2011-08-03

The Effects of Gender and Elicitation Method on the Prosodic Cues Used by 7- to 11-year-old Children to Signal Sentence Type

Lacey Ann Powell
Brigham Young University - Provo

The Effects of Gender and Elicitation Method on the Prosodic Cues Used by 7 to 11 year-old Children to Signal Sentence Type

Lacey A. Powell

A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of

Master of Science

Shawn L. Nissen, Chair
Ron W. Channell
Christopher Dromey

Department of Communication Disorders

Brigham Young University

December 2011

ABSTRACT

The Effects of Gender and Elicitation Method on the Prosodic Cues Used by 7 to 11 year-old Children to Signal Sentence Type

Lacey A. Powell
Department of Communication Disorders
Master of Science

The purpose of this study was to examine the prosodic cues used by 7 to 11 year-old children to signal questions and declarative statements in terms of changes in fundamental frequency (F0), duration, and intensity. Additional aims were to evaluate how children's use of prosody changes as a function of gender and method of elicitation. A group of 16 children participated in three different types of elicitation tasks (imitative, reading, and naturalistic). An acoustic analysis revealed that the participants produced the different sentence types using a variety of acoustic cues. Not only do children vary the mean of F0 and intensity at the end of the sentences, but they also seemed to use relative differences in peak intensity and F0. Differences between sentence types were also found in the F0 and intensity slope in the terminal portion of sentences. In addition, the way in which the participants signaled sentence type changed as a function of speaker gender and elicitation method for a limited number of acoustic measures. Although the present study found acoustic differences in how the participants' produced the sentence types, additional research is needed to determine the perceptual impact of such differences.

Keywords: children, development, elicitation, gender, prosody, suprasegmental

ACKNOWLEDGMENTS

I would first like to thank my thesis chair, Dr. Nissen, for your time, encouragement, and confidence throughout this process. I appreciate all of the hours you have put in editing many drafts, analyzing the data, and providing me with feedback and suggestions. Thank you for cheering me on and encouraging me every step of the way. I would also like to thank my committee, Dr. Dromey and Dr. Channel for your time, expertise, and insights.

I am also very grateful for the support of a wonderful cohort—Shara, Maggie, Aersta, Chelsea, Jen, Keri, Brandon, and Matt. I have truly enjoyed studying, laughing, commiserating, and working with each one of you over the past two years. Your friendship is the reason that I enjoyed graduate school as much as I did.

I would also like to sincerely thank my parents for both their financial and emotional support throughout my education at BYU. Thank you for your many prayers, unfailing love, and all that you have sacrificed on my behalf. I am also grateful for the love and encouragement from two of my greatest examples—my sisters.

My sincere gratitude and love goes to my husband Ryan. I appreciate your complete patience over the past year as I worked toward finishing this graduate program. I love you for being so understanding and providing constant support whenever I need.

Table of Contents

List of Tables

Table Page

List of Figures

Figure Page

List of Appendices

Introduction

The use of prosody is important for speech communication. While the meaning of an utterance is primarily conveyed to the listener through combinations of sound segments or phonemes that make up words, a significant portion of the meaning in an intended message is also expressed through the suprasegmental or prosodic aspects of speech. Prosodic cues are conveyed through acoustic features such as relative changes in fundamental frequency (F0), intensity, duration, tempo, and even vowel quality differences (Crary & Tallman, 1993; Wingfield, Lahar, & Stine, 1989). These acoustic features can be expressed independently or in combination to create a variety of prosodic cues that are perceptually salient to a listener. For example, a speaker will often raise the F0 of syllables or words for emphasis. Researchers have also shown that duration and intensity tend to increase on stressed words or syllables (Bolinger, 1989). Prosodic cues can be limited to a single sound or extend over whole words, sentences, or even conversations.

Communicative Functions of Prosody

The use of prosodic cues can help speakers accomplish a number of different communicative functions. Prosody can be used to convey different emotional states to the listener, intentionally or not. As speakers vary their F0, different emotional states are conveyed to the listener. For example, prosodic cues of higher mean F0 and greater F0 variability are typically perceived as happiness by listeners (Viscovich et al., 2003).

Prosodic cues can also direct the listener to a particular portion of an utterance that contains important or contrastive information. Bolinger (1978) found that speakers in a majority of languages used the cues of accent and tone to direct listeners to particular points of emphasis in an utterance. The ending portion of questions and some types of non-questions were found to

have a terminal upward glide in F0. Speakers have also been found to contrastively accent various portions of utterances by varying the duration or intensity of those portions of speech (Cruttenden, 1986).

Another function of prosody is the facilitation of listener recall. A study by Stine and Wingfield (1987) evaluated the degree to which young and elderly adults rely on natural prosodic contours in speech recall. Using a series of word strings with different types of prosody, the researchers concluded that both young and elderly adults had better immediate recall of sentences with typical prosody than those with absent or atypical prosody. This study provides some evidence that prosody is used to facilitate listener recall.

Research has also shown that through the use of prosody, speakers can effectively indicate boundaries in speech, within and between sentences. A study by Lehiste, Olive, and Streeter (1976) examined the effectiveness of varying the prosodic cue of duration to indicate proper boundaries in sentences. Findings from this study revealed that speakers were able to effectively signal sentence boundaries by modifying the durations of words at the beginning and end of utterances.

Prosody can also help speakers clarify lexical ambiguities in an intended message. In a study conducted by Beach (1991) participants were presented with sentence fragments that had two options for completion and were instructed to determine from which of two alternative sentences they thought the fragment originated. Results revealed that listeners consistently chose the sentence ending that was implied by prosodic information of the sentence fragment. Thus, the authors concluded that lexical ambiguities may be clarified by speakers through the use of prosodic cues.

Another important function of prosody is to assist a speaker in signaling sentence type. For example, without prosody, the meaning of the sentence *Jane went to school* could be ambiguous. In English, this sentence can be expressed either as a statement or a question depending on the speaker's intonation. For typical English speaking adults, it is generally accepted that yes-no questions and interrogative statements are marked with rising intonation and declarative statements by a terminal downward glide in F0 (Bolinger 1989; Chafe, 1988; Miller & Schwanenflugel, 2006). For example, the question *Do you have any money?* would typically be expressed with a rising F0 contour. However, the statement *You need to go to the bank* would be typically be stated with a terminal downward glide. Relative changes in F0, duration, and intensity are used to signal sentence type, with F0 being the most perceptually salient to listeners (Allen & Arndorfer, 2000; Eady & Cooper, 1986; McRoberts, Studdert-Kennedy, & Shankweiler, 1995). While there is a substantial body of knowledge surrounding how adults signal sentence type, there are gaps in the literature regarding this function of prosody in children.

Children's use of Prosody to Signal Sentence Type

One area in need of additional research is how and when speakers develop the ability to prosodically mark sentence type, especially across different age groups. Few researchers have conducted studies with older children to examine the prosodic development of signaling sentence type. To date, most research that has been conducted to examine prosodic development in children has been done with infants or preschool-aged children (Leob & Allen, 1993; Patel & Grigos, 2006; Wells, Peppe, & Goulandris, 2004). Since a primary mechanism of signaling sentence type in adults involves varying the F0 contour across an utterance, findings from studies that examine the ability to control intonation may be indicative of a young child's ability to mark

sentence type. Snow (1994) examined the development of prosody in children ages 12 to 20 months. Findings from this study indicated that children acquire the skills to control intonation before being able to control timing. Additionally, Leob and Allen (1993) examined 3 and 5 year-old children's abilities to imitate various intonation contours of modeled sentences. These researchers concluded that the older children were able to more consistently imitate the various F0 contours, while the younger children were only able to partially imitate the contours. Wells et al. (2004) hypothesized that as participants listened to and repeated a list of familiar and unfamiliar words, the unfamiliar words would be repeated with a rising intonation, thereby marking an inquiry. Researchers found that a group of younger children (5-year-olds) had more difficulty producing a rising tone than the older group of children (13-year-olds). These results indicated that children's ability to mark questions with rising intonation improves as children mature into preadolescence. Findings from each of these studies provide some insight into the beginning stages of how young children develop the ability to vary their F0 during speech, but these studies fail to give a comprehensive view of the various means children use to signal the sentence type.

Several studies have more directly addressed how children signal sentence type. Allen and Arndorfer (2000) conducted an experiment to examine sentence-final intonation contours produced by hearing-impaired and normally hearing children between 7 and 15 years of age. Children's speech samples containing both matched interrogative and declarative statements were used in a perceptual task where adult listeners identified the intended sentence type. The adult listeners were able to correctly identify whether the utterances were an interrogative or a declarative with a high degree of accuracy for the normal hearing children, which provides some evidence that children may have developed the ability to signal sentence type by 7 years of age.

Patel and Grigos (2006) found that between 7 and 11 years of age children begin to exhibit adult-like prosodic patterns, including the ability to mark sentence type. Their findings revealed that similar to adult speakers, the child participants primarily relied on relative changes in F0 to signal sentence type.

