# SYLLABLE NUMBER AND DURATIONS OF INFANT VOCALIZATIONS DURING MOTHER-INFANT INTERACTION

A Thesis by

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DURING MOTHER-INFANT INTERACTION

The following faculty members have examined the final copy of this thesis for form and content, and recommend that it be accepted in partial fulfillment of the requirement for the degree of Master of Arts, with a major in Communication Sciences and Disorders.

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# DEDICATION

To Lisa Braziel and the campers of Camp Summit
who taught me that each person, no matter what their medical diagnosis,
has something amazing to offer the world
*The way you live, may not matter at all...you never know, it might*

# ACKNOWLEDGMENTS

This project would not have been possible without the support of many people. Many thanks to my advisor, Dr. Douglas F. Parham, who was always reassuring in his guidance and direction. I extend thanks to my committee members, Dr. Kathy Strattman and Dr. Elaine Bernstorf for their knowledge and support. Finally, thanks to my parents, Tim and Linda, along with numerous friends who have supported and loved me throughout this entire process. It would not have been possible without all of you.

# ABSTRACT

*Introduction:* Although much is known about how infants produce sounds during the first two years of life, little is known about how they change their speech behaviors during communication with another person. More research is needed to determine how infants alter vocalizations when communicating with a parent. This exploratory study focused on the length and complexity of infant vocalizations during mother-infant vocal interaction. The purpose was to examine how infant response type and maternal input influence the duration and number of syllables of infant vocalizations.

*Methods:* Mother-infant communicative interaction was captured using high-quality digital audio recording. The duration and the number of syllables of each of the infants' vocalizations were compared between two response conditions: (1) when the infant responded to the mother's utterance, and (2) when the infant did not respond. The type of maternal utterance (comment, question, or command) was also coded to test for an effect on the vocalization variables.

*Results:* Few trends emerged. There was large variability in median durations and their ranges across infants and conditions. Whereas the median number of syllables was similar across infants and conditions, the ranges of number of syllables differed.

*Discussion:* The findings represent an important step toward identifying and categorizing infant speech behaviors and the ways in which mothers could increase speech development in their infants. The results of this study could serve as an additional component for describing infant speech development.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF FIGURES

# CHAPTER 1

# REVIEW OF THE LITERATURE

## *Introduction to Speech Development*

There are many foundational language behaviors that emerge in the first year of life that are psychological in nature. Infants begin by responding to familiar sounds in their environment and then begin to produce sounds that will become increasingly recognizable as approximations or fully developed speech sounds. Within a few months of birth, infants can discriminate between a number of consonant pair contrasts (e.g., /ma/ from /pa/, /pa/ from /ba/, and /ba/ from /ga/) along with some vowel contrasts (e.g., /a/ from /i/, /i/ from /u/), as well as changes in intonation and stress. Infants are not initially capable of detecting other contrasting consonants such as /sa/ from /za/, and /fa/ from /ta/ (Eilers & Minifie, 1975). Infants develop at varying rates and identified periods will overlap in development.

From birth to the first four weeks of life, infants' vocal output consists of crying and vegetative sounds (Oller 2000). These include the vegetative sounds associated with feeding and digesting. Additionally, some sounds can be identified as quasi-resonant nuclei that are vowel-like, but not fully resonant vowel sounds.

From one to four months of age, infants enter into a stage marked by sounds typically referred to as cooing. They are identified as sound productions that are more vowel like in nature, typically resembling the sound /u/. These are produced more often when infants are in a comfortable, pleasurable state with face-to-face interactions with their caregivers.

Marginal babbling emerges when the infant is four to six months old. Marginal babbling is the production of a variety of vowel-like sounds with occasional vocal tract closure, approximating syllables such as consonant-vowel combinations (CV) (e.g., /ba/), or vowel-

consonant (VC) syllables (e.g., /ab/). The pitch and duration of these vowel sounds are variable. There is generally an expansion in the variety of consonants, vowels, and their combinations. Infants tend to use stop-plosives (e.g., /p, b, t, d, k, g/) during this period.

The sixth to eighth month of life is characterized by vocal play. Vocal play can be described as longer strings of syllables expanded out of marginal babbling; here the infant is experimenting with sounds. Next, the infants produce reduplicated babbling, where a given syllable is duplicated in strings of repetitive syllables (e.g., /da da da da da/). The non-reduplicated babbling or variegated babbling occurs when the strings of syllables are more varied. The consonants and vowels may change from one syllable to the next within the same string. Echolalia also emerges in this period. Echolalia is a relatively immediate reproduction of speech directly after hearing it.

Around nine to twelve months of age, infants produce jargon which consists of strings of syllables produced with stress and intonation that mimic real speech; an infant's utterance might sound like an adult statement, command, or question. This is a natural final step in the prelinguistic progression: crying to cooing to babbling to speech (Oller, 2000).

*Speech Development and the Environment*

Research available on babbling has indicated that infants of parents with higher levels of education demonstrate a greater variety of phoneme types, starting around seven or eight months of age (Irwin, 1948). Irwin also determined that there were no significant differences between male and female infants or among infants from different racial groups. By one year of age, there is a core group of sounds (/h/, /d/, /b/, /m/, /t/, /g/, /w/, /n/, /k/) used in 80% of the consonants in an infant's babble inventory in homes where American English is spoken. The continuity hypothesis is based on the idea that babbling gradually approximates the language in infants'

environments (Pinker, 1984). Each infant's repertoire of sounds is gradually shaped toward the surrounding language; therefore, the infant begins to sound increasingly like the speakers around him or her, also known as phonetic drift. The Autism Theory, proposed by Mowrer (1952, 1980), attempts to explain the continuity hypothesis; it argues that infant sound productions are operant behavior and can be influenced by their consequences (Mowrer, 1980). A caregiver's vocalizations become reinforcements during feedings and interactions. The more the infants' sounds approximate their caregiver's, the more self-reinforcing they become. This selective reinforcement is not a conscious effort by the caregiver, but is self-reinforcing for the infant.

There are three dimensions—or stages—of a speech act: perlocutionary, illocutionary, and locutionary (Bates, 1976). These also relate to the communication phases or stages through which infants progress during speech development. The perlocutionary stage occurs during the first half of an infant's first year and is based primarily on a caregiver's interpretation of an infant's behavior. The caregiver infers the meaning of an infant's actions by imposing a communicative significance on the infant's nonverbal behaviors, cries, smiles, and vocal sounds. Most infant behaviors at this age happen unintentionally, as a reflexive response to the infant's physiological state (e.g., hunger or discomfort). The lesson learned in this stage is that when an infant acts in a responsive environment, people will respond in turn. Infants will use cry behaviors, gaze patterns, social smiles, and vocal behavior. Caregivers contribute to communication using baby talk, joint attention, and dialogues (e.g., during turn-taking games like *peek-a-boo*). The caregiver knows that communication with a new infant will soon be possible and he or she helps facilitate the infant's developing communication.

The illocutionary stage emerges during the second half of the first year of life. The infant signals his or her intentions, and begins to indicate identifiable intentions using gestures and

vocalizations. Infants begin to understand a cause-effect or means-end relationships with their caregivers by establishing joint reference and joint action. These joint attentions are established through routines and the anticipation of those routines. Eventually infants learn their part and can initiate the interaction. Protoimperatives (e.g., throwing a toy) begin to be used in this stage and include infant gestures that signal for an object and include requests, commands, or demands. Protodeclaratives are more conversational; the infant's primary goal is to attain his or her caregiver's attention. Infants also add in phonetically consistent forms—also called *units*—that have distinguished utterance boundaries, recognized as reoccurring and reliably associated with certain situations or circumstances (Dore, Franklin, Miller, & Ramer, 1976). Their phonetic composition is also relatively constant. Dore's Primitive Speech Acts (1974) that are expressed early on include calling, greeting, requesting action, protesting an action, or repeating/practicing a response. Each primitive speech act begins as a discriminated behavior occurring in high context situations. The illocutionary period serves as a transition from intentions to conventional language. As infants begin to approach their first birthday, they move toward utterances, phonetically consistent forms, and approximations of true words.

