VOLUBILITY OF 12-MONTH-OLD INFANTS IN VARYING SOCIAL CONDITIONS

by

HAILEY DENSON

(Under the Direction of Suneeti Nathani Iyer)

ABSTRACT

It has been found that the vocalizations of infants are related to later spoken language development. The present study examines these early vocalizations using the measure of volubility, or rate of vocalizations. Volubility of 17 typically developing infants around 12 months of age was longitudinally studied across three conditions: parent talking to and interacting with infant, parent not talking and interacting with infant, and parent talking to interviewer while infant was present in the same room. Results indicated that there were no significant differences in volubility across social conditions, although there was considerable variability across infants. These results suggest that volubility of 12-month-old infants is robust. Infants vocalize even when no one is talking to them or when a stranger is present. Results also indicated that volubility might be associated with a few sociodemographic variables (e.g., sex, language status).

INDEX WORDS: Prelinguistic, Infant, Volubility, Vocalizations, Social

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DEDICATION

I would like to dedicate this thesis to several individuals: my dad, Rusty Denson, my mom, Mary Denson, my sister, Keelie Denson, my boyfriend, Bruce Dubberly, and the best dog in the entire world, Kanga.

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CHAPTER 1

REVIEW OF THE LITERATURE

Introduction

It has become evident that vocalizations of infants (or prelinguistic vocalizations) are related to the development of later spoken language (Locke, 1993). This continuity shows that it is important to examine prelinguistic vocalizations when assessing infants at risk for later speech and language deficits. The present study seeks to examine one aspect of these prelinguistic vocalizations, namely volubility.

Volubility, or the amount or rate of speech-like vocalizations, has been studied for its clinical significance. Factors that have been found to affect volubility in infants and toddlers include socioeconomic status (Oller, Eilers, Steffens, Lynch, & Urbano, 1994), autism (Patten et al., 2014; Warren et al., 2010), and Down syndrome (Berger & Cunningham, 1983; Thiemann-Bourque, Warren, Brady, & Gilkerson, 2014). Volubility does not appear to be not affected by hearing loss (Clement, 2004; Nathani, Oller, & Neal, 2007; Petinou, Schwartz, & Mody, 2007), cleft palate (Chapman, 2001), or sex and ethnicity (Camp, Burgess, Morgan, & Zerbe, 1987). Results regarding effects of prematurity on volubility are conflicting, with some research reporting no effects (Oller et al., 1994), and some research reporting that preterm infants have lower volubility after the onset of canonical babbling (Törölä, Lehtihalmes, Hikkinen, Olsén, & Yliherva, 2012).

In addition to its clinical significance, volubility has been shown to be useful in predicting subsequent development. It has been found that volubility can predict later language behaviors (Cameron, Livson, & Bayley, 1976; Camp et al., 1987; McCathren, Yoder, & Warren, 1999; Paul & Jennings, 1992; Rescorla & Ratner, 1996; Locke, 1989) and later cognitive ability in typically developing infants (Kagan, 1971; Roe, 1975) although these results await confirmation as there are some methodological issues with existing studies on this topic (e.g., short observation times used, calculation of volubility in different ways).

Most of the above-mentioned studies have, however, included infants younger or older than 12 months of age. Given that 12 months of age is a period of linguistic transition, i.e., a period when infants start producing their first words, it would be useful to examine the nature of volubility at this transitional age.

<u>Volubility in 12-Month-Old Infants</u>

To our knowledge, eight investigations have examined volubility of 12-month-olds. A summary of these studies can be found in Table 1. Although these studies typically examined a range of ages, only the data relevant to the ages for this study, i.e., 12 months of age, is shown in Table 1. It should also be noted that, with the exception of Stevenson et al. (1986), most did not express volubility in terms of utterances/minute, which resulted in estimated values having to be calculated from data provided within the articles.

As seen in Table 1, a large range for volubility for 12-month-olds from 1.65 utterances/minute (Gilkerson & Richards, 2008) to 7.92 utterances/minute (Camp et al., 1986) has been reported. The wide range of volubility is probably due to the fact that there were several methodological differences/limitations across the studies. Two of the studies had small sample sizes of five and six infants (Chapman, 1991; Nathani & Stark, 1996) and two used short observation periods of 15 minutes or less (Camp et al., 1987; Stevenson, Leavitt, Roach, Chapman, & Miller, 1986). Studies that were conducted using LENA recording devices (Gilkerson & Richards, 2008; Greenwood, Thiemann-Bourque, Walker, Buzhardt, & Gilkerson, 2011), which record infant vocalizations over a 12-hour observation period, may have included naptime and/or TV time, resulting in the some of the least volubility values reported in the literature.

Furthermore, three of the studies are cross-sectional and five are longitudinal. Only two studies took socioeconomic status of the infants into account (Greenwood et al., 2011; Oller et al., 1994). This is a problem due to the fact that SES has been shown to have an effect on volubility (Oller et al., 1994). Some of the studies were performed in the laboratory, while others were done in the home. Camp et al. (1987) was done in a health clinic. Although most of the studies used naturalistic play environments to collect data, one study used conditioning techniques to elicit vocalizations (Nathani & Stark, 1996). Half of the studies separated utterances when there was 1-second of silence. However, half of them used different criteria. These criteria ranged from 300 milliseconds of silence (Gilkerson & Richards, 2008; Greenwood et al., 2011) to 2 seconds of silence (Chapman, 1991; Nathani & Stark, 1996). One study used the criteria that vocalizations must be “uninterrupted” and did not specify any time criteria (Camp et al., 1987). Given these methodological differences, it is difficult to come to any conclusions regarding 12-month-olds’ volubility.

The present study attempted to add to the limited normative database, especially in the laboratory setting using a longitudinal design, on the volubility of 12-month-old infants. Advantages of the laboratory setting include the ability to control the communicative situations in which infants are observed (Nathani & Stark, 1996) and to eliminate distracting stimuli as well as control the lighting and camera positions (Fogel, Toda, & Kawai, 1988). In addition, contemporary breath-group criteria, i.e., intuitively perceived silences of approximately 1-second, were used to separate utterances. Volubility was explicitly reported as utterances/minute.

Infant Volubility in Different Social Conditions

In addition to contributing normative data, the present study will also attempted to determine the effects of different social conditions on volubility. Three conditions were examined, namely parent talking and playing with the infant, infant playing alone without parent talking and/or actively interacting, and parent talking with experimenter in the room while infant is playing in the room. Although it has been suggested in the literature that infant volubility is variable across social conditions (e.g., Locke, 1993), few studies have directly examined the effects of different conditions on volubility. Some studies did collect data using multiple social conditions, but did not separate results into their respective conditions (e.g., Roe, 1975; Stark, Bernstein, & Demorest, 1993).

Furthermore, most studies that have investigated the effects of different social conditions have included infants younger than 12 months. Nevertheless, these studies have shown clear differences in volubility across different social conditions. Vocalizations increased when infants were left alone as compared to in social situations (Jones & Moss, 1971; Shimada, 2012). This increase was speculated to occur due to infants participating in self-stimulation (Locke, 1989; Locke & Pearson, 1992) or motor practice (Locke, 1989). Younger infants also increased their vocalizations in a “still-face” condition following a period of interaction with an adult (Franklin et al., 2014; Goldstein, Schwade, & Borstein, 2009; Weinberg & Tronick, 1996). These results were presumed to be indicative of infants trying to reestablish social interaction when the adult became non-responsive.