While previous studies have provided some insight into the development of prosody, further research is needed to provide a more complete understanding of the continuum of prosodic development. One longitudinal study by Smith and Kenny (1998) has shown that for children of similar chronological age, prosodic aspects of speech are not acquired at the same rate or with the same developmental pattern. Their data provide some evidence that although a child develops the ability to use one prosodic cue in an adult-like manner, they are often not as adept at using other types of prosodic cues.

Studies need to be conducted with larger sample sizes to more fully understand how children develop the ability to signal sentence type. To date, most studies in this area of research have been conducted with a relatively small numbers of subjects, which limits the ability to generalize findings to the population at large. The study by Allen and Arndorfer (2000) involved six child participants and the study by Patel and Grigos (2006) involved four participants in each age group. These studies have provided valuable insight into how some children signal sentence type, but since children do not develop the use of prosody uniformly (Smith & Kenny, 1998), studies with larger numbers of participants are needed.

Current research shows inconsistent findings regarding gender-related differences in children's prosodic development. Some studies have reported that there are no significant differences in prosody between boys and girls. The study by Patel and Grigos (2006) revealed no significant gender-related differences in the prosodic cues used by 4, 7, and 11 year-old

children. Similarly, a study by Wells et al. (2004) examining the intonational development in preadolescent children also failed to find any differences in the use of prosody between boys and girls. On the other hand, a study by Ferrand and Bloom (1996) reported significant intonational differences between boys and girls, both in their F0 and in the percentage of rising and falling F0 changes. In light of these conflicting results, it remains unclear whether male and female children develop prosody in a similar manner.

Another area in need of additional research is the possible effect that the elicitation method might have on a speaker's prosodic patterns. To date, a variety of elicitation tasks have been used by researchers to examine how children signal sentence type. Previous research investigating the ability to signal sentence type has primarily used imitative tasks (Crary & Tallman, 1993; Leob & Allen, 1993; Wells et al. 2004), such as having the participants repeat back a recorded list of spoken stimuli or mimic the speech of the researcher. Although the task of imitating words or phrases may indirectly relate to the ability to manipulate the mechanisms that underlie changes in speaking F0, it is unclear if findings from this type of task generalize to the more complex use of prosody to mark a linguistic change in sentence type. Thus, it is unclear whether the participants in this type of experiment are exhibiting inherent speech characteristics or merely mimicking the production patterns of the researcher.

The question-statement prosodic contrast has also been elicited through a variety of different reading tasks (Allen & Arndorfer, 2000; Fitzsimons et al., 2001; Miller & Schwanenflugel, 2006). In such studies, the participants were often instructed to read a list of sentences or a cohesive passage and their speech was recorded. Similar to the imitative methods, having participants read stimuli may also elicit predictable productions in terms of linguistic context, but may not produce findings that can be generalized to a speaker's performance in

natural situations. Differences in reading proficiency or the use of a different style of prosody when reading may limit the ability to generalize results obtained in this manner.

Few research studies have used methods that elicit the question-statement contrast naturalistically. Snow (1994) evaluated the prosodic cues of intonation and timing through semi-structured play activities with very young children aged 12 to 20 months. Patel and Grigos (2006) also used a naturalistic procedure designed to elicit two specific types of interrogative and declarative sentences. However, the authors reported that in order to elicit their target phrase, additional cues and sometimes models were used, resulting in productions that were at times neither volitional nor naturally produced. Such variability in elicitation tasks can complicate the accurate comparison of findings across studies. Therefore, additional research is required to account for prosodic differences that may be directly related to the elicitation task.

Study Purpose

Previous research has provided valuable insight into the basic mechanisms and approximate age at which children acquire and use prosodic aspects of speech to signal sentence type. However, additional studies that involve larger numbers of participants, study the possible role of gender in prosodic development, and use more naturalistic methods of elicitation are needed to more fully understand how children signal sentence type. Thus, the purpose of this study was to examine how a relatively large group of children used prosody to linguistically mark sentence type, by acoustically analyzing speech samples elicited through a variety of controlled and naturalistic tasks. Specifically, this study addressed the following research questions:

1. Do 7 to 11 year-old children use relative changes in F0, intensity, and duration to signal sentence type (questions and declarative statements)?

2. How does children's use of prosody to signal sentence type differ as a function of gender?
3. How does the method of elicitation influence how children use prosody to signal sentence type?

Method

Participants

Eight boys and eight girls between the ages of 7 and 11 years of age (M = 10:0) participated in this study. All participants were monolingual speakers of American English and had minimal exposure to a second language (i.e., not having lived outside of the United States for more than 6 months and having parents/guardians who also speak American English as their native language). The parents or guardians of each participant reported that the child had no diagnosed history of hearing, speech, or language problems. All the participants were required to pass a hearing screening prior to the collection of data, exhibiting pure-tone air-conduction thresholds ≤25 dB HL at octave frequencies from 500 to 8000 Hz at the time of their participation. The participants were recruited from the Brigham Young University community and surrounding areas.

After having the experimental task explained to them, each participant read and signed a document of assent (Appendix A). In addition, each participant's parent or guardian read and signed an informed consent document (Appendix B). Approval to conduct the study was obtained from the Brigham Young University Institutional Review Board for Human Subjects Research prior to the collection of data. The children and guardians were paid a nominal compensation for their participation in the study.

Procedure

Speech data were collected using three different types of elicitation tasks. The procedures for each task are described below.

Imitation task. The methods for the imitation task were based on those described by Leob and Allen (1993). The stimuli used to elicit the participant imitations consisted of ten prerecorded utterances spoken by a female adult. Of the ten matched utterances, five were spoken as declarative statements with a terminal downward glide and five as interrogative statements with a rising intonation contour. The syntax, content, and vocabulary of the target sentences were designed to be familiar to preadolescent children. All words within the elicitation sentences contained one or two syllables, and all sentences were relatively short and syntactically simple. Following the presentation of a recorded model of each target sentence, the participants were instructed by the experimenter to repeat the stimulus sentences exactly as they heard them. For example,

> I am going to play you some sentences. I want you to say the same thing that you hear. Like a copy cat. I will play one sentence at a time, and then you will repeat it. Are you ready? Let's try a few. *Mary went to the store. John went to school.*

The child was first presented with two recorded trial sentences that were in the same format as the elicitation sentences. It was not necessary to imitate the intonation in the trial sentences, because this study examined whether the children would imitate the intonation contour of the utterances without being told to do so. If the child was able to successfully repeat the script of the trial sentences, the participant was then asked to repeat the target sentences. If the child became distracted during the task, the examiner checked the child's attention by saying "Ready?"

Reading task. The methods for the reading task were based on those described by Allen and Arndorfer (2000). Two different scripts were used in the reading task, one to familiarize the child with the task, and the other for the collection of speech data. Each script consisted of an alternating dialog between two children, marked by cartoon faces with different hairstyles preceding each sentence. The words of each sentence were bracketed partially by a cartoon bubble emerging from the face of the cartoon speaker. This format, rather than the conventional one where the talker's name precedes the utterance, was chosen to make it as clear as possible that there are two people talking. The syntax, content, and vocabulary were designed to be familiar to the children, containing mono- or bisyllabic words arranged in sentences that were relatively short and syntactically simple. An example of paired sentences is shown in Figure 1.

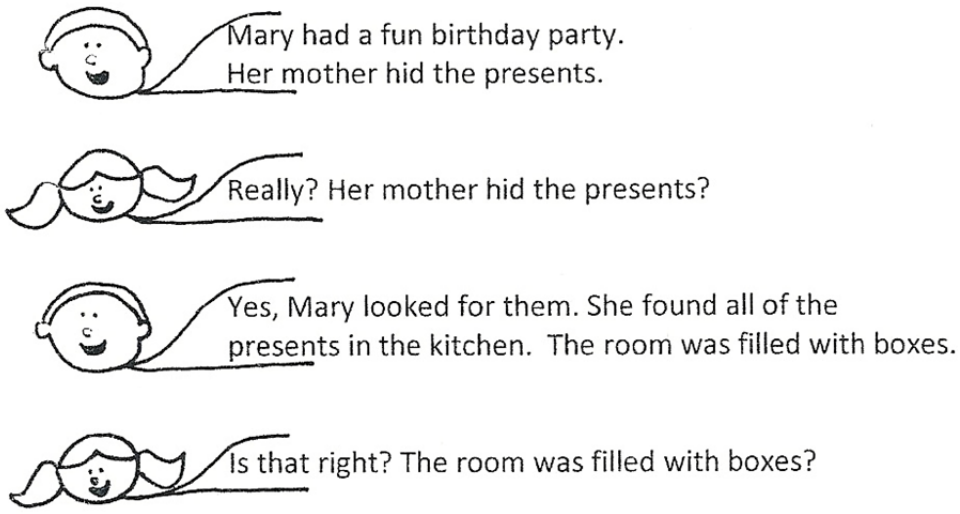

Figure 1. Sample of paired questions and statements used in the reading task.