The locutionary stage emerges in the second year of life when the infant uses words, signs, or symbols to communicate intentions. This is advanced from the illocutionary stage because these gestures and vocalizations were encoded with an idiosyncrasies from the language adults understand (Bates, 1976). Children entering this stage are becoming consistent communicators who need to interact with the people in their environment. The infants changing mode of communication will not be all at once, but gradually over time. As infants transition to the locutionary stage they show moments of intentionality within their idiosyncratic gestures and vocalizations from the illocutionary stage (Paul, 2007).

*Parent-Infant Interaction*

There are many important dynamic variables in the communicative interactions of a mother-infant dyad (Goldfield, 1987). These variables may be impacted by a variety of factors such as joint attention, speaker arousal, and listener engagement (Huttenlocher et al., 1991; Stern, Spieker, Barnett, & MacKain, 1983; Warren, & Yoder, 1998; Yoder & Warren, 1999).

The mother-infant interaction literature has not attempted to give a perceptually-based account of how the speech output of one conversational partner (mother or infant) produces anticipatory or reactive physiological changes in the other partner (Beebe, Alson, Jaffe, Feldstein, & Crown, 1988). The adult speaker can modify speech in ways that influence adult listeners and, presumably, infants (Fernald, A., Taeschner, T., Dunn, J., Papoušek, M., de Boysson-Bardies, B., & Fukui, I., 1981). It is also unclear whether the age of an infant is a relevant factor in how adult speech output impacts infant speech output. Many parents believe their infants have advanced receptive skills. Paul (2007) reported that a child's comprehension strategies are related to context and not the actual vocabulary. Around 18 months of age, typically developing infants move from understanding single words outside of the routine but still require some contextual support to understanding words for absent objects and some two-word combinations (Chapman, 1978).

Phonological systems rely on types of segments and not individual segments; so infants must attend to the segments in order to learn words. In order to acquire a phonological system infants must generalize from attested to expected patterns. At 9 months of age, infants capitalize on voicing regularities to learn sound patterns instead of segmenting lexical patterns. (Saffran & Thiessen, 2003).

Healthy infants develop the ability to interact with others during the first years of life (Oller, Eilers, & Basinger, 2001; Papaeliou, Minadakis, & Cavouras, 2002). As the complexity of an infant's vocalizations change over time, the infant becomes more effective as a social communicator (Oller, 2000; Stark, Bernstein, & Demorest, 1993). Effective social communication skills result in more adult interactions meaning more language input for the infant to process for learning.

Little is known about how an infant develops the physiological capacity to use speech to respond to—and to influence—communicative partners (Jaffe, J., Beebe, B., Feldstein, S., Crown, C. L., & Jasnow, M. D., 2001; Papoušek & Papoušek, 1989). Although much is known about how infants produce sounds during the first two years of life, little is known about how they change their speech behaviors during communication with another person. There are two classifications for preverbal attempts infants make based on the reaction of the adult (Bates, 1976). Proto-imperatives are used to influence an adult to do or not do something; examples include requesting objects or actions and rejections or protests. Proto-declaratives are used to get an adult to focus on an object or event—such as showing off, or pointing out objects—; these are used to establish joint attention through social interaction. These preverbal intentions appear in typically developing infants between 8 and 18 months of age (Paul, 2007). After 18 months more advanced intentions in infants' communicative behaviors are discourse functions, which refer to previous speech acts. The discourse functions include: requests for information, acknowledgements, and answers (Paul, 2007). More research is needed to determine how infants alter vocalization within the context of communicating with a parent.

Regarding infant vocalization, there is general agreement on the developmental sequence of sounds that infants produce during the first few years of life (Jaffe, J., Beebe, B., Feldstein, S.,

Crown, C. L., & Jasnow, M. D., 2001; Koopmans-van Beinum & van der Stelt, 1986; Nathani, Ertmer, & Stark, 2006; Oller, 1980, 2000; Papoušek & Papoušek, 1989; Scheiner, E., Hammerschmidt, K., Jürgens, U., & Zwirner, P., 2002; Stark, Bernstein, & Demorest, 1993). From 9 to 18 months of age, infants move from being participants in interactions to being intentional communicators (Paul, 2007). Transitioning to intentional communication indicates when functional communication is present (Paul, 2007). Although much is known about how infants produce sounds during the first two years of life, little is known about how they change their speech behaviors during communication with another person. More research is needed to determine how infants alter vocalization within the context of communicating with a parent.

This study focused on two areas of infant speech development. One was the acoustic duration of an utterance; the other was the number of syllables in a given utterance. Both variables were compared in two conditions: when the infant responded directly to the mother, and when the infant engaged in self-talk. Additionally, the type of response that a mother provided during mother-infant interaction could serve as an important variable to predict infant speech outcomes.

# CHAPTER 2

# MOTIVATION FOR THE STUDY

## *Motivation*

Little is known about how infants develop the different systems of speech production during communication with a familiar communication partner (e.g., his/her mother). There are numerous ways in which infant development in this area can be explored: phonological production, semantics, syntactic output, or the acoustic complexity of the utterances. This study will focus on the latter by exploring differences in both utterance duration (measured in milliseconds and serving as a proxy for utterance planning) and syllable complexity (measured in the number of syllables per utterance and representing control of the speech production mechanism). By studying this particular aspect of mother-infant interaction—namely, the way in which infants are able to quantifiably adjust their acoustic output in response to maternal language input—, it was hoped that knowledge might be gained that would aid in the early identification of infants who might be developing atypically. This study was designed to categorize infant speech behaviors to better describe speech development and develop better mother-infant interactions.

## *Variables of Interest*

*Dependent variables*. The two measures for this study were (a) the duration (milliseconds) and (b) the number of syllables of each of the infant's vocalizations.

*Independent variables*. The differences in the two dependent variables were compared across two conditions: (a) the infant's vocalization was a direct response to one of the mother's utterances, and (b) the infant's vocalization was not a response to one of her utterances. The type

of maternal utterance (comment, question, or command) also was coded to test for an effect on the two dependent variables.

*Research Questions and Predictions*

This study attempted to answer two research questions related to infant vocalizations during mother-infant communicative interaction:

(1) *Are there differences in (a) utterance durations and (b) number of syllables when the infant is responding directly to the mother and when the infant engaged in self-talk?* Based on pilot results (Lang, Parham, & Francois, 2011; Stevenson, Parham, & Francois, 2011), it was predicted that when the infant responded directly to one of the mother's utterances, the vocalizations would be shorter than if the infant was engaging in self-talk. It was speculated that most of the infant's direct responses to the mother would be single syllables, which would be shorter than syllables and syllable chains produced during self-vocalizing.

(2) *Are there differences in (a) utterance durations and (b) number of syllables when the infant is responding to different types of maternal utterances: comments, questions, or commands?* This was an open question, but it was speculated that the infant would respond to maternal commands with short single syllables.

# CHAPTER 3

# METHODS

## *Introduction*

The methods for the study included obtaining IRB approval, defining the study population criteria, determining the instrumentation needed, and analyzing the data collected during the study.

## *IRB Approval*

The protocols for this study were approved by the Institutional Review Board at Wichita State University (IRB No. 1425; Project Title: "Vocalization and Speech Breathing in Infants and Adults"). The informed consent form was explained to each parent by a member of the research team before the parent signed the form. Compensation of $20.00 for each recording session was provided to the families participating in the study.

## *Study Population*

Four infants (13 to 24 months old) and their mothers were recruited as subjects. By parental report, the infants were healthy, born at full term, and free of any documented or identified developmental diagnosis (including hearing pathology, allergies, pulmonary disease, or neuromuscular disease). The infants were 13, 15, 18, and 24 months of age, respectively. The 18-month-old was the only girl. For coding and identification purposes, the mother-infant dyads were labeled "13," "15," "18," and "24" to allow for quick reference to the infants' ages.