Volubility was also found to increase when infant vocalizations were reinforced (Bloom, Russell, & Wassenberg, 1987; Nathani & Stark, 1996; Ramey & Ourth, 1971; Rheingold, Gewirtz, & Ross, 1959; Routh, 1969). Infants in a conditioning phase when vocalizations were reinforced were more likely to vocalize than when reinforcement was not used. This result is indirectly supported by studies that examine the volubility of parents and infants. These studies determined that more talkative parents have infants who vocalize more (Gilkerson & Richards, 2009; Hart & Risely, 1995). Presumably, more talkative parents reinforce more of their infants’ vocalizations than taciturn parents although it could be speculated that biological forces may instead be at play here.

To our knowledge, only one study (Delack, 1976)[1] explicitly examined differences in volubility across different social conditions in 12-month-old infants. In this study, children between the ages of 1-12 months were evaluated. The infants were observed in several conditions: the infant interacting with the mother, the infant interacting with a stranger, the infant alone with various objects such as rattles or stuffed toys, and the infant sitting alone with no toys. This study found that infants vocalized the

[1] There is one more article (Delack & Fowlow, 1978), but it appears to be a duplicate printing of the 1976 study.

most when alone without toys, but the total duration of each condition observed was not included, thus making the results essentially uninterpretable. For example, if the infants spent more time in the "alone" condition, it would explain why volubility was highest in that condition rather than truly an effect of condition. Results also were not separated by age in an interpretable way, so age differences in vocalizations between conditions are unknown. The present study attempted to fill the gap regarding volubility across social conditions in 12-month-old infants.

In the present study, data were reported as rate of utterance production. Thus, the amount of time spent in each condition was taken into account, unlike in Delack (1976). The present data were derived from a broader dataset collected at the University of Georgia, which included vocalization data from infants 2 months to 5 years of age. Preliminary results (Iyer & Oller, 2013) from this broader dataset showed that 2-10-month-old infants vocalized the least in the interview situation when the experimenter was interviewing the parent. These preliminary results also showed no significant differences in volubility for the remaining two conditions, namely the parent naturally talking and playing with the infant versus the infant playing alone in a room or with a non-interactive and non-talking parent in the room. For the present study, it was hypothesized that the infants would vocalize most in the condition when the parent was talking and actively interacting with the child. This hypothesis was formulated because previous literature reported that vocalizations become more communicative in function between 9-13 months of age (Iyer & Ertmer, 2014; Stark et al., 1993). These results suggest that 12-month-old infants would have increased volubility in more social conditions. Correspondingly, it was hypothesized that the infants would vocalize least in the condition when the parent was non-talkative and non-interactive. The vocalization rate for the condition in which the infant was present in the room when an experimenter was interviewing the parent was hypothesized to be in between the other two conditions. This condition involved a social condition as opposed to the condition in which the parent was non-interactive, but vocalizations were not necessarily directed toward the infant unlike the condition in which the parent was actively interacting with the child.

In addition to overall utterance rate, non-fussy utterance rate was examined across the three conditions. Non-fussy utterance rate was examined because differences may be shown in the amount of fussiness across conditions, even if there are no differences found in the overall utterance rate.

Relationships between overall utterance rate and various sociodemographic variables (e.g., sex, language status, birth order, concurrent cognitive scores) were also explored. These relationships were not statistically analyzed because of small sample sizes. These relationships were instead descriptively analyzed to provide information about potential associations for future research.

The goals of the present study were therefore to:

- Evaluate volubility of 12-month-old infants (as measured by total utterances and number of non-fussy utterances produced per minute) across three conditions (talk, no talk, interview)
- Obtain normative values of volubility for 12-month-old infants
- Evaluate associations between volubility of 12-month-old infants across three conditions and various sociodemographic variables (sex, language status, birth order, concurrent cognitive scores)

Table 1

Studies of Volubility in 12-Month-Olds

Study	n	Age (mos.)	Utterances/ Minute	Type of Study	Setting	Time Observed	Utterance Segmentation Criteria
Gilkerson & Richards (2008)	65	12	1.65	L	Home	12 hrs.	300 milliseconds of silence
Greenwood et al. (2011)	30	13	1.94	L	Home	12 hrs.	300 milliseconds
Chapman (1991)	5	12-14	2.30	CS	Home	60 min.	1 second
Moeller et al. (2007)	21	12	3.00	L	Lab	30-60 min.	1 second
Stevenson et al. (1986)	25	12	4.36	CS	Lab	15 min.	1 second
Nathani & Stark (1996)	6	12	4.37	CS	Lab	30 min.	2 seconds
Oller et al. (1994)	53	12	5.90	L	Home	30 min.	"Breath group" or 1 second
Camp et al. (1987)	23	12	7.92	L	Clinic	5 min.	Uninterrupted

Note. Studies are listed in ascending order according to utterances/minute. C = cross-sectional; L = longitudinal.

CHAPTER 2

METHODS

Participants

The present study used data from a larger longitudinal study regarding infant vocalization for which data was collected on infants and children, from 2 months to 5 years of age. Data from 17 typically developing infants between 11-14.5 months of age from that broader dataset were used in the present study. One participant dropped out of the study slightly before 14.5 months of age. There were 10 males and seven females. The race and ethnicities for the group were (a) 10 White, not Hispanic; (b) 1 White, Hispanic; (c) 2 African American, not Hispanic; and (d) 4 Asian American, not Hispanic. Twelve infants were from monolingual English families and five infants were from bilingual families. The bilingual families all had English as one language, with the other languages including Chinese, Spanish, Gujarati, and Hindi. Included in the sample were one set of identical twins and another set of siblings, as well as one infant who was born 4.5 weeks prematurely. Eight of the 17 infants were first-born, seven of the infants were second-born (both identical twins were included in second-born), and two of the infants were third-born.

The socioeconomic status of the participants was relatively homogeneous and was categorized according to the criteria developed by Eilers, Oller, Levine, Basinger, Lynch, and Urbano (1993). These categories spanned a range from 1 (both parents completed college, professionally employed, two-parent homes) to 5 (no completion of high school, unskilled, single-parent homes). The present sample included twelve 1’s, four 2’s (at least one parent completed college, white collar middle management employment, two-parent homes), and one 3 (some college but not completed, transitional white collar nonmanagement employment).

According to the Census (2015) for Clarke County, Georgia, the present sample is a skewed illustration of the surrounding population (see values in Table 2). The proportion of White, non-Hispanic participants in the study sample is similar to the surrounding area. However, the proportion of other ethnic groups is not representative such that African American and White, Hispanic groups were underrepresented in the sample and the Asian American group was overrepresented in the sample. More males were also included in this sample than would be found in the area. Members of this sample were in a higher socioeconomic group than members of the general population. This was due to the intensive longitudinal aspect of the broader study and the method used for recruitment of participants. Although flyers at daycare centers and email listservs for mothers were used, most participants were recruited using word-of-mouth in a university setting to maximize longitudinal participation. Correspondingly, families who had higher education levels were more likely to be recruited.

Although race, sex, and birth order have not been shown (or studied) to affect volubility (Camp et al., 1987), SES has been shown to affect volubility. Oller et al. (1994) observed that infants from higher SES homes had higher volubility than those from lower SES homes. This finding will not affect the results of the present study because no infants from lower SES homes were included. However, it will limit the generalization of the results to infants from higher SES homes.

Each of the infants was determined to be typically developing based on parent report and results from several developmental tests done at various intervals until 5 years of age. The parent report was done through a parent intake questionnaire at the beginning of the study and bi-weekly parental updates. There were no motor or developmental concerns expressed by any of the parents. The developmental tests administered are listed in Table 3. All of the infants performed within normal limits on every test, barring two infants who performed slightly below the passing score on the motor component of the Bayley Scales of Infant Development. Because the pediatrician or parents noted no concerns, this was not considered to be criteria for exclusion in the present study. According to the parents, the first word for each child was produced either before or during the present measured age range, occurring between 8 and 14.5 months (M=11.56 months). This average falls within the well-established norms that a typically developing infant should produce a first word around 12 months of age.