The experimental script contained five pairs of target sentences, for a total of 10 targets per talker. The two items of each pair were lexically identical, with only the final punctuation (period vs. question mark) distinguishing the declarative from the interrogative form. Only the final punctuation and the context were used to determine if each sentence should be spoken as a declarative or an interrogative. The following instructions were given to the participants:

> Now I am going to have you read a conversation between two cartoon children. I want you to read the sentences exactly as you see them on the page. Let's try a few just to practice. Ready?

After the child demonstrated that they were able to read the practice script, they were asked to read the experimental script.

Naturalistic Speech Sample. A naturalistic speech sample of approximately 10 minutes was obtained from each participant. This sample was elicited by engaging the child in a task similar to the game of *Go Fish.* The following instructions were given to the participants prior to data collection:

> We are going to play a game of Go Fish. Are you familiar with how to play that game? (If not, the child was provided with some basic instruction concerning the rules of the game.) I am first going to show you each card one at a time and I want you to describe the card. For example, "That is a red fish."

Each child was asked to describe the pictures prior to starting the game to obtain a baseline of the child's prosody with basic declarative statements. The researcher then gave further instructions as follows:

> On your turn, you will ask me a question like, "Do you have a blue fish?" I would respond in a complete sentence by saying, "No, I don't have a blue fish" or "Yes, I have a blue fish." Let's practice.

The child and researcher then played a practice round to train the child for the task. Once the child demonstrated understanding of the task, the researcher told the child:

> Ok, we are ready to begin playing the game. Do you have any questions before we start?

Recording

The participants' speech was recorded directly to a laptop computer in a quiet environment in the child's home. A head-mounted, low-impedance dynamic microphone (SM10A-CN) was used to record the speech samples. The microphone was positioned approximately 2 inches from the participant's mouth. The recordings were sampled at a rate of 44.1 kHz and a quantization of 24 bits with Adobe Audition software. Subsequently, the recorded sound files were archived to a PC computer hard drive for further analysis. All recorded sentences were high-pass filtered at 65 Hz. In cases of inaccurate articulation, peak clipping, or an error in the recording, the participant was asked to repeat the test item and the stimulus was re-recorded.

Acoustic Analysis

Acoustic analysis of the speech samples was completed in a manner similar to the methodology described by Patel and Grigos (2006). Praat acoustic speech analysis software (version 5.1.20; Boersma & Weenink, 2009) was used to segment the sentences into an initial and terminal portion as illustrated in Figure 2. The target phrase was the terminal portion that consisted of the last three words of each sentence. Segment boundaries were determined by making an auditory judgment regarding the beginning or end of a segment, as well as consulting the acoustic waveform and intensity envelope.

F0 measurement. Praat was used to extract an F0 track plotted over time for the initial and terminal portion of each target sentence. The extraction algorithm relied on autocorrelation, as described in Boersma (1993). Custom designed Matlab programs were used to calculate the mean F0, peak F0, and F0 range of each initial and terminal speech section. From these calculations, additional values of mean F0 ratio, peak F0 ratio, and F0 slope were computed.

The mean F0 ratio was the mean F0 of the terminal portion of the sentence divided by the mean F0 of the initial portion. Thus sentences with relatively higher F0 values in the terminal portion of the sentence would have a F0 ratio above 1. The peak F0 ratio was based on peak values and was calculated in a similar manner. The F0 slope was calculated from the minimum and maximum F0 values as a function of time (Hz per second) and was measured only across the terminal portion of the sentence.

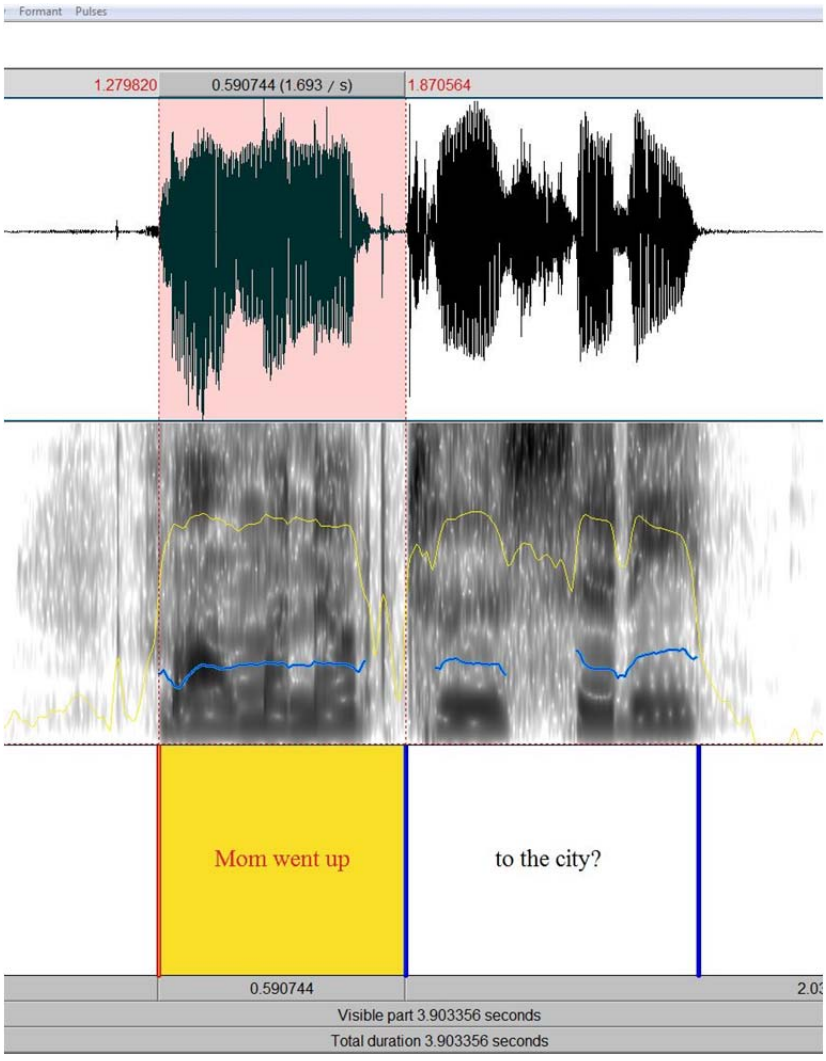

Figure 2. Example of the analysis of a target sentence using Praat analysis software.

Intensity measurement. Praat was also used to calculate mean and peak intensity measures of the initial and terminal portions of each target sentence. From these measures, mean and peak intensity ratios were also calculated, by comparing the intensity of the initial and terminal portions of each sentence.

Duration measurement. Duration values were also calculated for the initial and terminal portions of each target sentence. The duration of each portion of the sentence was computed to the nearest millisecond (ms) also using Praat analysis software. Ratio values were calculated by dividing the duration of the terminal portion of the target sentence by the duration of the initial portion.

Measurement reliability. To examine the reliability of the extracted acoustic measures, speech samples from 10% of the speaker productions were selected and reanalyzed by another individual. These additional sets of duration, intensity, and F0 measurements were extracted, recorded, and checked in the same manner as the original measures. Comparisons of the duration measures produced correlations of 0.95, F0 measures produced correlations of 0.85, and intensity measures were correlated at 0.99.

Statistical Analysis

The data in this experiment were analyzed using a repeated measures analysis of variance (ANOVA) to examine any significant acoustic variation (F0, intensity, duration) in the speakers' productions as a function of sentence type, speaker gender, and the method of elicitation. The dependent variables of the analysis were mean F0 ratio, peak F0 ratio, F0 slope, mean intensity ratio, peak intensity ratio, intensity slope, and duration ratio. Partial eta squared or η^2 measures of effect size were also computed for any significant ANOVA results (the value of $\eta 2$ can range from 0.0 to 1.0, and can be considered a measure of the proportion of variance explained by a dependent variable when controlling for other factors). Greenhouse-Geisser

adjustments were used to adjust the *F*-test degrees of freedom when significant deviations from sphericity were found. Statistical significance was determined at a .01 alpha level.

Results

Results from the repeated-measures ANOVA (*F*-ratios, probabilities, and effect sizes for significant main effects and interactions) that directly address the research questions of this study are included in the text below and are organized according to the independent variables of sentence type, speaker gender, and method of elicitation. A detailed listing of the descriptive statistics (mean and standard deviation) for each of the dependent measures can be found in Tables 1-2 below.

Sentence Type

The statistical analysis indicated a significant difference between the mean F0 ratios across sentence type, $F(1, 14) = 94.412$, $p < .001$, $\eta^2 = .87$. The mean F0 ratio value was higher for questions ($M = 1.13$, $SD = .03$) than for statements ($M = .88$, $SD = .02$). A statistically significant difference between sentence types was also found for the measure of mean intensity ratio, $F(1, 14) = 41.671$, $p < .001$, $\eta^2 = .74$, with higher values for questions ($M = .97$, $SD = .01$) as compared to that found in statements ($M = .91$, $SD = .01$).