## *Setting*

The recordings took place in the two-room Speech Development and Communication Lab at the Eugene M. Hughes Metropolitan Complex in Wichita, KS. The first room was an observational playroom designed to resemble a family-friendly living room; including child-

friendly decorations and cushioned furniture. The second room was equipped with a large one-way mirror for observation and contained the recording equipment except for the digital recorder.

*Instrumentation*

Speech output from the mothers and infants was captured using a Sennheiser Evolution G2 100 Series wireless microphone system (Sennheiser Electronic Corporation, Old Lyme, CT), A lapel microphone was attached to the infant's shirt. A high-quality digital audio recorder also was used to capture an additional audio signal (at 48,000 or 96,000 samples per second). These audio recordings were used to track the participants' utterances to increase the possibility of a good reading.

All signals were captured using USB-based data acquisition modules (Data Translation, Inc., Marlboro, MA) and digitally recorded and stored on a computer using a software program called TF32 (Lab Automation Level) (Milenkovic, 2001). This recording was ongoing and not voice-activated to avoid missing any initial vocalizations.

*Study Protocol*

Each infant was placed in a high chair in the observational playroom, with the parent seated in a comfortable chair facing the infant. The high chair provided sufficient support for the infant without constricting the infant's ability to move (as would have been the case with a car seat with straps). The lapel microphone was placed on the infant, and the digital recorder was positioned at a standardized distance (36 inches) in front of the infant. The mother was instructed to talk and interact with her infant in similar ways as she would in the home environment. She typically brought toys and books from home to use when they interacted with the baby. No other instructions were given to the mother. Recordings lasted between 30 minutes and 1 hour,

depending on the demeanor of the infant. None of the infants became visibly upset during the recordings. After each recording, the mother was debriefed on the purpose of the study and encouraged to set up a follow-up recording (to participate in a larger, longitudinal study exploring speech development).

*Data Analysis*

The acoustic signal of both the mothers and the infants were examined to identify all possible utterances. An utterance was classified as not analyzable if there was background noise in the recording that prevented the correct interpretation of the recorded utterance. Because of the quality of the audio signals, less than 2% of all utterances across recordings were considered not analyzable. All mother-infant dyads produced a sufficient number of analyzable signals (e.g., at least 100 each). Table 1 shows the duration of each recording, total number of utterances, and the total duration of each infant's utterances.

TABLE 1

DURATION OF RECORDING, TOTAL NUMBER OF UTTERANCES, AND TOTAL INFANT UTTERANCE DURATION BY EACH MOTHER-INFANT DYAD

| Dyad | Recording time | Total utterances | Total utterance duration |
|---|---|---|---|
| | | Infant | |
| 13 | 24m, 16s | 110 | 2m, 29s |
| 15 | 25m, 0s | 227 | 2m, 47s |
| 18 | 26m, 0s | 146 | 2m, 40s |
| 24 | 24m, 6s | 470 | 7m, 49s |
| | | Mother | |
| 13 | (Same as above) | 168 | -- |
| 15 | (Same as above) | 261 | -- |
| 18 | (Same as above) | 638 | -- |
| 24 | (Same as above) | 541 | -- |

The audio recordings were viewed as a waveform within the same software program used to collect the audio recordings, TF32 (Milenkovic, 2001). This software program has a labeling function that allowed coder to identify the start and end times of any segment in a signal of interest. For example, Figure 1 shows an 80-second example of a typical audio recording. The infant's utterances are identified with a black "I," and the mother's utterances with a yellow "M." This labeling function let coders export the data to another format (e.g., Microsoft Excel), where the durations of each utterance were coded.

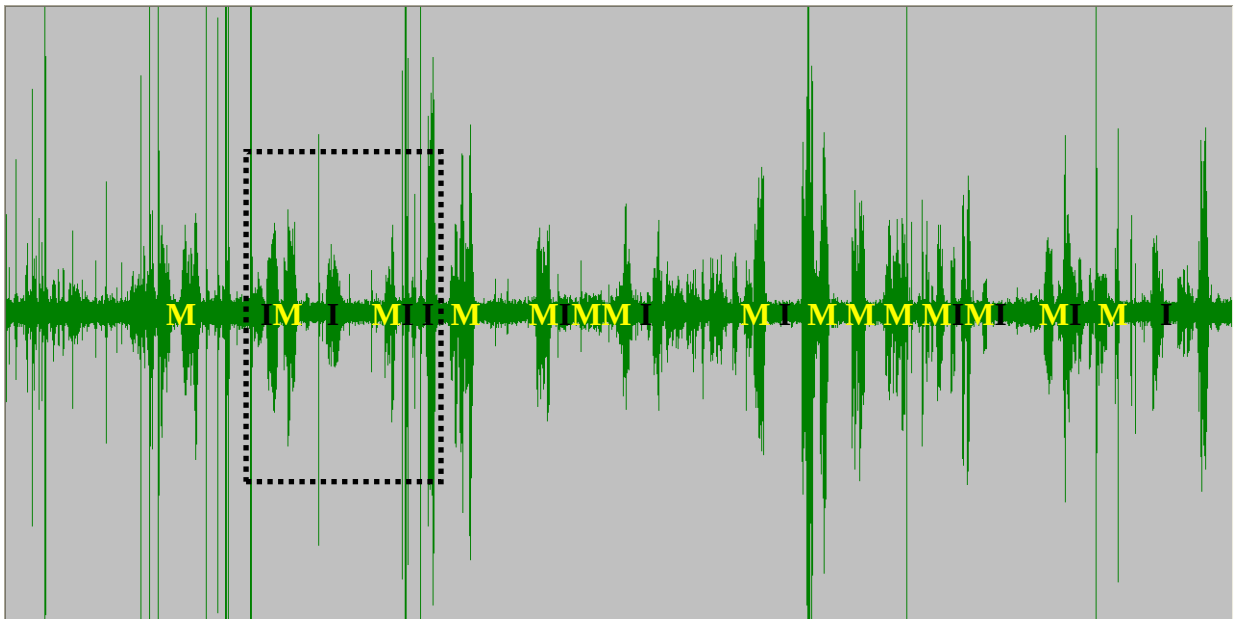


Figure 1. Eighty-second example of a typical audio recording with infant (I) and mother (M) utterances identified (the dashed box is shown in Figure 2).

Figure 2 shows a 12-second example of a typical audio recording. As with Figure 1, the infant's utterances are identified with a black "I," and the mother's utterances with a yellow "M."