<u>Recording Procedures</u>

Sessions were recorded once every two weeks from 11-14.5 months of age. A total of 119 sessions should have occurred for the 17 infants. However, a few sessions (12% of the total sessions) were missed due to scheduling issues or participant absence (e.g., family vacation, illness). After each session, the participants were given a monetary compensation of $15-20, depending on the child's age.

Each infant was recorded in three different conditions to constitute one session. The three conditions included:

1. "No Talk" – the infant was either alone in the room or with a parent who had been instructed to be preferably non-interactive (e.g. to read a

magazine or to sit quietly) and non-talkative, unless the infant was in distress or was unsafe in any way.

2. “Talk” – the infant was with a parent in the room who had been instructed to play and talk with the child naturally

3. “Interview” – the infant was present in the same room while an experimenter was interviewing the parent

In each of the conditions, age-appropriate toys were supplied for the infant to play with. To increase control of the study, all sessions took place in the laboratory. This allowed for consistent recording procedures and recording equipment to be used. It also allowed for better sound quality as the sessions took place in a sound-treated room. The novelty of recording in a laboratory was not expected to affect results because the infants had been recording in the laboratory setting for about 8 months when the present study was conducted.

Approximately 10 minutes were recorded in each condition for each infant (talk: M= 12.43 minutes, no talk: M = 10.02 minutes, interview: M = 9.57 minutes). Breaks for the infants were provided as needed for things such as changing or feeding. Sometimes, a condition was missing (11% of the possible conditions) or contained less than 10 minutes (27% of the possible conditions) in recorded sessions because of several reasons. These reasons included developmental testing being conducted during the session, scheduling and technical issues, experimenter oversight, or other circumstances such as the infant becoming uncontrollably upset and the session being cut short. Two of the infants (the set of identical twins) had no interview condition available for analysis because both infants were recorded in this condition together. This resulted in utterances made by one infant being indistinguishable from the other.

It was attempted to record these conditions in a random order for each session, but this did not always happen (see Table 4). It was found that the talk condition was the least likely to be recorded as the third condition. Only 12% of all talk conditions were recorded as the third condition within a session, the remaining talk conditions were pretty evenly split between the first and second conditions. No talk was least likely to be recorded in the first condition. Only 17% of all no talk conditions were recorded as the first condition within a session, the remaining no talk conditions were evenly split between the second and third conditions. Interview was least likely to be recorded in the second condition. Only 22% of all interview conditions were recorded as the first condition within a session, the remaining interview conditions were pretty evenly split between the first and third conditions. In pilot observations, it was found that infants who were recorded in the no talk condition first became fussy and the session had to be ended often before other conditions could be recorded. This led to the no talk condition being less likely to be recorded first. Experimenter oversight also contributed to order of conditions not being randomized for some infants. This non-randomization could affect interpretation of the results because infants may have vocalized more or less in one condition in anticipation of the next condition (e.g., infant may have vocalized more in talk condition in an attempt to keep parent from becoming non-interactive for subsequent no talk condition, if no talk mostly occurred after talk).

Selection of Sessions

Out of the two available sessions for each month, one session was selected from each month between 11-14 months (only one session between 14-14.5 months was recorded for each infant, so that session was also selected). These sessions were picked if at least 10 minutes had been recorded in each condition within that session. If a condition did not have 10 minutes, it was supplemented by coding more time from the corresponding condition in the remaining session for that month until a total of 10 minutes for that condition was reached. Despite this supplementing, some conditions had less time available to code in a given month due to previously mentioned reasons.

Data from over the entire age span from 11-14.5 months was therefore, collapsed in order to evaluate vocalization patterns around 12 months. After this collapsing, all infants had at least 10 minutes available in each condition for analysis. In addition, preliminary analysis of the results showed high variability in volubility across sessions. The collapsing of the data allowed for a more stable and representative average of the child's vocal behavior to be calculated for the age of interest.

Recording Equipment and Digitizing of Sessions

Each of the sessions took place in a sound-treated booth. To record the audio, wireless microphones were attached to both the infant (Samson ALI) and the parent (Samson CT7). The infant was also outfitted with a specially made vest that had a pocket in which the transmitter for the microphone was stored while the infant moved around throughout the session. To record the video, the booth was equipped with three remote-controlled Canon VC-C4 digital cameras mounted on an adjustable pole that were accessed by an experimenter outside the booth. Video and audio data was recorded onto mini DV tapes using a Eurorack UB802 Ultra Low Noise Design 8-input 2-bus audio mixer and a Videonics Digital video mixer.

The sessions that had been recorded onto the mini DV tapes were digitized into mpeg2 files using Adobe PremierePro. The audio data was low-pass filtered at 25 Hz to remove electrical noise using the TF32 (Milenkovic, 2001) program and saved as wav files. The digitized audio and video sessions were then burned onto one compact disc, which allowed for easy access to the data on different computers.

Coding Software

The video and audio sessions were analyzed using a customized software, the Action Analysis Coding and Training System (AACT; Delgado, 2006) This software allowed for audio data to be analyzed using tf32 software incorporated within AACT as well as video data. It also allowed for the audio and video sessions to be played at the same time in separate windows. This gave the coder an accurate idea of what was happening during the session while listening to the audio. The tf32 software allowed for spectrographic and waveform displays of the audio signal.

Identifying Utterances

This study used the specifications for an utterance that were determined by Oller (1980, 2000). First, vocalizations produced by the infant were determined to be speech-like (protophones) or non speech-like using perceptual listening and viewing of the sessions within AACT (Delgado, 2006). Protophones included sounds such as vowels, raspberries, squeals, or babbling. Fusses and chuckles were also included as protophones. Purely fixed signals, such as crying and laughing, and vegetative sounds, such as burps and grunts, were not considered speech-like, following Oller’s recommendations.

To distinguish between utterances, the use of the “breath group” concept was implemented (Oller & Lynch, 1992). This states that an utterance is considered to be separate from another utterance if there is an audible ingressive breath or the silence is perceived to be enough for the infant to take a breath, usually one second. In order to identify utterance boundaries, utterances were zoomed into using the tf32 (Milenkovic, 2001) waveforms. Once the boundaries were found, often located to the precise millisecond, two cursors were placed on either side of the utterance and the utterance was noted within the AACT program (Delgado, 2006). This recorded the identification of an utterance, as well as its duration (duration was not analyzed in the present study). Comments were used on occasion to indicate the type of utterance or the reason why a vocalization was not determined to be an utterance. The number of speech-like utterances per minute was used to determine overall utterance rate and the number of non-fussy utterances per minute was used to determine non-fussy utterance rate.

Coders

The coders were trained undergraduate or graduate students in the field of speech-language pathology. There are a total of eight different coders, but the present author has done 66% of the coding. Each coder received half a semester of training before coding experimental data. This training included learning the criteria used to identify utterances and how to use AACT (Delgado, 2006). Practice coding was then done using sessions that had previously been coded. This allowed for new coders to compare their work to the work of experienced coders and examine the reasons for any discrepancies. After the two coders obtained good agreement (over 80%) on multiple sessions, the new coder was then allowed to move on to experimental data.

Observer Drift

In order to minimize observer drift and ensure consistent coding, 20% of each session was checked by an expert, with nearly 20 years of experience in infant vocalizations. In order for the session to be considered acceptable, the original coder and the expert had to have agreement of over 80% regarding number of utterances and the duration of each utterance. Any discrepancies within these sessions were resolved by the expert and the coder and the session was considered a completed “master” session. If agreement was less than 80%, the session was recoded and checked again. No more than two recodes were permitted for each session before it would be discarded. Out of the 91 coded sessions, 12 had to be recoded once and 0 had to be recoded twice. None of the sessions had to be discarded.