The analysis also indicated statistically significant differences in sentence type for the peak F0 ratios, $F(1, 14) = 128.411$, $p < .001$, $\eta^2 = .90$, which were significantly higher for questions than for statements. The mean peak F0 ratios for the questions and statements were 1.02 ($SD = .03$) and .78 ($SD = .02$), respectively. Significant differences between questions and statements were also found for the F0 slope (measured across the terminal section of each sentence), $F(1, 14) = 8.817$, $p < .001$, $\eta^2 = .38$. Results showed that the mean slope for questions was lower than for statements, at - 54.3 Hz/sec and -200.2 Hz/sec, respectively. The difference

Table 1

Acoustic Measures for Male Speakers

Measures	Elicitation Condition	Statements		Questions	
		Mean	*SD*	Mean	*SD*
Mean F0[a]	Naturalistic	.928	.047	1.008	.063
	Imitative	.792	.032	1.263	.048
	Reading	.918	.048	1.114	.039
Mean Intensity[a]	Naturalistic	.927	.017	.958	.021
	Imitative	.875	.012	1.006	.012
	Reading	.909	.028	.976	.012
Peak F0[a]	Naturalistic	.809	.045	.927	.065
	Imitative	.731	.042	1.101	.042
	Reading	.777	.035	.982	.039
Peak Intensity[a]	Naturalistic	.866	.014	.897	.018
	Imitative	.827	.010	.968	.008
	Reading	.827	.010	.915	.008
F0 Slope[b]	Naturalistic	-189.747	34.817	-166.727	20.580
	Imitative	-233.321	47.409	-316.791	29.062
	Reading	-146.908	31.135	-168.898	44.874
Intensity Slope[b]	Naturalistic	-69.385	5.270	-76.541	7.184
	Imitative	-69.983	4.513	-90.138	5.295
	Reading	-92.325	5.060	-103.475	5.225
Duration[a]	Naturalistic	.219	.017	.244	.027
	Imitative	.238	.012	.275	.010
	Reading	.246	.019	.293	.017

[a]These values are ratio measures between the last three words in the target sentences and the beginning portion of the sentences. [b]These values were calculated on the last syllable of each sentence.

Table 2

Acoustic Measures for Female Speakers

Measures	Elicitation Condition	Statements		Questions	
		Mean	*SD*	Mean	*SD*
Mean F0[a]	Naturalistic	.937	.047	1.075	.063
	Imitative	.841	.032	1.157	.048
	Reading	.865	.048	1.161	.039
Mean Intensity[a]	Naturalistic	.925	.017	.978	.021
	Imitative	.901	.012	.983	.012
	Reading	.924	.028	.934	.012
Peak F0[a]	Naturalistic	.836	.045	.996	.065
	Imitative	.783	.042	1.056	.042
	Reading	.791	.035	1.045	.039
Peak Intensity[a]	Naturalistic	.861	.014	.928	.018
	Imitative	.863	.010	.936	.008
	Reading	.840	.010	.918	.008
F0 Slope[b]	Naturalistic	-157.527	34.817	-247.731	20.580
	Imitative	-268.913	47.409	-342.630	29.062
	Reading	-205.013	31.135	-283.027	44.874
Intensity Slope[b]	Naturalistic	-80.327	5.270	-88.533	7.184
	Imitative	-81.488	4.513	-95.284	5.295
	Reading	-95.371	5.060	-107.694	5.225
Duration[a]	Naturalistic	.201	.017	.243	.027
	Imitative	.255	.012	.271	.010
	Reading	.227	.019	.274	.017

[a]These values are ratio measures between the last three words in the target sentences and the beginning portion of the sentences. [b]These values were calculated on the last syllable of each sentence.

between the slope of the intensity for the terminal section between questions and statements also showed significant differences, $F(1, 14) = 50.147$, $p < .001$, $\eta^2 = .78$. Mean values for the slope of the intensity of the terminal section was lower for the questions ($M = -93.61$, $SD = 3.21$) than for the statements ($M = -81.48$, $SD = 2.43$).

Results also showed statistically significant differences between the ratios of duration measures between questions and statements, $F(1, 14) = 23.974$, $p < .001$, $\eta^2 = .63$. Results showed a higher duration ratio for questions than for statements, with averages of .27 ($SD = .01$) and .23 ($SD = .01$), respectively.

Gender

The statistical analysis indicated a three-way interaction among sentence type, method of elicitation, and gender for the measure of peak intensity ratio $F(1, 14) = 15.235$, $p < .001$, $\eta^2 = .52$. Refer to Tables 1 and 2 for detailed listings of acoustic measures for the male and female speakers. As illustrated in Figure 3, for the male speakers, the degree of difference in the peak intensity ratios between the questions and statements changed depending on the elicitation task, with the greatest difference being noted on the imitation, then reading, then naturalistic tasks. Figure 4 shows that for the female speakers, the degree of difference between sentence types appears similar across all elicitation tasks.

Method of Elicitation

The analysis demonstrated that the way in which sentence type was acoustically marked differed as a function of the elicitation condition for the measures of mean F0, $F(2, 28) = 10.705$, $p < .001$, $\eta^2 = .43$, and intensity ratios, $F(2, 28) = 5.797$, $p < .001$, $\eta^2 = .29$. As illustrated in Figures 5 and 6, for both measures the acoustic contrast between the questions and statements decreased when the method of elicitation was naturalistic, with the greatest differences found in the imitation and reading tasks.

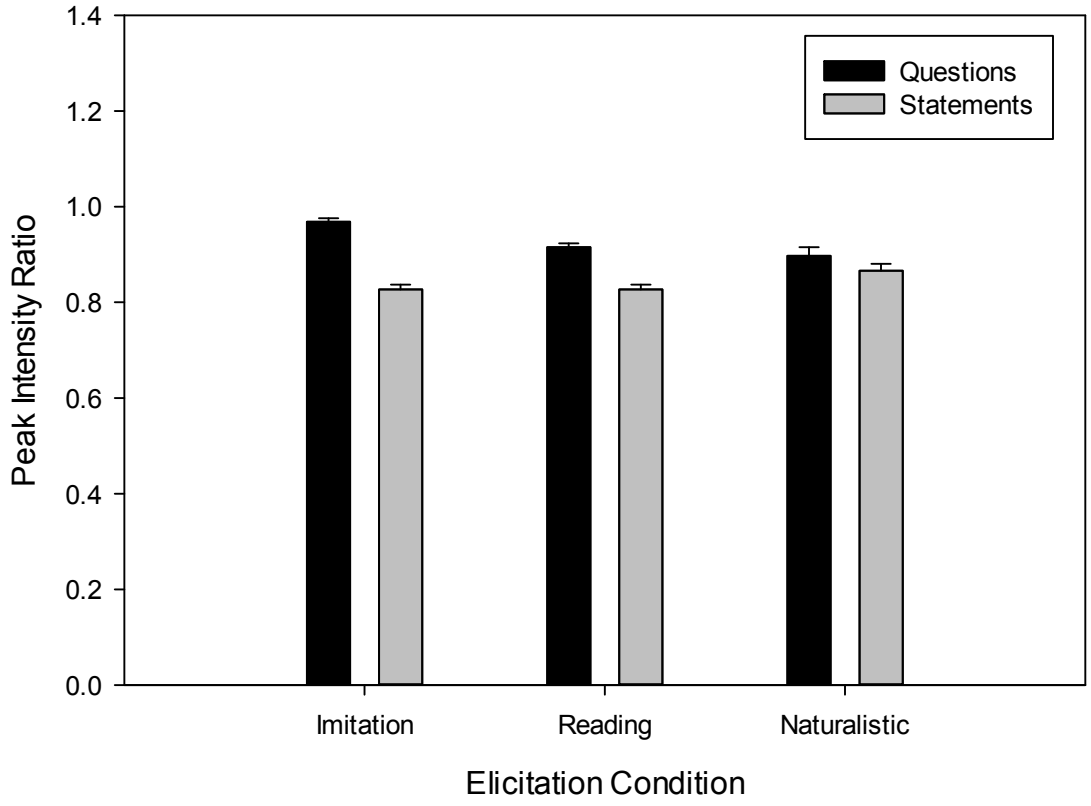

Figure 3. Peak intensity ratio across sentence type and elicitation condition for male speakers.