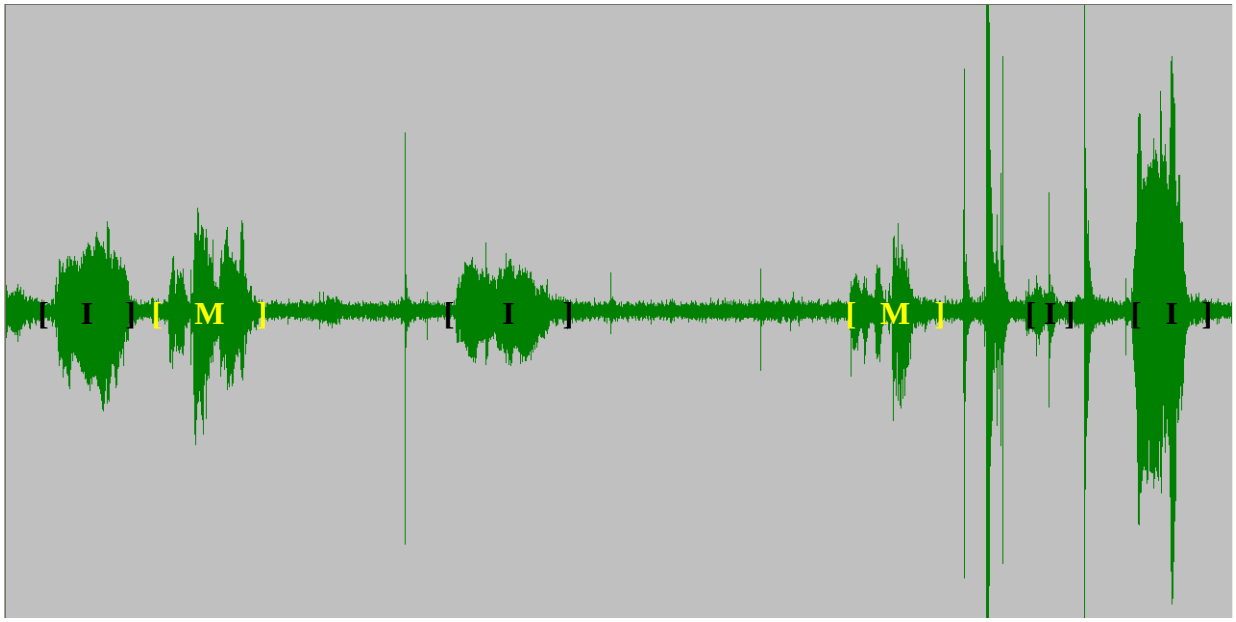


Figure 2. Twelve-second example of a typical audio recording with infant (I) and mother (M) utterances identified.

The TF32 labels allowed the coders, (including the primary advisor and graduate students) to give a unique identifying code to each utterance. For the purposes of this study, coders identified each infant's utterances and each mother's utterances using a code developed for a previous study (Lang, Parham, & Francois, 2011; Stevenson, Parham, & Francois, 2011). The coders determined—based on consensus coding—if the infant was responding (a) directly to the mother (mother-directed) or (b) engaging in self-directed vocal play. A mother-direct response from an infant was recognized as part of an exchange happening with the mother. A mother-direct response also was included if the infant was negotiating for the same product. Self-directed talk was identified as a non-direct response to the mother or not participating in a negotiation with the mother.

They also coded for whether the mother's utterance was (a) a comment (e.g., "This is your book."), (b) a question (primarily based on the use of questions words; e.g., who, what, where; and the upward inflection in the mother's voice; e.g., "Do you want your book?"), or (c) a

command (identified as a statement of force with decreased inflection; e.g., “Open your book.”). These were the only three types of verbal stimuli for the infant.

The coders saved their work as a “TXT” file that was imported into various, more advanced software programs (e.g., Microsoft Excel). Figure 3 shows an example of the “TXT” file produced by TF32 following the coders identification of utterances in the audio file. Infant utterances were identified simply with an “i”; maternal utterances (stimulus types) are identified as comments (“m.”), questions (“m?”), and commands (“m!”).

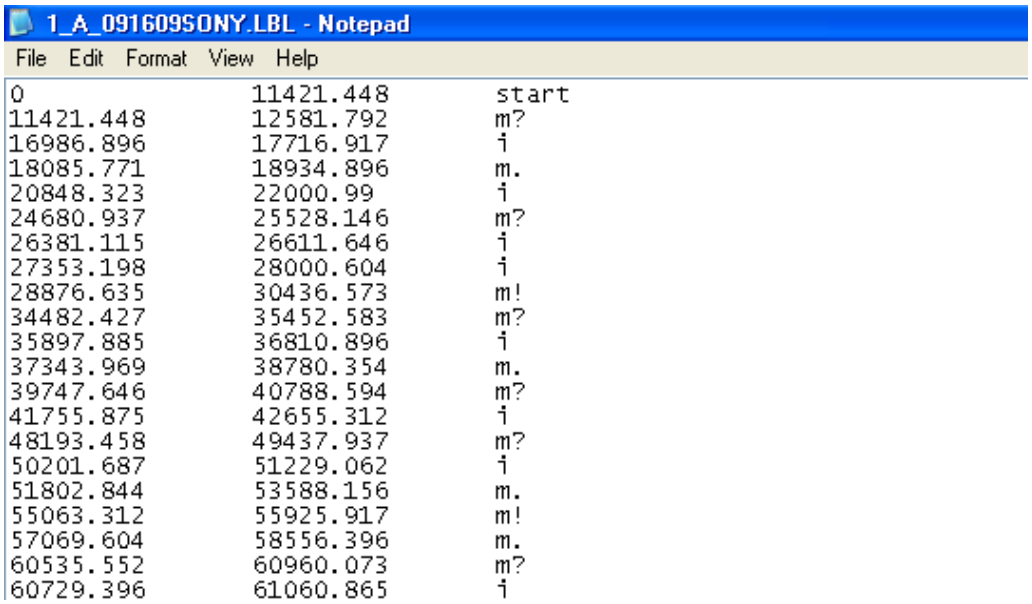


Figure 3. Example of the “TXT” file produced by the TF32 software program that shows the start (first column) and end (second column) times of each utterance, as well as a unique utterance code (third column).

Figure 4 shows how the “TXT” file was expanded using Microsoft Excel to provide the codes that allowed for the variables of interest of this study to be tested.

| | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | start | end | duration | bothcode | momcode | infantcode | link | transcription | syllables | |
| 2 | 0 | 11421.448 | 11421.448 | start | | | | | | |
| 3 | 11421.448 | 12581.792 | 1160.344 | m? | 3 | | 1 | m: You gonna make your train go? | 7 | |
| 4 | 16986.896 | 17716.917 | 730.021 | i | | 1 | 1 | b: doh | 1 | |
| 5 | 18085.771 | 18934.896 | 849.125 | m. | 1 | | 2 | m: It's going. | 3 | |
| 6 | 20848.323 | 22000.99 | 1152.667 | i | | 1 | 2 | b: nom | 1 | |
| 7 | 24680.937 | 25528.146 | 847.209 | m? | 3 | | 3 | m: Is it stuck? | 3 | |
| 8 | 26381.115 | 26611.646 | 230.531 | i | | 1 | 3 | b: yah | 1 | |
| 9 | 27353.198 | 28000.604 | 647.406 | i | | 2 | | b: doh | 1 | |
| 10 | 28876.635 | 30436.573 | 1559.938 | m! | 2 | | | m: There you go. Get 'em all put together. | 10 | |
| 11 | 34482.427 | 35452.583 | 970.156 | m? | 3 | | 4 | m: What does your train say? | 5 | |
| 12 | 35897.885 | 36810.896 | 913.011 | i | | 1 | 4 | b: tch (3x) | 3 | |
| 13 | 37343.969 | 38780.354 | 1436.385 | m. | 1 | | | m: tch (5x) | 5 | |
| 14 | 39747.646 | 40788.594 | 1040.948 | m? | 3 | | 5 | m: Cool. What is this? | 4 | |
| 15 | 41755.875 | 42655.312 | 899.437 | i | | 1 | 5 | b: whi-ding | 2 | |
| 16 | 48193.458 | 49437.937 | 1244.479 | m? | 3 | | 6 | m: Can you say choo-choo train? | 6 | |
| 17 | 50201.687 | 51229.062 | 1027.375 | i | | 1 | 6 | b: tu tu tai(whispering) | 3 | |

Figure 4. Example of a portion of a Microsoft Excel file containing the variables of interest, coded for this study.

The full coding of the dataset in Microsoft Excel allowed for the data to be represented across the variables of interest.

*Statistical Analysis*

Because of the variety of infant ages and the uneven distribution of utterances across conditions (see Table 2 below in the *Results* section), it was determined that inferential statistical comparisons would not be appropriate for this dataset. In order to explore the research questions, descriptive statistics were calculated for the durations and the number of syllables for each infant and each combination of conditions:

(a) The infant's response type (mother-directed vs. self-directed): Were there trends in the durations or number of syllables of the infant's utterances when the infant was responding directly to the mother and when the infant was not responding to the mother (i.e., engaged in self-directed vocal play)?

(b) The mother's utterance type (comment, question, vs. command): Were there trends in the durations or number of syllables of the infant's utterances given the mother's utterance type?