Observer Agreement

Observer agreement was assessed using both interobserver and intraobserver agreement. To examine interobserver agreement between coders, approximately 20% of the sessions for each infant were compared to the work of a second trained observer. To determine intraobserver agreement within an observer, 10% of the data for an infant was coded a second time by the original observer. Intraclass correlation coefficients (ICC) values were 0.97 for interobserver agreement and 0.99 for intraobserver agreement, which shows high consistency between and within observers.

Fidelity of Conditions

Fidelity between the conditions of talk and no talk was assessed to ensure that parents had a lower rate of vocalizations in no talk compared to talk. To assess fidelity, approximately 10% of the sessions for each infant were analyzed for parent utterance rate. A paired-samples repeated-measures *t* test indicated that the mean parent volubility in Talk (M = 16.73, SD = 4.88) was indeed significantly greater than the mean parent volubility in No Talk (M = 3.12, SD = 2.94), $t(16) = -9.49$, $p<.05$.

Statistical Analysis of the Data

One-way repeated-measures analyses of variances (ANOVAs) were used to analyze the relationships of volubility across conditions. The independent variable included three conditions: talk, no talk, and interview. The dependent variable was the overall utterance rate or non-fussy utterance rate. It was necessary to conduct two separate ANOVAs for each dependent variable, as the number of participants was unequal across the three conditions due to the entirely missing interview condition for two participants. The first analysis included values from all three conditions for 15 of the 17 infants, for whom data was available for all three conditions. The second analysis included values from two conditions, talk and no talk, for all 17 of the infants. Relationships between volubility and various sociodemographic variables, e.g., sex, language background, were also explored. In addition, concurrent relationships between volubility and cognitive scores were examined.

Table 2

Sample and Population (Athens-Clarke County, GA) Characteristics

	Criteria	Sample Percentage	Population Percentage
Race/ Ethnicity	White, not Hispanic	58.8	56.6
	African-American, not Hispanic	11.8	27.3
	Asian-American, not Hispanic	23.5	4.3
	White, Hispanic	5.8	10.7
Education	Bachelor's degree or higher	94.1	39.5
	High school graduate or higher	100.0	85.1
Gender	Female	41.1	52.2
	Male	58.9	47.8

References: U.S. Census Bureau, 2015

Table 3

Developmental Tests

Test	Description	Age of Administration
Bayley Scales of Infant Development – Second Edition (BSID-II)[1]	Measures developmental delays – motor and cognitive components	12 months
Visual Reinforcement Audiometry (VRA)[2] or Otoacoustic Emissions (OAE)	Hearing screening	7 months
Early Social Communication Scales (ESCS)[3]	Measures nonverbal communication skills	14 months
MacArthur Communicative Developmental Inventories – Long Form: Words and Gestures (MCDI-2)[4]	Measures receptive and expressive vocabulary	11 months

References: [1]Bayley, 1993; [2] Liden & Kankkunen, 1969; [3] Mundy, Delgado, Block, Venezia, Hogan, & Selbert, 2003; [4]Fenson, 1993

Table 4

Order in Which Conditions Were Recorded (Number of Times in Each Position)

Condition	First	Second	Third
No Talk	13	32	32
Talk	44	41	12
Interview	35	19	31

CHAPTER 3

RESULTS

Volubility Across Social Conditions

A total of 9,706 utterances for the 17 infants were analyzed for associations between volubility and social conditions. The utterance rate across Talk, No Talk, and Interview conditions is shown in figure 1. Results from 15 infants for whom data was available across all three conditions did not show a significant difference between volubility across the three social conditions, $F(2, 13) = 0.604$, $p > .05$.

A second one-way repeated measures ANOVA was used to analyze the relationship between volubility and social condition for the conditions of Talk and No Talk for all 17 infants for whom data was available. No significant differences in volubility were found between the conditions of Talk and No Talk for this analysis either, $F(1, 16)=1.927$, $p > .05$.

The non-fussy utterance rate across Talk, No Talk, and Interview conditions is shown in figure 2. The results for non-fussy utterances matched those found for overall utterance rate, such that no significant differences were found for 15 of the infants across all three conditions, $F(2, 13) = 0.219$, $p > .05$, and no significant differences were found between Talk and No Talk conditions for all 17 infants $F(1, 16) = 0.638$, $p > .05$.

Volubility and Sociodemographic Variables

Associations between volubility and several sociodemographic variables were descriptively explored. No statistical analysis was performed, as the sample sizes of these groups were too small to have significant results.

Based on figure 3, an association was suspected between volubility and sex. It appears that on average, females vocalized more than males in every social condition. An association was also suspected between volubility and language status (monolingual or bilingual), as shown in figure 4. On average, monolingual infants vocalized more in No Talk and Talk conditions, but bilingual infants vocalized more in the Interview condition. However, no association between volubility and birth order (first-born or later-born) was suspected based on the present study. These results are shown in figure 5. There was however considerable individual variability as evidenced by the wide range of standard deviations on each figure.

Concurrent Associations between Volubility and Cognitive Scores

Cognitive scores were compared to average overall volubility for each infant. A scatterplot analyzing the association between volubility and mental scores on the Bayley Scales of Infant Development at 12 months of age can be found in figure 6. No significant correlation was found, $R^2 = 0.07$. It was also attempted to analyze the relationship between volubility and expressive language scores at 11 months on the MacArthur Communicative Developmental Inventories – Long Form (MCDI-2). However, many of the infants scored below the 1st percentile at this age, so further analysis was not attempted due to floor effects.

Individual Differences

The minimum and maximum utterance rates for each condition, as well as mean utterance rates, are listed in table 5. This table shows that there was a large range in volubility for each condition, although the mean volubility across conditions is similar. Figure 7 shows the mean volubility across conditions for each individual infant. Infant vocalizations were extremely variable, with some infants vocalizing much more than others. In addition, although the mean volubility was not found to vary across social conditions, it was found that the volubility of individual infants did vary across conditions. When examining conditions in which individual infants vocalized the least, it was determined that of the 15 infants, for whom data was available in all three conditions, four infants vocalized least in the No Talk condition (ranged from 5-46% less than the average utterance rate of the next voluble condition), seven infants vocalized least in the Talk conditions (ranged from 13-36% less than the average utterance rate of the next voluble condition), and four infants vocalized least in the Interview condition (ranged from 10-54% less than the average utterance rate found in the next voluble condition).