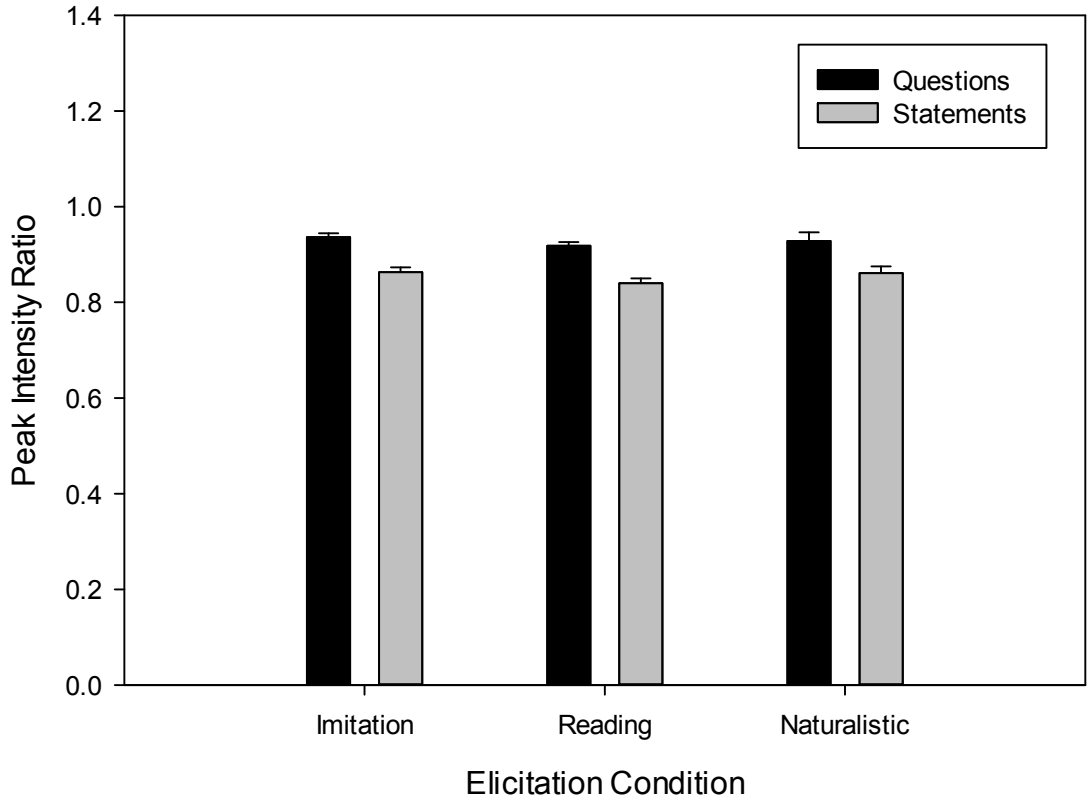

Figure 4. Peak intensity ratio across sentence type and elicitation condition for female speakers.

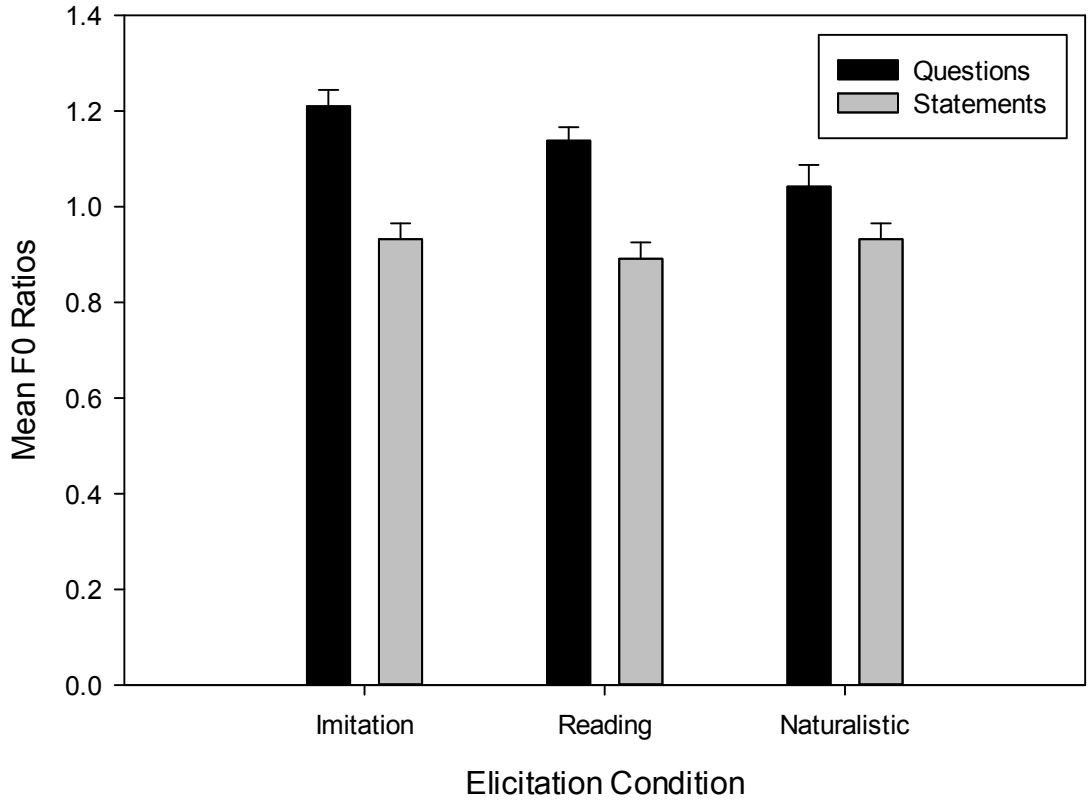

Figure 5. Mean F0 ratio across sentence type and elicitation condition.

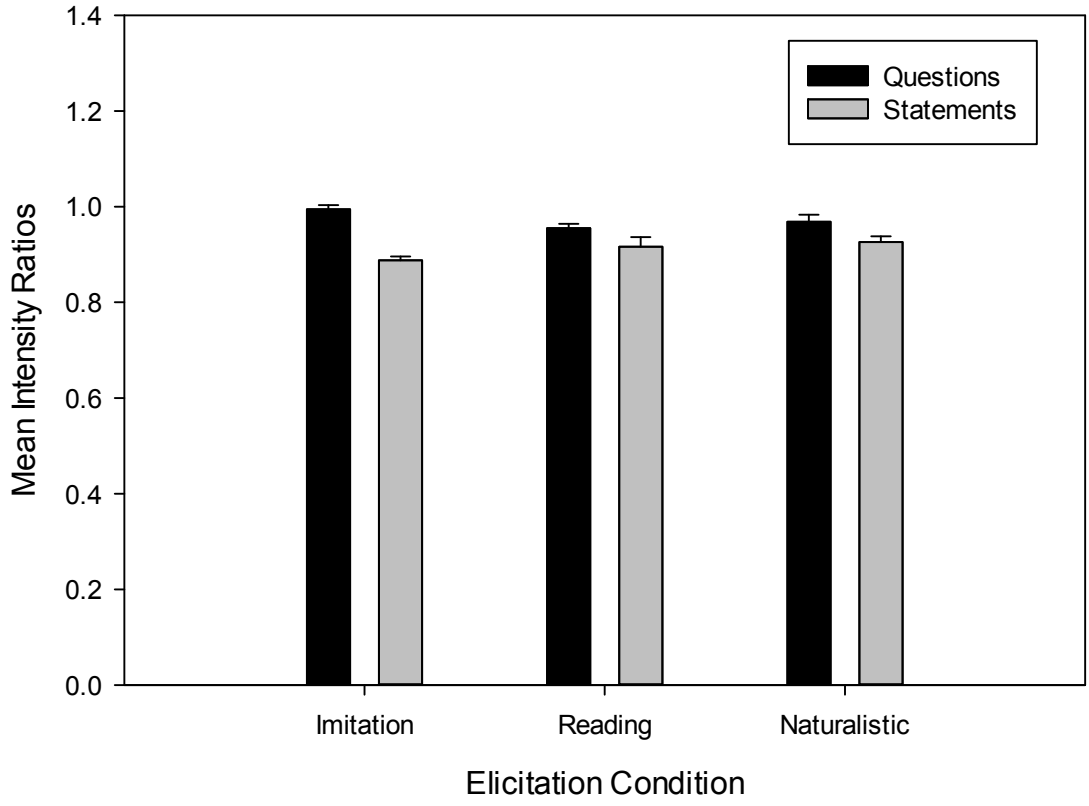

Figure 6. Mean intensity ratio across sentence type and elicitation condition.

Discussion

The first aim of this study was to determine what prosodic cues are used by children to signal questions and declarative statements in terms of changes in F0, duration, and intensity. The results showed that children ages 7 to 11 use all three acoustic cues to signal sentence type. These results were similar to previous research (Allen & Arndorfer, 2000; Patel & Grigos, 2006) that also found that children from 7 to 11 years of age use all three acoustic cues to prosodically mark sentence type. Concerning the cue of F0, the results of this study indicated that it is not only important to examine the average F0 and its range, but also the F0 slope. Patel and Grigos (2006) commented that while previous studies have primarily focused on the mean and range of the F0, examining the slope is also valuable because it provides insight into the shape of the underlying F0 contour and allows for comparisons of the speed of change in terminal F0 between questions and statements.

While data from these studies reveal that children likely rely on multiple acoustic characteristics to signal the sentence type, it is unclear how individual children may weight or use certain prosodic cues more or less than others. Additionally, the perceptual impact of children's use of these acoustic cues is unclear. Thus, it would be valuable to conduct a perceptual study to examine the salience of such differences for listeners.