Because utterance durations and the number of syllables are variables that typically are not normally distributed (Lang, Parham, & Francois, 2011; Stevenson, Parham, & Francois, 2011), the median and the range of the variables were calculated instead of means and standard deviations.

# CHAPTER 4

# RESULTS

## *Distribution of Infant Utterances*

This chapter will look at the numbers that the coding provided and what the numbers revealed about trends concerning the number of syllables and utterance duration during mother-infant interactions.

Table 2 provides the cell distribution of the utterances across infants and conditions.

TABLE 2

DISTRIBUTION OF DATA BY MOTHER'S STIMULUS TYPE AND INFANT'S RESPONSE TYPE BY INFANT

| | Infant response type | |
|---|---|---|
| Mother stimulus type | Mother-directed | Self-directed |
| | Infant 13 | |
| Comment | 11 | 52 |
| Command | 1 | 16 |
| Question | 13 | 17 |
| | Infant 15 | |
| Comment | 56 | 48 |
| Command | 7 | 5 |
| Question | 85 | 26 |
| | Infant 18 | |
| Comment | 23 | 21 |
| Command | 7 | 7 |
| Question | 70 | 18 |
| | Infant 24 | |
| Comment | 37 | 69 |
| Command | 31 | 52 |
| Question | 191 | 90 |

Figure 5 shows the same data in the form of bar charts for each infant.

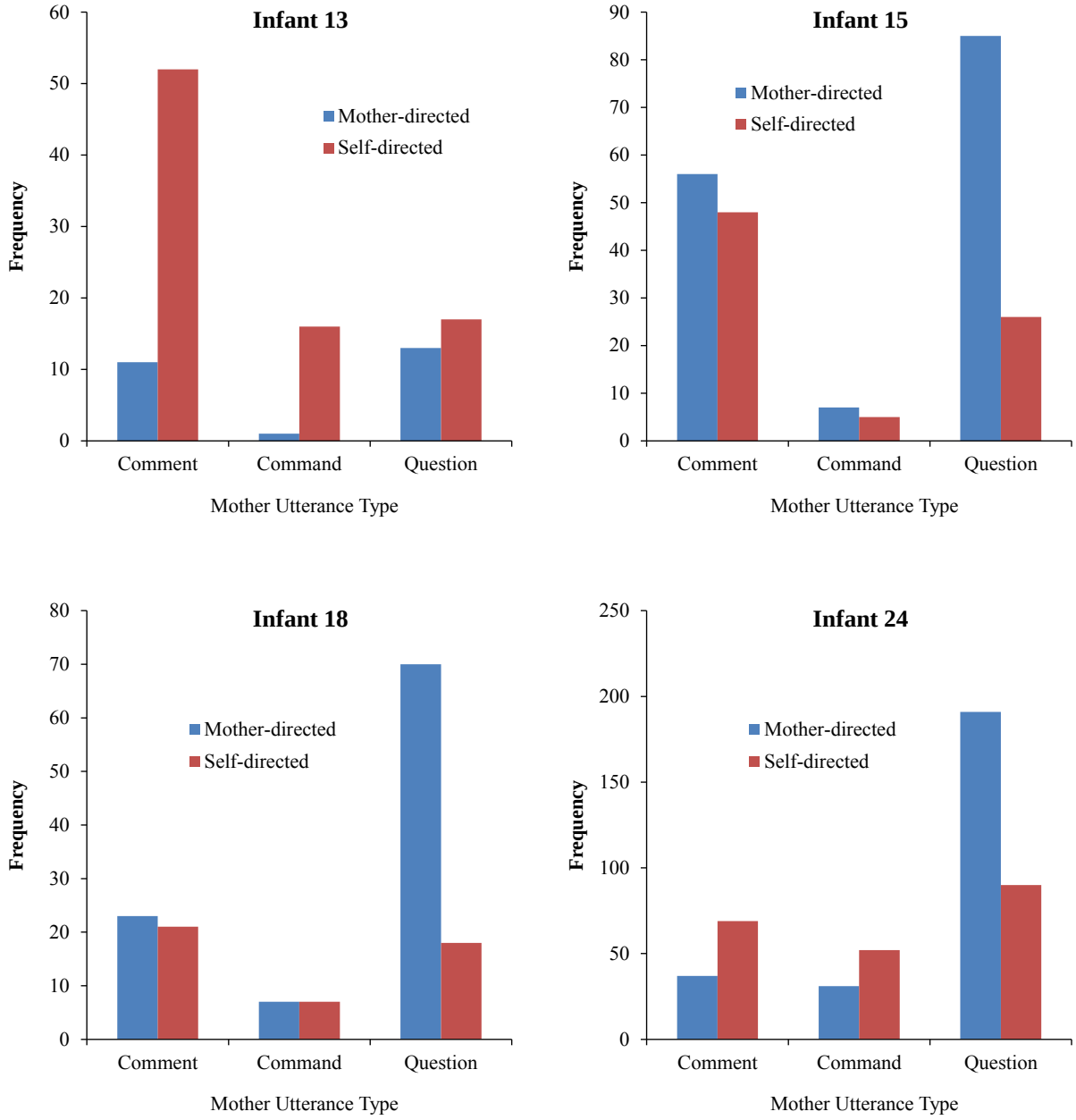


Figure 5. Distribution of utterances across infants for all conditions.

*Results of Descriptive Statistics: Durations*

The medians and ranges (both in milliseconds) for the durations of the infants' utterances are presented in Table 3.

TABLE 3

MEDIANS (RANGES) IN MILLISECONDS FOR INFANTS' UTTERANCE DURATIONS

| Mother stimulus type | Infant response type | |
|---|---|---|
| | Mother-directed | Self-directed |
| | Infant 13 | |
| Comment | 793 (250-2592) | 1407 (250-4604) |
| Command | 579 (--)[a] | 1432 (290-3140) |
| Question | 941 (192-1463) | 951 (259-4268) |
| | Infant 15 | |
| Comment | 399 (152-1799) | 788 (152-4022) |
| Command | 638 (283-1491) | 303 (233-839) |
| Question | 465 (182-2809) | 741 (152-5609) |
| | Infant 18 | |
| Comment | 998 (347-4000) | 1313 (405-2992) |
| Command | 1106 (415-1501) | 1042 (336-3635) |
| Question | 803 (257-2765) | 1195 (271-3318) |
| | Infant 24 | |
| Comment | 1005 (190-2924) | 772 (143-3528) |
| Command | 1251 (436-2604) | 818 (198-4501) |
| Question | 572 (103-3622) | 1028 (177-3129) |

[a]Median and range were not computed because there was only one utterance in this category.

Figure 6 shows the same data in the form of bar charts for each infant. The bars represent the ranges of the data and the black diamonds identify the median values.