Table 5

Utterance Rates Across Three Social Conditions

	No Talk	Talk	Interview
Minimum	1.05	1.95	2.33
Maximum	10.69	11.18	9.34
Mean (SD)	5.90 (2.54)	5.06 (2.15)	5.40 (2.20)

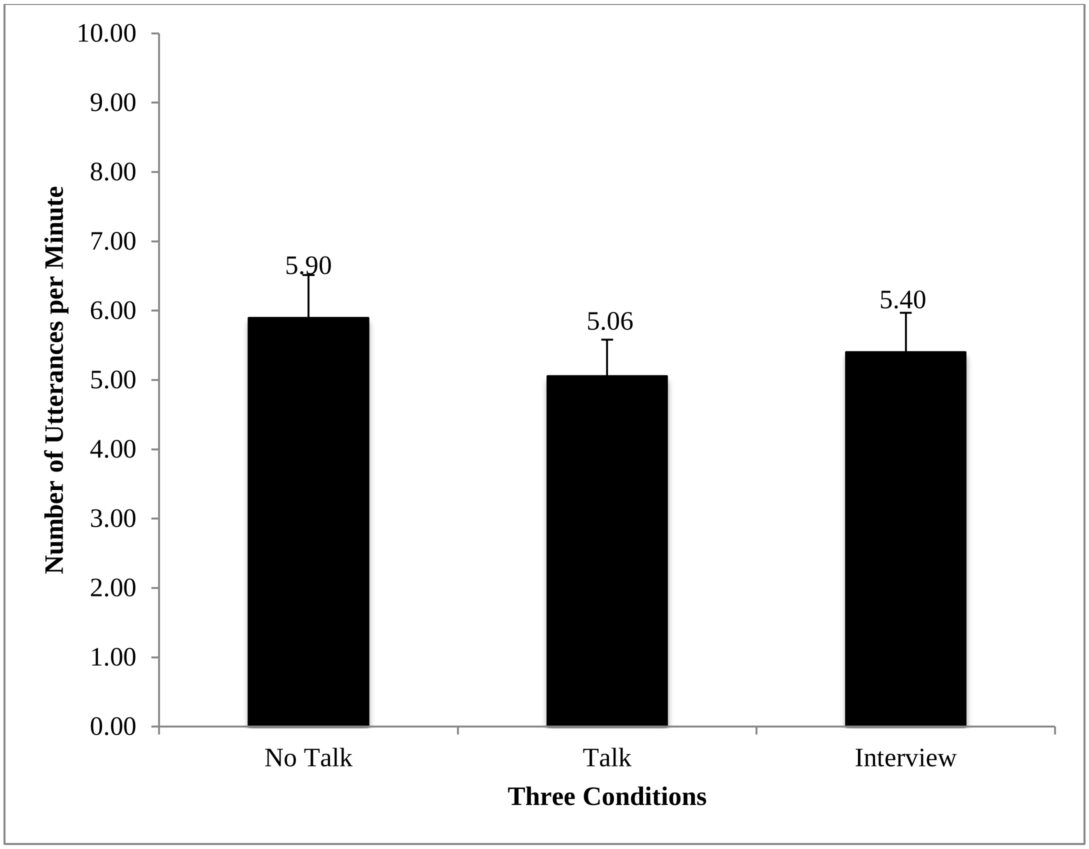

Figure 1. Mean utterance rates (and standard errors) across three social conditions from 11-14.5 months of age for all 17 infants.

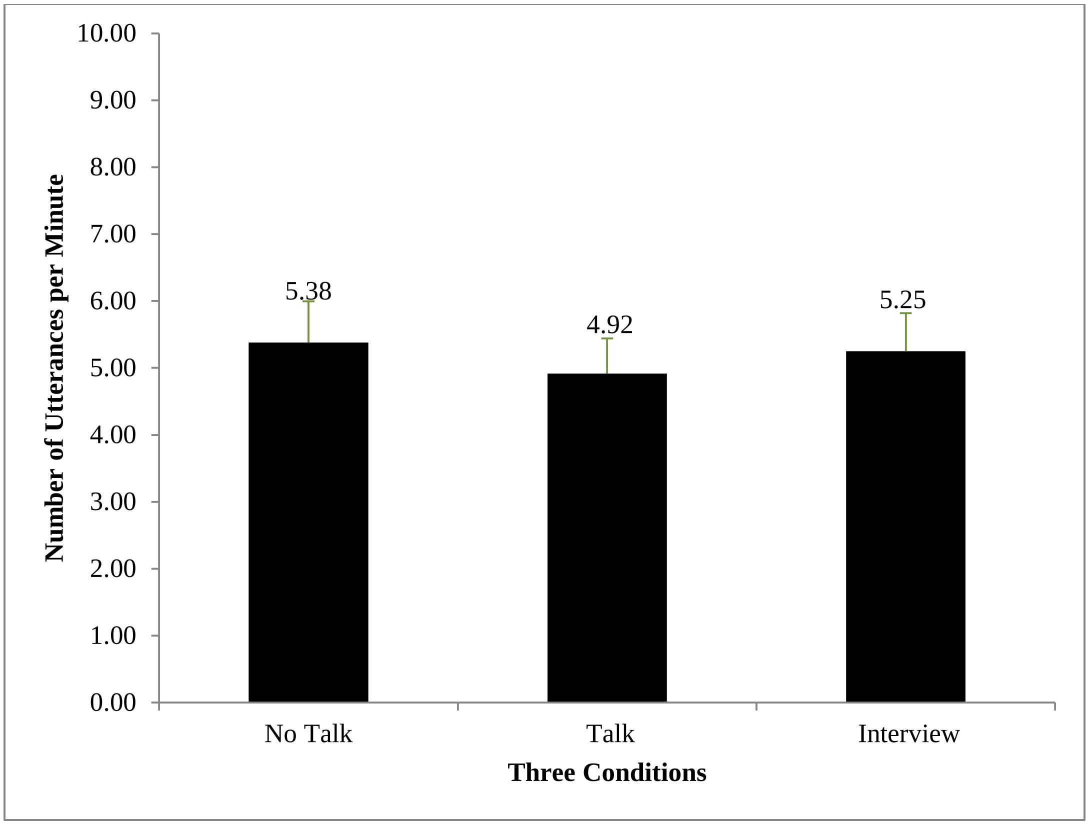

Figure 2. Mean non-fussy utterance rates (and standard errors) across three social conditions from 11-14.5 months of age for all 17 infants.

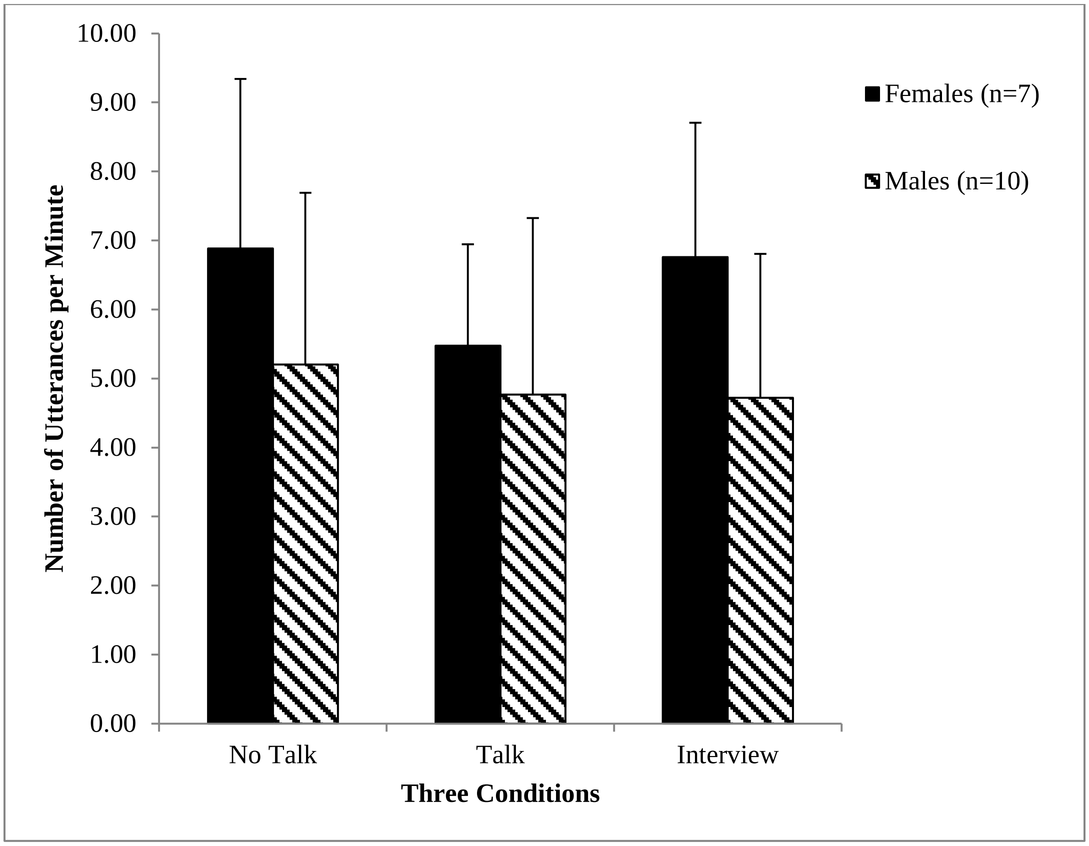

Figure 3. Mean utterance rates (and standard deviations) across three social conditions separated by sex.