The second aim of this study was to determine how children's use of prosody in signaling sentence type might differ as a function of speaker gender. In general, considering all of the measures examined in the present study, there were few gender-related differences in how the participants marked sentence type. The statistical analysis indicated one significant gender difference for peak intensity ratio, which varied as a function of the elicitation task. For this measure, the degree of difference between sentence types decreased for the males as the method

of elicitation became more naturalistic, a result not found for the female speakers. Such findings may reveal that for this specific acoustic cue (peak intensity), boys have not yet developed an adult-like use of this cue in naturalistic contexts. Another possible explanation for such findings could be that since all participants were asked to imitate utterances presented by a female voice, the male children were trying to imitate a speech style that is not typical for male speakers. However, previous research has shown that adults primarily rely on the prosodic cue of varying their F0 to signal sentence type and not peak intensity (Cruttenden, 1986). Another possible explanation for such results may be that this is simply a style difference between males and females of this age.

Previous research has found some gender-related differences in how acoustic cues are used to signal sentence type in the speech of children (Ferrand & Bloom, 1996) and adults (Fitzsimons et al., 2001). However, in contrast to the findings of the present study, both of these studies only found F0 differences, whereas the present study found acoustic differences between genders in peak intensity and not F0. Differences between the findings of this study and previous research in this area may have been due to differences in methodology or participant population. Additional research is needed to more fully examine possible gender-related differences in the way children prosodically mark sentence type.

The third aim of this study was to examine how children's use of prosody to signal sentence type changes as a function of elicitation method. Results showed significant differences among the methods of elicitation used in the present study. Overall, the mean F0 went up at the end of each question for all three elicitation conditions, but the degree of F0 increase varied across the different tasks. For the imitation condition, there was a relatively large gap between

the mean F0 ratios of questions and statements, whereas for the naturalistic task there was a much smaller degree of difference.

Several reasons might explain the differences across the type of elicitation task found in this study. First, the preadolescent children in this study may not have fully developed the use of certain types of prosodic cues. They may still be fine-tuning the ability to vary their F0 to signal sentence type, and it may be difficult for them to fully express the contrast in more natural situations. The use of intensity showed a pattern similar to that found for F0, whereby as the elicitation task became more naturalistic, the intensity difference between sentence types decreased. Second, for the imitative task the participants may have been mimicking the prosodic patterns of the administrator rather than showing their actual abilities in natural contexts. Considering that a large amount of previous research investigating the ability to signal sentence type has used imitative tasks (Crary & Tallman, 1993; Leob & Allen, 1993; Wells et al, 2004), the differences in elicitation task found in this study provide some context with which to evaluate the validity of previous findings. Third, speech while reading may have different prosodic patterns than speech in natural conversation. There may be additional differences between read and spontaneous speech due to the individual's reading proficiency. Fourth, it may not be the nature of the different tasks, but rather the linguistically different stimuli in each task. An experiment in which the stimuli are linguistically similar across all three types of elicitation task may or may not have similar findings.

Future research in this area that includes a perceptual component would be of value. Although the present study found significant differences in children's productions of acoustic cues, the perceptual impact of such differences remains unclear. The degree of acoustic difference needed for a noticeable perceptual difference in sentence type and the perceptual

weight or salience of each acoustic cue has yet to be fully explained. In addition, it would be of interest to complete this study with a wider range of participant age and an adult control group. It is possible that adult productions would be similar to those of the child participants, given that the speech samples were elicited, collected, and measured in a similar manner. Thus, an adult control group could provide additional insight to the results of this study produced by child participants.

The findings of this study indicate that children between 7 and 11 years of age signal sentence type through a variety of acoustic cues associated with relative changes in F0, intensity, and duration. Not only do children vary the F0 and intensity mean, but they also change the peak and slope of these speech parameters at the terminal section of the sentence to mark a difference in sentence type. While this study found gender-related differences for the measure of peak intensity, in general the boys and girls participating in the study tended to signal sentence type in a similar manner. Additionally, the method of elicitation does seem to have an effect on the degree to which children use certain prosodic cues to differentiate questions and statements, with children generally showing a decrease in contrast for more naturalistic tasks. Despite the limitations of the current study, these data may provide additional insight into the prosodic cues used by preadolescent children to signal sentence type.

References

Allen, G. D., & Arndorfer, P. M., 2000. Production of sentence-final intonation contours by hearing-impaired children. *Journal of Speech, Language, and Hearing Research, 43,* 441-455. doi: 1092-4388/00/4302-0441

Beach, C. M. (1991). The interpretation of prosodic patterns at points of syntactic structure ambiguity: Evidence for cue trading relations. *Journal of Memory and Language, 30*, 644-663.

Boersma, P. (1993). Accurate short-term analysis of the fundamental frequency and the harmonics-to-noise ratio of a sampled sound. *Proceedings of the Institute of Phonetic Sciences, 17,* 97–110. University of Amsterdam.

Boersma, P., & Weenink, D. (2009). Praat (Version 5.1.20). [Computer Software]. University of Amsterdam.

Bolinger, D. (1978). Intonation across languages. In J. H. Greenberg (Ed.), *Universals of human language: Vol. 2. Phonology*. Hillsdale, NJ: Erlbaum.

Bolinger, D. L. (1989). *Intonation and its uses: Melody in grammar and discourse*. Stanford, CA: Stanford University Press.

Bonvillian, J. D., Raeburn, V. P., & Horan, E. A. (1979). Talking to children: The effects of rate, intonation, and length on children's sentence imitation. *Journal of Child Language, 6*, 459-467. doi: 10.1037/a0012848

Chafe, W. (1988). Punctuation and the prosody of written language. *Written Communication, 5,* 395-426. doi: 10.1177/0741088388005004001

Crary, M. A., & Tallman, V. L. (1993). Production of linguistic prosody by normal and speech-disordered children. *Journal of Communication Disorders, 26*, 245-262.

Cruttenden, A. (1986). *Intonation.* Cambridge University Press, Cambridge.

Eady, S. J., & Cooper, W. E. (1986). Speech intonation and focus location in matched statements and questions. *Journal of Acoustic Society of America, 80,* 402-415.

Ferrand, C. T., & Bloom, R. L. (1996). Gender differences in children's intonational patterns. *Journal of Voice, 3,* 284-291. doi: 10.1016/S0892-1997(96)80009-9

Fitzsimons, M., Sheahan, N., & Staunton, H. (2001). Gender and the integration of acoustic dimensions of prosody: Implications for clinical studies. *Brain and Language, 78,* 94-108. doi: 10.1006/brln.2000.2448

Lehiste, I., Olive, J. P., & Streeter, L. A. (1976). Role of duration in disambiguating syntactically ambiguous sentences. *Journal of the Acoustical Society of America, 60*, 1199-1202.

Leob, D. F., & Allen, G. D. (1993). Preschoolers' imitation of intonation contours. *Journal of Speech & Hearing Research, 36*, 4-13.

McRoberts, G. W., Studdert-Kennedy, M., & Shankweiler, D. P. (1995). The role of fundamental frequency in signaling linguistic stress and affect: Evidence for dissociation. *Perception and Psychophysics, 57*, 159-174.

Miller, J., & Schwanenflugel, P. (2006). Prosody of syntactically complex sentences in the oral reading of young children. *Journal of Educational Psychology, 98*, 839-853. doi: 10.1037/0022-0663.98.4.839

O'Shaughnessy, D. (1979). Linguistic features in fundamental frequency patterns. *Journal of Phonetics, 7,* 119-145.

Patel, R., & Grigos, M. (2006). Acoustic characterization of the question-statement contrast in 4, 7, and 11 year-old children. *Speech Communication, 48,* 1308-1318. doi: 10.1016/j.specom.2006.06.007

Smith, B. L., & Kenny, M. K. (1998). An assessment of several acoustic parameters in children's speech production development: Longitudinal data. *Journal of Phonetics, 26,* 95-108. doi: 10.1006/jpho.1997.0061

Snow, D. (1994). Phrase-final syllable lengthening and intonation in early child speech. *Journal of Speech and Hearing Research, 37*, 831-840.

Stine, E. L., & Wingfield, A. (1987). Process and strategy in memory for speech among younger and older adults. *Psychology and Aging, 2*, 272-279. doi: 10.1037/0882-7974.2.3.272

Viscovich, N., Borod, J., Pihan, H., Peery, S., Brickman, A. M., Tabert, M., Schmidt, M., & Spielman, J. (2003). Acoustical analysis of posed prosodic expressions: Effects of emotion and sex. *Perceptual and Motor Skills, 96,* 759-771.