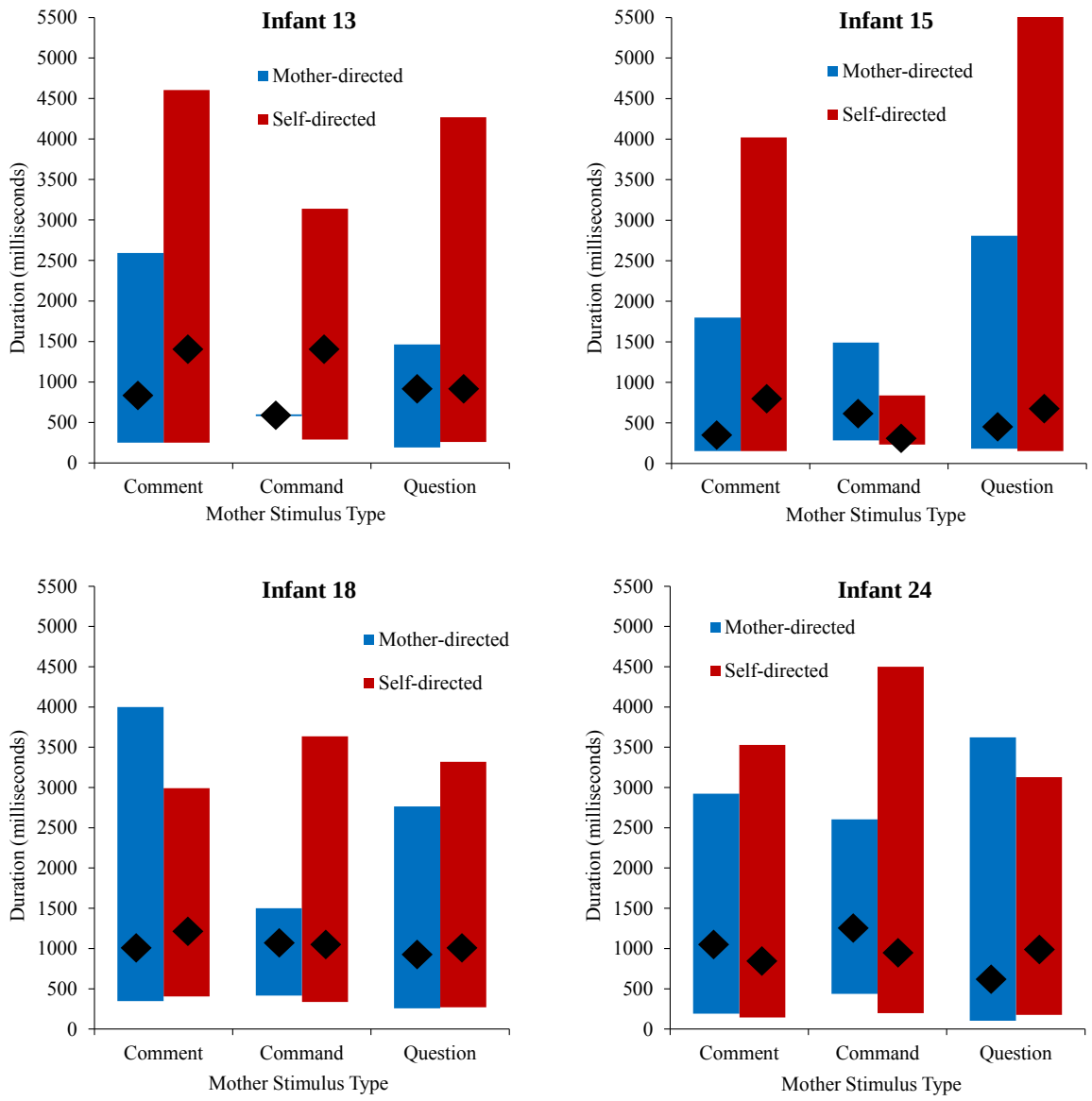


Figure 6. Ranges and medians of utterance durations within infants for all conditions.

*Results of Descriptive Statistics: Number of Syllables*

The medians and ranges for the number of syllables of the infants' utterances are presented in Table 4.

TABLE 4

MEDIANS (RANGES) FOR NUMBERS OF SYLLABLES IN INFANTS' UTTERANCES

| Mother utterance type | Infant response type | |
|---|---|---|
| | Mother-directed | Self-directed |
| | Infant 13 | |
| Comment | 2 (1-3) | 1.5 (1-5) |
| Command | 2 (--)[a] | 1 (1-5) |
| Question | 1 (1-3) | 1 (1-3) |
| | Infant 15 | |
| Comment | 1 (1-4) | 1.5 (1-9) |
| Command | 2 (1-2) | 1 (1-3) |
| Question | 2 (1-8) | 2 (1-5) |
| | Infant 18 | |
| Comment | 2 (1-5) | 3 (1-9) |
| Command | 2 (1-3) | 2 (1-7) |
| Question | 2 (1-4) | 2 (1-4) |
| | Infant 24 | |
| Comment | 2 (1-5) | 1 (1-7) |
| Command | 2 (1-6) | 1 (1-5) |
| Question | 1 (1-6) | 1 (1-7) |

[a]Median and range were not computed because there was only one utterance in this category.

Figure 7 shows the same data in the form of bar charts for each infant. The bars represent the ranges of the data and the black diamonds identify the median values.

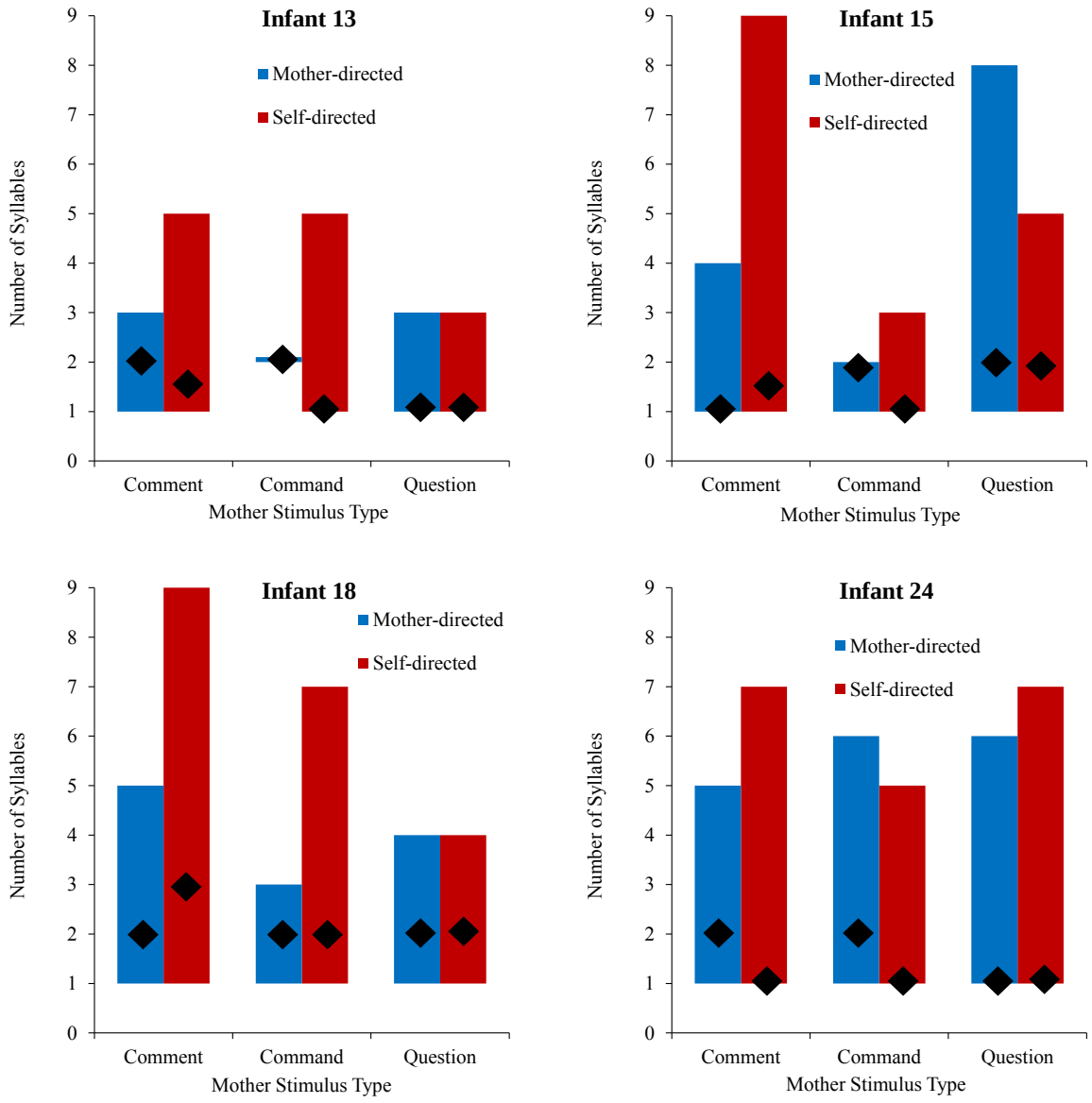


Figure 7. Ranges and medians of number of syllables within infants for all conditions.