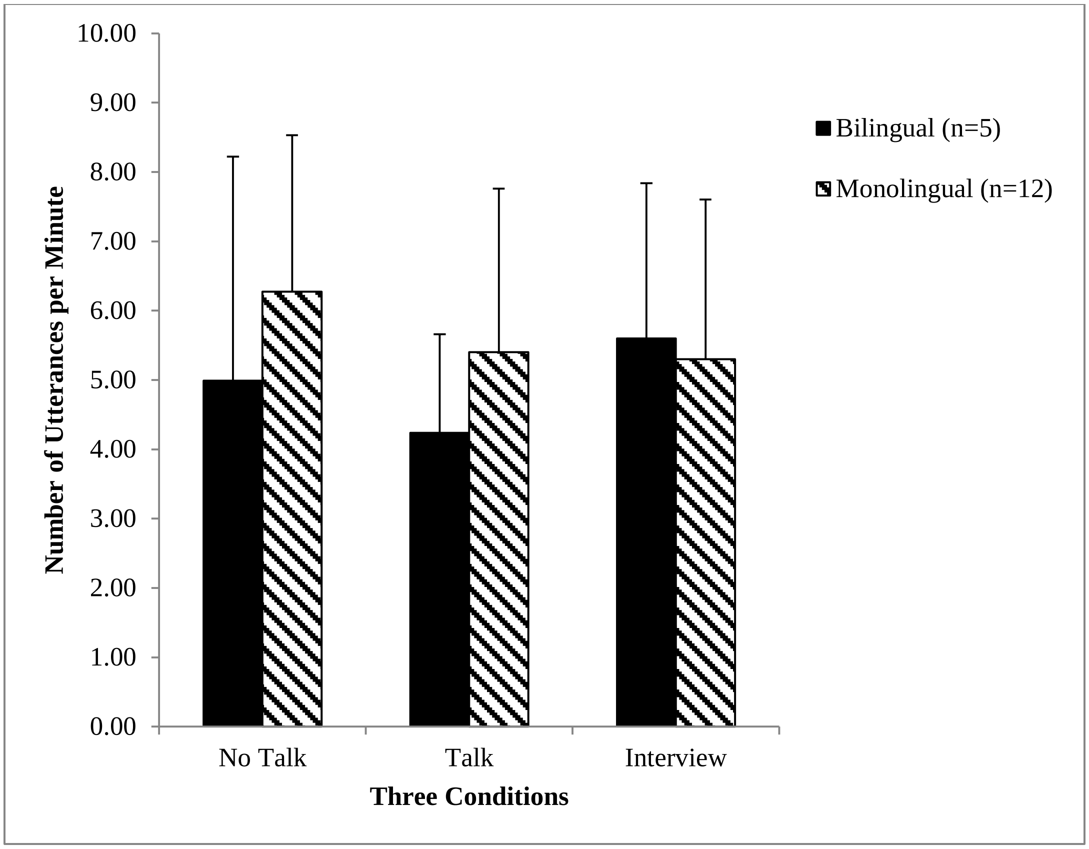

Figure 4. Mean utterance rates (and standard deviations) across three social conditions separated by language status (monolingual and bilingual).

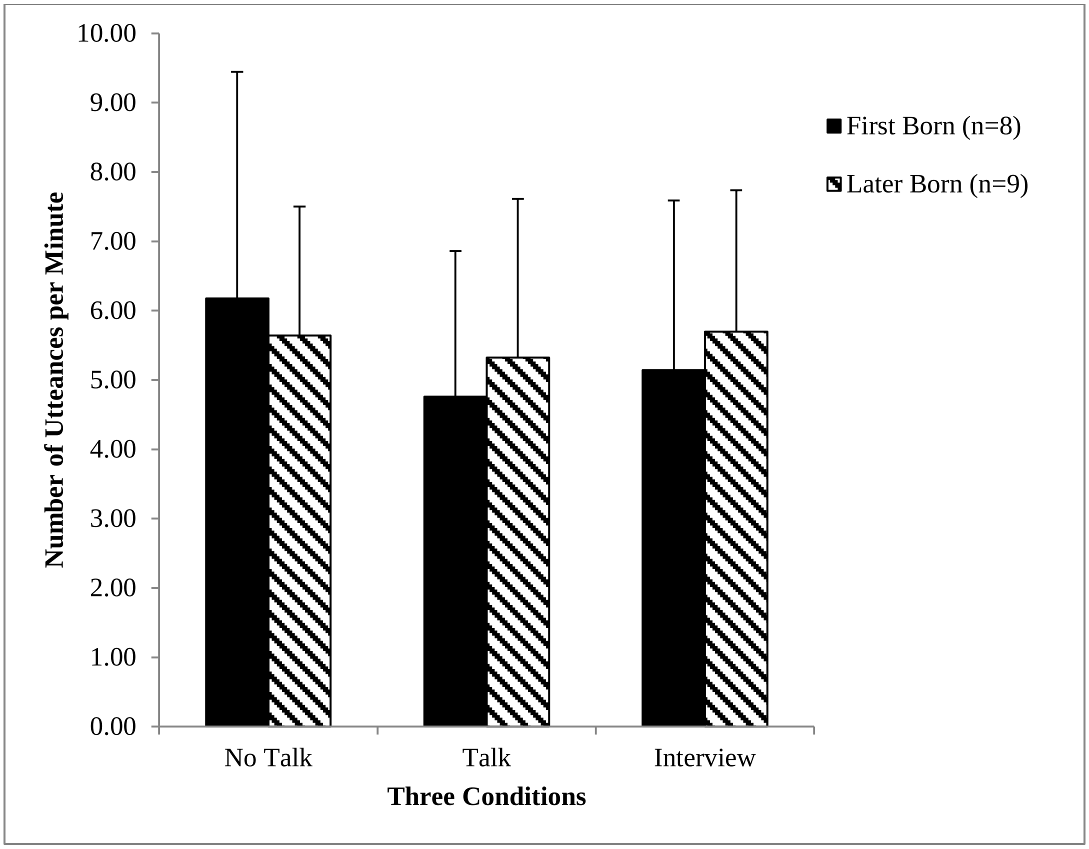

Figure 5. Mean utterance rates (and standard deviations) across three social conditions separated by birth order (first-born and later born).