Wells, B., Peppe, S., & Goulandris, N. (2004). Intonation development from five to thirteen. *Journal of Child Language, 31*, 749-778. doi: 10.1017/S030500090400652X

Wingfield, A., Lahar, C. J., & Stine, E. A. (1989). Age and decision strategies in running memory for speech: effects of prosody and linguistic structure. *Journal of Gerontology, 44*, 106-113. doi: 10.1093/geronj/44.4.P106

Annotated Bibliography

Allen, G. D., & Arndorfer, P. M., 2000. Production of sentence-final intonation contours by hearing-impaired children. *Journal of Speech, Language, and Hearing Research, 43,* 441-455. doi: 1092-4388/00/4302-0441

The purpose of this study was to describe the intonation contours produced by hearing-impaired children in terms of a number of acoustic characteristics and listeners' perceptions. Participants for this study included six children with normal hearing and six severe-to-profoundly hearing impaired children. Participants ranged from 7:9 to 14:7 years of age. Speech samples were obtained from each child as they read 10 declarative sentences and 10 interrogative sentences. Twelve adult participants listened to the speech samples and decided if each sentence was a question, statement, or another type of utterance. Acoustic analysis of the speech samples revealed that all six of the normally hearing children and four out of six of the hearing impaired children were able to use F0, duration, and intensity to prosodically mark the questions and statements. Additionally, the perceptual task results revealed that listeners were able to correctly identify the sentence type of the productions by the normally hearing children with a high degree of accuracy.

Beach, C. M. (1991). The interpretation of prosodic patterns at points of syntactic structure ambiguity: Evidence for cue trading relations. *Journal of Memory and Language, 30*, 644-663.

This study examined speakers' ability to use prosodic cues to clarify lexical ambiguities. Participants for this study consisted of forty native English speaking undergraduate students. Participants were presented with sentence fragments that had two options for completion. They were instructed to determine which sentence they thought it originated from. Results revealed that listeners consistently chose the sentence ending that was implied by the prosodic information of the sentence fragment. The author concluded that lexical ambiguities may be clarified by speakers through the use of prosodic cues.

Bolinger, D. (1978). Intonation across languages. In J. H. Greenberg (Ed.), *Universals of human language: Vol. 2. Phonology*. Hillsdale, NJ: Erlbaum.

By exploring the accent, tone, and terminals of questions and non-questions, this study aimed to describe the traits of intonation shared by a majority of languages. The author found that speakers used the cues of accent and tone to direct listeners to particular points of an utterance. The ending portion of questions and some types of non-questions were found to have a terminal upward glide in F0.

Bolinger, D. L. (1989). *Intonation and its uses: Melody in grammar and discourse*. Stanford, CA: Stanford University Press.

This book describes many aspects of intonation and its various uses. Four different topics are addressed in this book. The first part describes variation in prosody and the differences that result from age, gender, dialect, and language. The next two sections address the relationship between intonation and grammar. Information that is of particular interest for this study is found

in section two because it describes typical intonation produced with various types of questions as well as with declarative statements. The fourth section of the book addresses intonation and logic.

Bonvillian, J. D., Raeburn, V. P., & Horan, E. A. (1979). Talking to children: The effects of rate, intonation, and length on children's sentence imitation. *Journal of Child Language, 6*, 459-467.

The effects of rate, intonation, and length variance on children's ability to imitate sentences were evaluated in this study. Participants for this study included 12 nursery school children with a mean age of 3:9 years. Speech samples were recorded as the children imitated previously recorded sentences. Analysis of the speech samples revealed that the children were able to imitate shorter sentences (six or fewer words) more accurately than longer ones.

Chafe, W. (1988). Punctuation and the prosody of written language. *Written Communication, 5,* 395-426. DOI: 10.1177/0741088388005004001

The purpose of this study was to examine the degree to which punctuation reflects the covert prosody of written language. Participants for this study were divided into two groups: a "young subject" group with 20 undergraduate students and an "older subject" group comprised of eight adults with a mean age of 64. All participants completed a reading aloud task and a repunctuating task (inserting punctuation in passages from which the author's punctuation has been removed). The primary conclusion drawn was that an awareness of prosodic imagery is an important ingredient of "good writing."

Crary, M. A., & Tallman, V. L. (1993). Production of linguistic prosody by normal and speech-disordered children. *Journal of Communication Disorders, 26*, 245-262.

The linguistic prosody of children with normal speech and children with speech disorders were described and compared in this research study. Fourteen children participated in this study with an average age of 5:7 years. The children were divided into two equal sized groups. One of the participant group's displayed age-appropriate speech production skills and the other demonstrated severe speech disorders. Each child was presented with two stimuli that were each recorded with rising terminal contour and falling terminal contour. The children were to repeat each stimulus back exactly as they heard it. Analysis of the obtained speech samples revealed that there was not a significant difference between the two groups with respect to the mean F0.

Cruttenden, A. (1986). Intonation. Cambridge University Press, Cambridge.

The aim of this book was to widen the discussion of intonation to include other languages besides English. It includes sections on general features of prosody; stress, accent, and rhythm; forms of intonation; functions of intonation; and comparative intonation.

Eady, S. J., & Cooper, W. E. (1986). Speech intonation and focus location in matched statements and questions. *Journal of Acoustic Society of America, 80,* 402-415.

This study examined the effects of focus location on the prosodic attributes of duration and F0 with matched statements and questions. The group of participants for this study was comprised of six male adult students. Participants read matched statements and questions following recorded stimuli that were designed to elicit specific foci in the sentences. One interesting finding that resulted from acoustic analysis of the speech recordings was that a rising F0 intonational contour was always the primary prosodic cue used to indicate interrogative statements.

Ferrand, C. T., & Bloom, R. L. (1996). Gender differences in children's intonational patterns. *Journal of Voice, 3,* 284-291.

Differences in intonation patterns between genders were investigated in this study. Participants for this study were divided into four age groups (3:0-4:11, 5:0-6:11, 7:0-8:11, and 9:0-10:11 years), each comprised of 10 boys and 10 girls. Informal conversation samples were obtained from each child as they interacted with a clinician. Acoustic analysis of 10 declarative utterances from each participant was completed. Results of the study indicated that for males starting at ages 7:0-8:11, their maximum F0, range, and percentage of rising and falling shifts all decreased. Such findings were not noted for females in the same age group. Thus, this study provides evidence for intonational differences between genders across development.

Fitzsimons, M., Sheahan, N., & Staunton, H. (2001). Gender and the integration of acoustic dimensions of prosody: Implications for clinical studies. *Brain and Language, 78,* 94-108. doi: 10.1006/brln.2000.2448

This study identified acoustic differences in prosody between genders. Participants for this study were 10 men and 10 women with an age range of 24-31 years. Speech samples were obtained from each participant as they read 10 sentences. Each sentence was read twice with both declarative prosody and interrogative prosody. Acoustic analysis of the speech samples revealed that there were statistically significant differences between the genders in their speech rate, pitch range, and pitch slope.

Lehiste, I., Olive, J. P., & Streeter, L. A. (1976). Role of duration in disambiguating syntactically ambiguous sentences. *Journal of the Acoustical Society of America, 60*, 1199-1202.

The aim of this study was to evaluate the acoustically perceptual cues that listeners use to disambiguate syntactically unclear sentences. Specifically, researchers examined the effectiveness of varying duration to indicate proper boundaries in sentences. Stimuli for this study consisted of ten recorded sentences in which the prosodic cue of duration was manipulated. Participants for this study were 30 undergraduate students who listened to each sentence and then chose the conveyed meaning out of a field of two. Findings from this study supported the idea that by manipulating the prosodic cue of duration, speakers can effectively signify sentence boundaries.

Leob, D. F., & Allen, G. D. (1993). Preschoolers' imitation of intonation contours. *Journal of Speech & Hearing Research, 36*, 4-13.

Authors examined typically developing preschoolers' intonation contours as elicited through an imitation task. Participants for this study included five 3-year-old and five 5-year-old children. Speech samples were obtained from the children as they imitated sentences with three different intonation contours: declarative, interrogative, and monotone. Acoustic analysis of the imitated sentences revealed that overall, the 5-year-old children were able to imitate the presented intonation contours more frequently than the 3-year-olds. The primary findings from the 3-year-olds were that they were only able to partially imitate the contours. Between groups, the largest difference was found in the children's ability to imitate the interrogative contour.

McRoberts, G. W., Studdert-Kennedy, M., & Shankweiler, D. P. (1995). The role of fundamental frequency in signaling linguistic stress and affect: Evidence for dissociation. *Perception and Psychophysics, 57*, 159-174.

The role of fundamental frequency and the relationship between its linguistic and affective uses were evaluated in this study. Speech samples were obtained from four adult male speakers as they repeated two sentences with varying prosody. Each sentence was stated as a declarative statement with neutral stress, a question with neutral stress, and a question with contrastive stress. Among other results, acoustic analysis of the speech samples revealed that a terminal downward glide was the most powerful determinant between questions and statements.

Miller, J., & Schwanenflugel, P. (2006). Prosody of syntactically complex sentences in the oral reading of young children. *Journal of Educational Psychology, 98*, 839-853.