*General Summary of Descriptive Results*

Because no inferential statistical differences were computed for this data (see *Statistical Analysis* section above), the results were examined for numerical trends. For mother-directed responses, the utterances of Infants 15, 18, and 24 following commands were longer in duration than those following comments or questions. Across the four infants and across mother utterance types, self-directed utterances had higher median durations than corresponding mother-directed

utterances in 8/12 comparisons, and higher maximum in 9/12 comparisons. There was large variability in median durations and their ranges across infants and conditions. The median number of syllables ranged between 1 and 2 (Infant 3 had a median of 3 syllables in one condition). The ranges of number of syllables differed across infants and conditions.

# CHAPTER 5

# DISCUSSION

## *Restatement of Research Questions*

This study attempted to answer two research questions related to infant vocalizations during mother-infant communicative interaction:

(1) *Are there differences in (a) utterance durations and (b) number of syllables when the infant is responding directly to the mother and when the infant engaged in self-talk?*

(2) *Are there differences in (a) utterance durations and (b) number of syllables when the infant is responding to different types of maternal stimulus types: comments, questions, or commands?*

## *Interpretation of Results*

The youngest infant (13 months) engaged in more self-directed babbling and vocalizing than the other three infants. It is speculated that he was in the process of developing the intentionality of his communication, and that the older infants used their communication more intentionally and therefore produced more mother-directed babbling and vocalizations.

If the mother takes the lead in providing verbal stimuli to the infant, the infant might vocalize more because the infant does not have to initiate an interaction. If the infant has learned the back-and-forth rhythm of conversation, vocalizations are produced less likely at random, but instead are produced as part of an interaction. This interaction involves imitation and when the mother starts the interaction, the infant has a model to imitate. This was probably the case for Infant 18, who produced a large number of vocalizations, despite the mother's continuous vocal output (see Table 1). On the other hand, if a mother takes the lead in providing verbal stimuli to the infant, the infant may vocalize less because they have been conditioned to vocalize as a

response. The infant will not vocalize as an independent being but instead only as a responder to the mother. It is speculated that this was the case for Infant 18, who vocalized less; her mother dominated the vocal space based on the number of maternal utterances (see Table 1).

Also, the infant may vocalize more if the mother responds to a vocalization because the infant wants to interact and knows that he or she will get the mother's attention and affection if they vocalize. Based on the audio recordings, more vocalizations seemed to occur when the infants sought this interaction; the mother conditions the vocalizations with a consistent response to them.

The mother-infant dyads frequently used books and toys during the interactions. Books and toys may help a mother elicit more vocalizations from an infant because they give a visual reference for what is being said. It gives a mother and infant a place for their joint attention. It also establishes a routine (e.g., rolling a ball back and forth, turning the pages of a book) which can help an infant anticipate what the mother will do and say and begin to participate in the routine. Imitation—by both mothers and infants—was another important part of the interactions. The mothers also frequently engaged their infant by speaking to them about the things in their environment. This attention may elicit more vocalizations from their infants than not speaking directly to them.

*Parenting Implications for Speech and Language Development*

In the first year of life, babies' sound productions are shaped by and toward the language input they receive (Paul, 2007). The perlocutionary stage from 0-6 months is based entirely on the caregiver's interpretation of the infant's behaviors as communication. As infants transition from the perlocutionary stage to the illocutionary stage, they learn that their intentions can have an effect on a caregiver (e.g., if the infant cries, the mother will pick him or her up). If there is no

input from the caregiver in this interaction during the first six months, then the development of the cause and effect of communication will be much slower. Parents and caregivers can develop this intentionality by having joint attention with their baby. Joint attention is the shared focus of two or more individuals on an object. If the baby was looking at a toy, the caregiver commented about it. (e.g., "Look at all the colors: blue, purple, red, orange"; "It is making noise"; "That surprised you"). Maintaining joint attention is also an important aspect of developing the conversational turns which caregivers can do by mentioning the same word over and over (e.g., "It's a ball, roll ball, red ball, it's a round ball"). Repeatedly saying the word "ball" helps the infant identify the object that he or she is manipulating and maintains attention on it for a number of moments. Infants are naturally curious about their environment, and parents can take the child's lead about what to comment on. In the recordings, the baby would point at pictures on the wall of the room and the parent would comment on them (e.g., "It's a fish"). Parents can comment about the environment around them; the noises happening, things that drive or go by, what actions the infant is doing, and what the parents are doing. These commands do not have to place demands on the infant to produce anything. For instance, when playing *peek-a-boo*, a parent in the study commented, "Where's mommy? Find mommy. There she is." These commands are also part of the initial tier of questions infants begin to respond to first (e.g., "Show me…," "Get the…").

Once the intention of communication is established by the infant, he or she transitions to the illocutionary stage where the parent or caregiver can begin to scaffold the infant's intentions. Scaffolding, pertaining to language, takes the communication production where it is and then expands it by one or two steps. For instance, if an infant grunts while reaching for a ball, a parent can respond "I want ball." Once the infant has the ball, the parent can describe it to him or her

(e.g., “red ball,” “round ball”). This expands the infant’s communication intention by two to three words. Simple sentences allow the infant to process the information more easily and should develop better an infant’s communication skills. Another way to scaffold an infant’s communicative intentions is to identify his or her gestures. If the infant shakes his or her head in way that suggests a “no” response, the parent can identify the action and acknowledge it verbally (e.g., “No, you do not want crackers”).

In the prelocutionary stage, parents can do several things for optimum communication development. They can take turns and develop the back and forth of waiting for the infant to do something before the caregiver goes again. They can imitate the infant’s actions or sounds. They can point things out, especially those objects within the gaze of the infant. They can set the stage with simple games, songs, or routines (e.g., “On your mark, get set…,” then letting the infant motion or vocalize before saying “Go”; Paul, 2007).

As infants move toward the locutionary stage of communication and the first birthday, they will begin to use utterances with the same intonation and prosody of adult-like words, even though they do not have all the sounds, which was observed in the 18 and 24 month old. Parents who encourage their infants to experiment and play with sounds while responding to their communicative intentions will see their infant become consistent communication partners. Infants with a means of communicating their wants and needs tend to have less frustration with communication. They resort to inappropriate behaviors (e.g., crying, hitting) less than their peers who have a less developed means of communication. As the infant reaches this stage, parents should continue to scaffold and encourage the infant to identify objects and actions. Communication exchanges should become longer and more involved. As an infant increases his or her mean length of utterance, parents can increase theirs in order to continue to increase the

infant's communicative skills. Developing conversational turn-taking skills is vital to developing the maintenance of joint attention in the first two years of life. If the infant or parent comments about something (e.g., ball) and the communication partner comments in return, it sets the stage for a back-and-forth conversation, even if the parent cannot understand every word that the infant is producing.

A subjective finding of this current study is that mothers scaffolded interactions by expanding what the infant produces and maintaining joint attention. Parents that scaffold with their infants tend to receive more feedback and communicative interaction from their baby. The more a parent or caregiver scaffolds and builds the interactions, the more language input the infant receives. These interactions are the foundations to communication for the rest of the infant's life.

*Clinical Implications for Speech and Language Development*

When an infant is at risk for developing a language disorder, parents can use many techniques to foster communication. As previously stated, parent responsiveness is a significant predictor of language development. Warren and Yoder (1998) are advocates for prelinguistic milieu teaching to transition to intentional communication. For example, the parent can adjust the environment to violate the expected routines to elicit communication. The parent can then follow the infant's lead and wait expectantly within the routine for the infant to respond. It is important for the parent or caregiver to wait and make his or her responses contingent on the infant's actions.