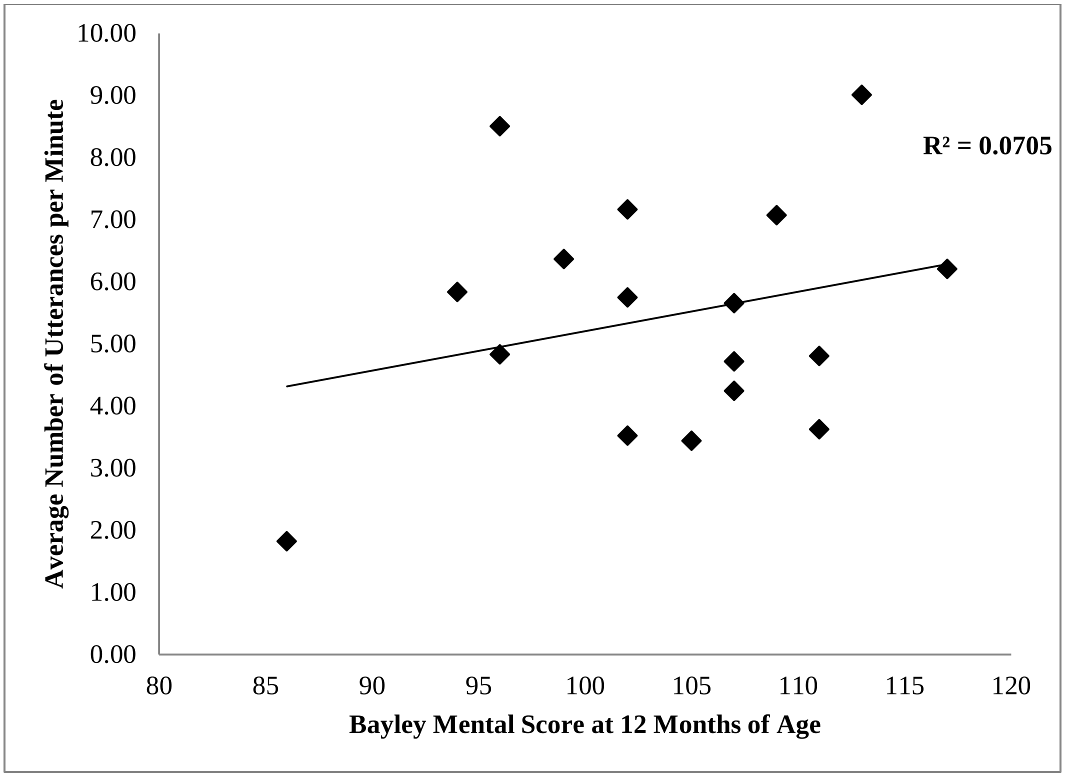

Figure 6. Mean utterance rates compared to scores on mental component of Bayley Scales of Infant Development at 12 months of age.

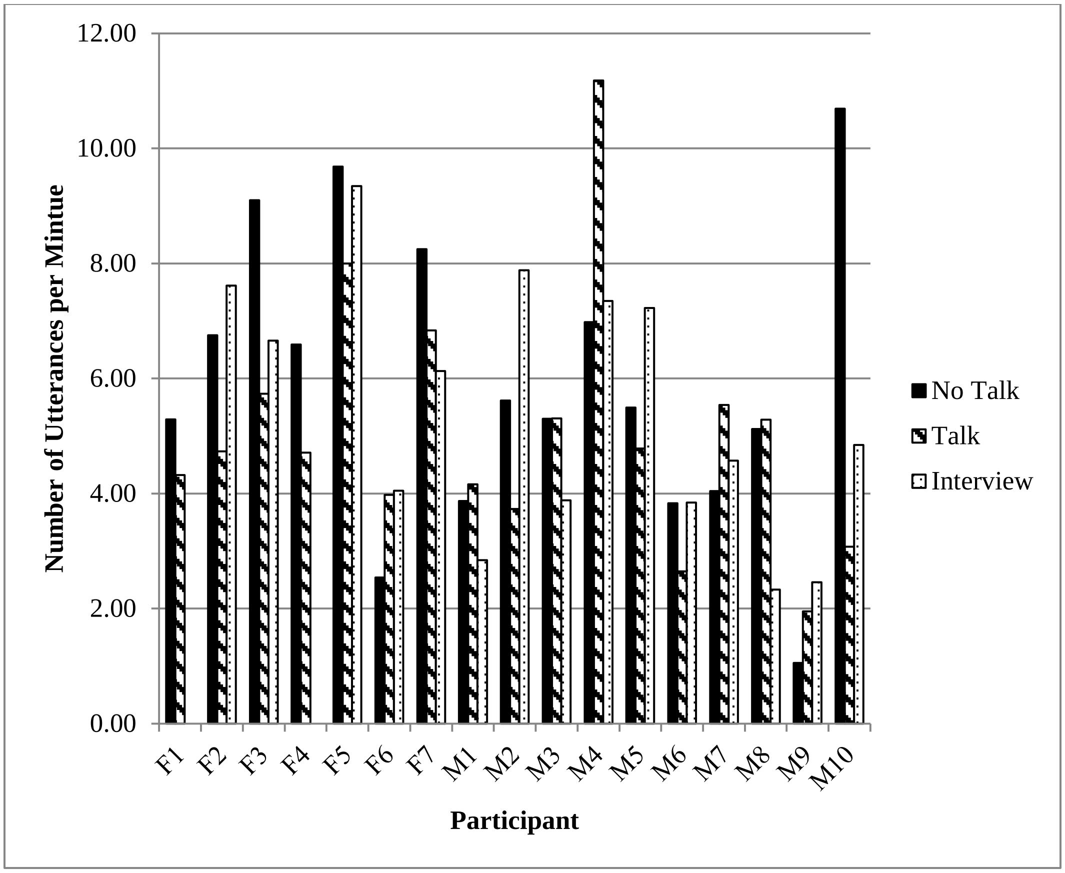

Figure 7. Individual differences in utterance rate across three social conditions for infants 11-14.5 months of age.

CHAPTER FOUR

DISCUSSION

Volubility Across Social Conditions

The purpose of the present study was to determine differences in volubility for infants 12 months of age across different social conditions. Results showed that volubility is robust to varying social conditions in 12-month-old infants. This same pattern was shown in the results for non-fussy utterance rate. Infants vocalized in conditions when an adult was talking and interacting with them as well as when no one was talking or interacting with them and when two adults were talking to each other rather than the infant. Thus, it appears that infants vocalize for their own purposes as well as for interactive reasons.

These findings do not support the apriori hypothesis that volubility would be highest in one of the conditions, namely the condition in which the parent was interacting with the infant. Furthermore, the results from the present study do not support findings from previous studies that found considerable differences in vocalization rates across varying social conditions. This includes research done on younger infants (e.g., Bloom, Russell, & Wassenberg, 1987; Franklin et al., 2014; Jones & Moss, 1971), findings from the broader study using infants 2-10 months of age (Iyer & Oller, 2013), and research done on infants 1-12 months of age (Delack, 1976). These studies found that volubility across infants tended to be lowest in one condition.

The null findings in the present study may have been due to the high variability in volubility found across the infants in the present study. When individual data were examined, the condition in which infants vocalized the least varied considerably across infants. Four infants vocalized least in the condition in which the parent was not talking and interacting with the infant, another seven infants vocalized least in the condition in which the parent was talking and interacting with the infant, and the remaining four infants vocalized least in the condition in which the experimenter was interviewing the parent. These individual differences potentially suggest that the optimal condition in which to elicit vocalizations may need to be tailored to each infant starting at 12 months of age.

Volubility Across Social Conditions Throughout the First Year of Life

It was found that the rate of vocalizations of 12-month-olds had a different pattern when compared to the vocalizations of the younger infants from the broader study (Iyer & Oller, 2013). Although the finding that there were no significant decreases in volubility during the condition when the parent was talking and interacting with the infant and the condition when the parent was not talking and interacting with the infant is consistent with the broader study, a different pattern was shown in the condition in which the experimenter was interviewing the parent. In the broader study, this condition was one in which least volubility was seen. For 12-month-old infants, no significant differences in volubility were seen between this interview condition and the other two conditions, namely talk and no talk.

