been transcribed.

1 Wow, so I get to read ya "Good Night Moon."
2 Yeah, this is a cool little high chair, eh?
3 Oh, that's great.
4 Just basic.
5 Yeah, that's cool.
6 Oh, let's see what's in the Bengle Spice again.
7 I don't think it is.
8 Nope, I'm sure I've had it before.
9 Yeah, no caffeine.
10 Cinnamon, chicory, carob
11 I'll have the Bengle Spice.
12 Oh yeah, I don't usually drink herb tea with milk.
13 That'll be a great trip back for you guys, though.
14 You'll have that nice transition when you come back.
15 It's actually not so bad going there.
16 For some reason, yeah.
17 I'm not sure why it's like that but I notice it for myself too, I, I feel more affected on the way back.
18 Cause you actually lose time on the way back, don't ya?
19 Or you get your three hours back on the way back, too.
20 Cause I found, if I'm going there, I think it was just the first, or he was waking up during the night anyway,
21 But he, it wasn't, he wasn't cranky or fussy or anything.
22 But it was coming home after being around all those people, that was the adjustment?
23 It's amazing how he got so use to that.
24 Oh but still, there's always gonna be someone.
25 And you'll get lots of free time.
26 Get to hang out, yeah.
27 In the living room?
28 Yeah, that would be good, especially if you're gonna be, cause how long are ya gonna be at your parents place for?
29 Yeah, that would make it worthwhile ta.
30 If your sister doesn't mind moving out of her room.
31 Cause that makes that yeah, my mom had a room set up for us with a,
32 A crib in it and everything and.
33 See if they can rustle up some stuff.
34 Anyone who's got kids.
35 Cause she's probably still a weight you can use the bassinette part.
36 Then it's just a bit of a lean.
37 Oh right, right, right I heard that someone had a suspicious,
38 I know and Christmas.
39 Well you're lucky you're flying three weeks before Christmas.

40 Well hopefully it won't because if, if there's nothing like that going on I think, I think it's smooth sailing cause noone, not many people are travelling right now.
41 So you might have an empty flight.
42 Yeah, I know.
43 Yeah, it sucks.
44 I saw a really good, a friend of mine email me a,
45 Really great article from the Guardian?
46 Which, I think the Guardian's a British paper, isn't it?
47 Yeah, I mean if you have email I can forward it to you, I just thought it was really good.
48 About.
49 No, not particularly.
50 It wasn't depressing, it was more like,
51 Really good insight on to was going on and how
52 Thee,
53 Oh yeah, huge eh?
54 Wow it's becoming illegal, it's becoming an act of,
55 I won't have any actually I'll just, and you can just leave the teabag in for, I usually leave the teabags in on herb teas, I don't find them all that strong.
56 Yeah, this article talked about the,
57 A lot about the US military and the government and, just the whole thing that they were involved in.
58 It's so convoluted.
59 That you know they backed.
60 They backed the Afghans, and they backed these people, they've got their fingers in all these different,
61 Wars and,
62 And who are we fighting really and.
63 Oh on the floor's fine, if you don't mind.
64 Thanks, that's great.
65 Just that and it, it ended up sorta, it kinda winded up, almost comparing.
66 Not comparing,
67 Almost comparing contrasting,
68 Olsama Bin Laden and George Bush and.
69 Almost like a yin yang sort of thing, like.
70 One is, this, one is the dark, one is the good, but not really the good because he's got all his fingers in that, and one's.
71 It's, it's almost,
72 Taking them both separately for what they,
73 Stand for
74 And thinking that they, like Bin Laden even stands for, not the same thing but he's, in his on way,
75 In his own world,
76 Doing his thing, and commanding,
77 This and.
78 Yeah, I didn't realize so much.
79 No, I know.

80 No yeah, I know.
81 Yeah, I know, I know it's unfortunate.
82 I guess that this guy made a mention of that, too, this, the sanctions in Iraq.
83 And saying that you know fifty thousand children have died, and.
84 Because of it.
85 And I guess.
86 Who was it, the woman, it's a woman,
87 Senator, I don't know who it was, who said, you know someone point blank, an interviewer asked her,
88 "Dya think it's worth it, like fifty thousand children have died due to these sanctions, do ya think that's worth it?" and she said well
89 You know if you're weighing and,
90 Pros and cons and this and that, she goes, yeah.
91 Yeah, this article was incredible.
92 And the whole heroine thing, and.
93 Oh my God.
94 Well, just that, that,
95 The, the Afghan government needed money so they made all the farmers grow opium and now they've created, you know, over a million addicts.
96 In, between Pakistan and Afghanistan.
97 And that heroine actually supplies all the heroine to the US.
98 So, so basically this guy's saying that it's a,
99 It's not, it's not even a war, it's like it's, it's, the US has named it.
100 Or you know, Bush has named it,
101 Ah, this war against terrorism.
102 And he was saying that, that you know the people that did it.
103 Oh oh, I guess the FBI had issued a statement saying that, you know, there's some questions about the identity of the,
104 Highjackers.
105 Same day that George Bush said that
106 You know, it's, we're sure it's them and so like does he know something that the FBI doesn't?
107 You know, that he's not telling us, or?
108 Cause, cause I'd didn't realize all the,
109 I mean I have my suspicions and conspiracy theories and stuff, but.
110 I, I just didn't realize what,
111 The US government had been involved in over the years, so much.
112 Yeah, I know.
113 It'll, cause and it, it's not even against, I mean they're not even positive it was Olsama Bin Laden.
114 And, but then they're,
115 They're going against the Taliban, they're bombing Afghanistan which is a country that.