For infants who do not initiate, there are two possible strategies parents can use: contingent motor imitation and contingent vocal imitation. The contingent motor imitation is an exact, reduced, or slightly expanded imitation of an infant's motor act that an adult does

immediately after the infant does it. Contingent vocal imitation is when the adult imitates an infant's vocalization. Something else that can be used to elicit communication in potential language delayed infants is the use of natural communication consequences. In this situation, the infant's communication is rewarded with his or her intended goal. For example, the infant points to a cookie, the adult says, "You want a cookie," and then acknowledging the form of communication used (e.g., "You pointed"; Paul, 2007).

*Study Limitations*

There are several limitations associated with this study. First, there was a large age range in the infants. More data would be needed to test the generalizability of the results. Second, the duration and number of syllables of the infants' utterances were not normally distributed. This limited the type of comparisons that could be performed. Third, the mothers themselves performed differently in terms of the number of utterances produced and how they interacted with their infants. A deeper exploration of the data is needed to identify explanatory variables related to the mothers. Fourth, few trends emerged from the data collected. It is speculated that the variability in the infants—above and beyond the differences in age—contributed to the lack of general trends within the conditions.

*Summary*

This exploratory study focused on the length and syllable count of infant vocalizations during mother-infant vocal interaction. The purpose was to examine whether infant vocalizations were longer in duration and had more syllables (1) when infants were responding to their mothers or (2) when they were vocalizing to themselves. The type of maternal utterance (comment, question, or command) was coded to test for an effect on the dependent variables. Whereas this was a study of typical infant speech development during communicative

interaction, an expansion of this study might help with diagnosing atypical patterns of infant utterance production during mother-infant interaction.

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# APPENDICES

APPENDIX A

INSTITUTIONAL REVIEW BOARD (IRB) APPROVAL LETTER

WICHITA STATE UNIVERSITY
RESEARCH ADMINISTRATION

**Date: September 21st, 2012**

**Principal Investigator: Douglas Parham**

**Co-Principal Investigator: n/a**

**Department: CSD, Box 75**

**IRB Number: 1425**

The University Institutional Review Board (IRB) has reviewed your research project application entitled:

**"Vocalization and Speech Breathing in Infants and Adults"**
***Application Renewal***

and approved the project according to the Federal Policy for the Protection of Human Subjects. As described, the project also complies with all the requirements and policies established by the University for protection of human subjects in research. Unless renewed, approval lapses one year after approval date.

Please keep in mind the following:

1. Any significant change in the experimental procedure as described should be reviewed by the IRB prior to altering the project.
2. When signed consent documents are required, the principal investigator must retain the signed consent documents for at least three years past completion of the research activity.
3. At the completion of the project, the principal investigator is expected to submit a ***final report***; the form is attached.

Thank you for your cooperation. If you have any questions, please contact me at ext. 6945.

Sincerely,

Michael Rogers, Ph.D.
Chairperson, IRB

Wichita State University, Wichita, Kansas 67260-0007 Telephone: (316) 978-3285 Fax: (316) 978-3550

APPENDIX B

IRB APPROVED CONSENT FORM


**Consent Form for Adult Participants and Their Infants**

**Purpose:** You and your infant are invited to participate in a study of speaking and breathing. The purpose of this research is to explore how speaking and breathing develop across different stages of the human life span.

**Participant Selection:** You and your infant are eligible to participate in this study because it focuses on how infants learn to speak. Your infant's speech can be compared with those of other infants and persons across the human life span. It is anticipated that between 40 and 50 infants and their families will participate in this study.

**Explanation of Procedures:**

- This study will take place in the Speech Development and Communication Lab at the Eugene M. Hughes Metropolitan Complex, located at Oliver and 29th Street.
- If you decide to participate, you will be asked to provide basic information related to your infant's health, such as the history of ear infections and/or complications during or after birth.
- Your role will be to encourage your infant to produce speech sounds.
- Your infant will be seated in a high chair or an alternative (for example, a Bumbo baby seat). You will be seated in a chair facing your infant. If your infant is too young or too small to fit in the seating devices, you will hold your infant.
- You and your infant will each wear a microphone, respiratory bands (around the rib cage and abdomen), and body movement sensors. You yourself can opt not to wear the equipment.
- To measure breath volume, you will be asked to blow air into a tube for several minutes and your infant will breathe into a small face mask for several seconds.
- You and your infant's speech, respiration, and body movements will be recorded. A video recording will also be made of the interaction.
- During the recording session, your infant will also interact with a graduate student from the Department of Communication Sciences and Disorders who is associated with the study. The role of the graduate student is to encourage your infant to produce speech sounds.
- Each recording session will last between one and two hours, but will be stopped if your infant becomes upset or distressed.
- You and your infant may be eligible to participate in future recording sessions while this research project is in progress.
- You will also be given the options of having your infant's hearing and/or overall development screened. If you are interested in one or both of these screenings, they will be scheduled either as part of the initial recording session or for a separate visit at another time.
- It is possible that the video recording will be used in the future in educational and/or academic settings. Your permission for the educational use of the video recording is an entirely separate issue than your participating in the study. You and your infant may agree to be in the study without agreeing to the educational use of the video recording.

**Discomfort/Risks:** There are no known physical risks to the infants or adults participating in this study. The instrumentation systems and the data collection methods are non-invasive and do not pose any direct physical risk to you or your infant. Regarding potential emotional risks, your infant might express some discomfort being in an unfamiliar setting, interacting with an unfamiliar adult, or wearing a face mask during the first part of the recording session. Your infant will not be out of your physical or visual contact, and you may stop the recording session at any time. Although no other risks are anticipated with this study, there is always a small chance of unforeseen risk.

**Benefits:** By participating in this research, you can be expected to benefit from knowledge gained about human development. The findings of this research will fill in the gaps of the current scientific knowledge of speech development.

**Compensation:**

- For you and your infant's combined participation in each recording session, you will receive a one-time monetary compensation of $20.00.
- Wichita State University does not provide medical treatment or other forms of reimbursement to persons injured as a result of or in connection with participation in research activities conducted by Wichita State University or its faculty, staff, or students. If you believe that you have been injured as a result of participating in the research covered by this consent form, you can contact the Office of Research Administration, Wichita State University, Wichita, KS 67260-0007, telephone (316) 978-3285.

**Confidentiality:**

- Any information obtained in this study in which you can be identified will remain confidential to the extent permitted by law and will be disclosed only with your permission.
- The data from you and your infant will be associated with unique codes known only to the study's research team and will be referenced only by those codes.
- Study-related files will be kept locked away when not in use by the research team.
- Federal agencies such as the Food and Drug Administration (FDA) and the Office for Human Research Protections (OHRP) may review study data as allowed by law.
- You will have the right to decide about the special use of the video recording for educational purposes (see separate form).
- You also reserve the right to have part or all of the recordings of you and your infant permanently erased at any time during or after the study.

**Refusal/Withdrawal/Termination:** Participation in this study is entirely voluntary for you and your infant. Your decision to participate or not will not affect your future relations with Wichita State University. If you agree to participate in this study, you are free to withdraw from the study at any time without penalty. If the Principal Investigator determines that your participation or your infant's participation in the study is causing undue discomfort or distress to you or your infant, the recording session will be terminated.

**Contact:** If you have any questions about this research, you can contact Douglas Parham, PhD, Principal Investigator, at the Department of Communication Sciences and Disorders at Wichita

State University, Wichita, KS 67260-0075 (Telephone: 316-978-5634; E-mail: douglas.parham@wichita.edu). If you have questions pertaining to your rights as a research subject, or about research-related injury, you can contact the Office of Research Administration at Wichita State University, Wichita, KS 67260-0007 (Telephone: 316-978-3285).

You are under no obligation to participate in this study. You may stop your participation and the participation of your infant at any time. Your signature indicates that you have read the information provided above and have voluntarily decided to participate. You will be given a copy of this consent form to keep.

| | |
|---|---|
| Signature of Parent/Legal Guardian as Participant | Date |
| Signature of Parent/Legal Guardian to Give Permission For the Infant to Be a Participant | Date |
| Signature of Person Conducting Informed Consent Discussion | Date |