This study described the role of prosody in oral reading for children. This study involved 80 children with a mean age of 9:3. Additionally, 29 undergraduate students were recruited for an adult comparison sample. Speech samples were obtained from each participant as they read a passage that was created to measure six specific areas of prosody. Three areas were of particular interest: basic declarative sentences, *wh* questions, and yes-no questions. Analysis of the speech samples revealed that the children with quick and accurate oral reading produced yes-no questions with an audible pitch rise and declarative sentences with a decline in pitch. Also, analysis of the adult speech samples revealed that they did not uniformly incline their pitch for *wh* questions, but they did mark yes-no questions with a pitch upswing.

O'Shaughnessy, D. (1979). Linguistic features in fundamental frequency patterns. *Journal of Phonetics, 7,* 119-145.

Authors examined patterns of fundamental frequency in natural speech with regard to sentence type, syntactic construction, emphasis, word type, and phonetics. Participants for this study were four adult male speakers. Speech samples were obtained as participants read sentences that were designed to elicit different uses of F0 to convey linguistic meaning. Among other findings, acoustic analysis of the speech samples obtained in this study indicate that questions were marked with an inclined F0 contour throughout the entire sentence, rather than only at the end of the phrase.

Patel, R., & Grigos, M. (2006). Acoustic characterization of the question-statement contrast in 4, 7, and 11 year-old children. *Speech Communication, 48,* 1308-1318.

The aim of this study was to provide acoustic characterization of the prosodic cues used by children in producing questions and statements. Three age groups were involved in this study: 4, 7, and 11 year-olds. Each age group consisted of four participants: two boys and two girls. Each child participated in a naturalistic elicitation task where they produced multiple repetitions of two phrases that were elicited both as declarative statements and declarative questions. Acoustic analysis of the speech samples revealed that in signaling questions, 4 year-olds primarily rely on duration; 7 year-olds rely on duration, intensity, and fundamental frequency; and 11 year-olds primarily rely on fundamental frequency. Results of this study suggest that children begin exhibiting adult-like prosodic patterns between the ages 7 and 11.

Smith, B. L., & Kenny, M. K. (1998). An assessment of several acoustic parameters in children's speech production development: Longitudinal data. *Journal of Phonetics, 26,* 95-108.

In this study, the development of children's speech through measurement of various acoustic parameters was assessed. Participants for this study were seven girls who were followed in a longitudinal study and speech samples were recorded from the girls at 8.5, 10, and 11.5 years of age. At each recording, they repeated one word 20 times. Acoustic analysis of the speech samples revealed that with each recording, the measured acoustic parameters became more adult-like; however, each participant did not develop at the same rate or with the same patterns. Also, researchers found that when a child had further developed one acoustic parameter, they were often not as adept at using other prosodic features.

Snow, D. (1994). Phrase-final syllable lengthening and intonation in early child speech. *Journal of Speech and Hearing Research, 37*, 831-840.

This article described the development of young children's prosody in terms of phrase-final syllable lengthening and intonation. Participants for this study were nine children ages 12-20 months. Speech samples were obtained through semi-structured play activities where the child, mother and investigator were present. The speech samples were analyzed and the data were compared to a longitudinal study of the speech development of children between the mean ages of 16 and 25 months. Analysis of the results suggested that children acquire the skills to control intonation before being able to control timing.

Stine, E. L., & Wingfield, A. (1987). Process and strategy in memory for speech among younger and older adults. *Psychology and Aging, 2*, 272-279.

The process and strategy of how younger and older adults remember speech was examined in this study. Specifically, this study set out to determine the degree to which elderly listeners rely on natural prosodic contour in speech recall. Another primary goal of this study was to determine the role of individual differences in working memory resources in the immediate memory for short passages of speech. The participants for this study were 24 older adults (M = 69.3 years) and 24 university undergraduate students (M = 18.8 years). The primary task was to present each participant with a series of tape-recorded word strings and they were to immediately

recall the list. Some of the word lists were recorded with normal, and some abnormal prosody. Results of this study revealed that both young and elderly adults had better immediate recall of sentences with typical prosody than those with absent or atypical prosody.

Viscovich, N., Borod, J., Pihan, H., Peery, S., Brickman, A. M., Tabert, M., Schmidt, M., & Spielman, J. (2003). Acoustical analysis of posed prosodic expressions: Effects of emotion and sex. *Perceptual and Motor Skills, 96,* 759-771.

The effects of emotion and gender on prosodic expressions are investigated in this study. Participants for this study were 10 men and 9 women, matched for age and education. Participants were presented with neutral-content sentences and asked to intone the statements with happy, sad, and neutral prosody. Acoustical analysis of the productions revealed that women produced significantly higher F0 values than the men. Additionally, the sentences that were intoned with happy expression were produced with significantly higher F0 values than were the sad sentences.

Wells, B., Peppe, S., & Goulandris, N. (2004). Intonation development from five to thirteen. *Journal of Child Language, 31*, 749-778.

The purpose of this study was to provide comprehensive insight into the development of intonation that takes place between the ages of five and thirteen years. This study involved 120 children divided into 4 groups with mean ages of 5:6, 8:7, 10:10, and 13:9. Each child participated in a collection of prosodic tasks centered on comprehension and production of intonation. One particular task involved having the children listen to a list of familiar and unfamiliar words and repeat each word. It was hypothesized that the unfamiliar words would be repeated with inquiring tone. Analysis of the results suggested that younger children (5-year-olds) have more difficulty in producing a rising tone to indicate a communication need than older children (13-year-olds).

Wingfield, A., Lahar, C. J., & Stine, E. A. (1989). Age and decision strategies in running memory for speech: effects of prosody and linguistic structure. *Journal of Gerontology, 44*, 106-113.

This article examined the qualitative nature of participants' segmentation strategies to recall running speech. Participants for this study consisted of an older group (18 adults with a mean age of 70.5 years) and a younger group (18 university undergraduates with a mean age of 19.0 years). Participants were presented with various types of passages that had been recorded with normal and abnormal prosody. Each participant was instructed to listen to the passage as it was presented and to recall aloud as much of what they heard as accurately as possible. Results of this study revealed that both age groups performed more similarly with the passages presented with normal prosody.

Appendix A

Child Assent to be a Research Subject

We want to tell you about a research study we are doing. A research study is a special way to find out about something. We are trying to find out more about speech patterns in children. You are being asked to join the study because you have never had a speech or hearing problem.

If you decide that you want to be in this study, this is what will happen. It will take less than an hour.

1. We will check your hearing to see if it is okay.
2. You will read a short story.
3. You will repeat some short sentences.
3. You will play a game similar to "Go Fish".
4. We will record your speech with a microphone.

Can anything bad happen to me?

Nothing in this study will hurt you.

Can anything good happen to me?

Being in this study won't help you, but we hope to learn more about how children speak.

Do I have other choices?

You can choose not to be in this study

Will anyone know I am in the study?

We won't tell anyone you took part in this study. When we are done with the study, we will write a report about what we found out. We won't use your name in the report. You will receive $15 in the form of cash or a gift certificate for being in this study. Before you say yes to be in this study, please ask the person helping to tell you more about anything that you don't understand.

What if I do not want to do this?

You don't have to be in this study. It's up to you. If you say yes now, but you change your mind later, that's okay too. All you have to do is tell us.

If you want to be in this study, please sign or print your name.

_____ _____ _____

Child's name Signature of the child Date

_____ _____ _____

Person obtaining Assent Signature Date

Appendix B

Parental Permission for a Child to Be a Research Subject

Introduction
The purpose of this research experiment is to examine differences in the way that children signify questions and statements in their speech. Your child is being invited to participate in this study because he/she is a native speaker of English with no history of any speech, language, or hearing disorders. This experiment is being conducted under the supervision of Dr. Shawn Nissen, an associate professor in the Department of Communication Disorders at Brigham Young University.

Procedures
In this experiment your child will be asked to (1) participate in a standard hearing and speech screening, (2) read a short story, (3)repeat some short sentences, and (4) participate in a game similar to "Go Fish". Your child's speech will be recorded with a microphone into a computer. The entire session will take approximately 45 minutes.

Risks/Discomforts
There are minimal risks for participation in this study.

Benefits
There are no direct benefits to participants. However, it is hoped that through your child's participation researchers will learn more about developing speech patterns in children.

Confidentiality
All information provided will remain confidential and will only be reported as group data with no identifying information. All data, including digital recordings of your child's responses will be kept on a password protected computer in a locked laboratory and only those directly involved with the research will have access to them.

Compensation
Your child will be paid $15.00 in the form of cash or a gift certificate for participation in this study.

Participation
Participation in this research study is voluntary. Your child has the right to refuse to participate and the right to withdraw later without any penalty.

Questions about the Research
If you have questions regarding this study, you may contact Dr. Shawn Nissen at (801) 422-5056 or at shawn_nissen@byu.edu.

Questions about your child's Rights as a Research Participant
If you have questions regarding your child's rights as a research participant, you may contact the BYU IRB Administrator, A-285 ASB, Brigham Young University, Provo, UT, 84602 or at (801) 422-1461.

I have read and fully understand the consent form. Any questions have been answered to my satisfaction. I give permission for my child to participate in this research.

Signed: _____ Date: _____
(signature of participant's parent or legal guardian)

Child's Name: _____