This discrepancy in results could be due to 12-month-old infants starting to interact in a more socially appropriate way. In the data for the younger infants, it is possible that many of the infants spoke simultaneously with either the experimenter or the parent during this condition. This could have led to these vocalizations not being heard. The older infants may be vocalizing less simultaneously with the other individuals in the room, thus allowing for more of their vocalizations to be heard and coded.

This change in vocalizations while in the presence of a stranger could also be explained by the phenomenon of “stranger anxiety,” or wariness around strangers. Prior studies have reported inconsistent results regarding the age of emergence and disappearance for this phenomenon. Some studies report that stranger anxiety peaks around 7-9 months of age and then subsequently decreases (Emde, Gaensbauer, & Harmon, 1976; Spitz, 1950; Tennes & Lampl, 1964). Others report that stranger anxiety emerges and then continues to increase through the end of the first year (e.g., Morgan & Riciutti, 1969). Still other studies report that stranger anxiety continues into the second year of life (e.g., Scarr & Salapatek, 1970). It has also been found that stranger anxiety can follow one of four trajectories due to individual differences across infants (Brooker et al., 2013). This inconsistency across studies may be due to some studies having a cross-sectional design (Morgan & Riciutti, 1969; Scarr & Salapatek, 1970) and some having a longitudinal one (Brooker et al., 2013; Spitz, 1950; Tennes & Lampl, 1964). The results from the present longitudinal study support the findings from the longitudinal studies that examined stranger anxiety and found that it peaks in the first year of life and then subsequently decreases. If this is in fact the case, this could explain the lack of volubility differences for the older group compared to the younger infants in the condition involving a stranger.

As stated earlier, infant vocalizations also become more communicative as infants get older (Iyer & Ertmer, 2014; Stark et al., 1993). Infants at 12 months of age may have vocalized more in the condition in which the infant was present while an experimenter was interviewing the parent compared to the younger infants because the older infants wanted to be involved in the conversation occurring around them whereas previously they were content with simply listening to the conversation. This, coupled with the increased number of people in the room, may make this condition appear to be a more social condition for the older infant and thus elicit more vocalizations.

Individual Differences

The variability found across infants (range was 1.89 to 9 utterances per minute) made it difficult to conclusively determine normative values of volubility. As previously explained, a wide range of volubility has been found in previous studies examining 12-month-old infants. Although this could be partially accounted for by methodological differences, it is highly likely that individual differences across infants could have widened this range as well. In addition, various factors such as sex, language status, or amount of parental input may have affected values for volubility. The present study had a mean that was in the middle of the range of values obtained by previous studies (5.45 utterances per minute overall, compared to the range of 1.65-7.92 from previous studies). Due to the high variability among infants, more infants would need to be examined to conclusively calculate normative values.

Sociodemographic Variables

Although the present study examined associations between volubility and various sociodemographic variables, results from these comparisons should be cautiously considered. The sample size for each group is too small to show any significant relationships, and, as mentioned, the variability observed in volubility across infants was very high.

The suspected association found between volubility and sex, such that females appeared to vocalize at higher rates than males, is inconsistent with previous research done by Camp et al. (1987), which found that the volubility between sexes during the first year of life was equal. This inconsistency could be due to methodological differences between studies. Camp et al. (1987), although a longitudinal study, only used observation periods lasting 5 minutes. The present study observed infants for much longer time intervals, which may have allowed more time for this difference to be observed. It should also be noted that the results from the two groups in the present study appear to have overlapping standard deviations. However, the present results do support conventional wisdom that females are more talkative than males and research that has mixed findings regarding differences in language development between sexes (Bauer, Goldfield, & Reznick, 2002; Bornstein, Hahn, and Haynes, 2004). In addition, the present results have potential implications for findings that show males to have a consistently higher risk of language impairment than females (e.g., Harrison & McLeod, 2010).

Results from the present study also showed that there was a potential association between volubility and language status, such that monolingual infants vocalized more than bilingual infants both when the parent was not talking and interacting with the infant and when the parent was actively talking and interacting with the infant. During the condition in which the infant was present while an experimenter was interviewing the parent, bilingual infants vocalized slightly more. To our knowledge, this association has not been previously studied and may be worthy of further investigation. However, as mentioned earlier, these results should be cautiously interpreted as the bilingual group only had five infants and the standard deviations between the groups appeared to overlap substantially.

Furthermore, results suggested that volubility and birth order did not appear to have an association. This is surprising due to previous research that has found mothers interact more with first-born infants (Jacobs & Moss, 1976) and that infants who have more talkative parents vocalize more (Gilkerson & Richards, 2009; Hart & Risely, 1995). This research suggests that first-born infants would vocalize more because their parents talked to them more. Presumably, parental input is not the only factor that affects the rate of vocalizations in infants at 12 months of age. In fact, the present data showed a slight negative relationship between parent utterance rate and infant utterance rate in the condition in which the parent was talking and interacting with the infant ($R^2 = 0.11$). Other factors (e.g., sex, parental input, language status, individual differences) might also affect volubility at this age. In addition, the present study found that parents of first-born infants did not seem to vocalize more than parents of later-born infants when examining parent vocalization rates during the condition in which the parent was talking and interacting with the infant (M = 16.71 utterances per minute for parents of first-born infants and M = 17.37 utterances per minute for parents of later-born infants). This unexpected finding could also be due to the small sample size of both the first-born group (n = 8) and later-born group (n = 9) and the fact that the first- and later-born groups came from different families. These results are however, in concordance with research that has found mixed outcomes regarding having older siblings as a risk factor for language impairment (Harrison & McLeod, 2010).

As previously mentioned, volubility has been shown to be potentially related to later cognitive scores (Kagan, 1971; Roe, 1975). The present study examined the concurrent associations between average volubility across all conditions with scores on the mental component of the Bayley Scales of Infant Development at 12 months of age. Contrary to results from previous studies, results showed no significant relationship between the two measures. These contradictory results could be due to the use of different measures of cognitive ability across studies. Because all infants were typically developing in the present study, there was also a lack of substantial variation in cognitive scores. In addition, in the present study, later cognitive scores could not be examined due to the fact that later cognitive testing was not done. However, there is no reason to expect that later cognitive scores would show a different pattern of association with volubility than concurrent cognitive scores, as research has found that scores on the Bayley Scales of Infant Development at 8 months of age are correlated with Stanford-Binet IQ scores at 4 years of age (Gannon, 1968). Also, there is little reason to expect that infants with a higher cognitive ability would vocalize more than infants with a lower cognitive ability within the range of typical cognitive development, and vice versa.

Study Limitations

This study was not without limitations. One important caveat to note is the sample size used in the present study. Seventeen infants may not be enough to show significant patterns, especially with the high variability observed in the sample. When comparing volubility with various sociodemographic variables, the number of infants in each group became even smaller. This small sample size could have skewed the results.

As previously discussed, the conditions were not always recorded in a random order. The No Talk condition was least likely to be recorded first, the Interview condition was least likely to be recorded second, and the Talk condition was least likely to be recorded third. This could have affected the volubility seen in each condition for this age range due to infants anticipating the next condition. The condition in which the parent was not talking or interacting with the infant was also recorded less often than the other two conditions. This could have affected the average volubility found in this condition because there was less overall data to analyze.

Another limitation is found when examining the generalization of the results for the present study. These results are only applicable to infants from higher SES homes. Because volubility has been shown to be affected by SES (Oller et al., 1994), results for infants from lower SES homes may be drastically different.

In addition, it should also be acknowledged that nonparametric statistics may have been more appropriate to analyze the present data than parametric statistics. To use parametric statistics, it is recommended that the sample size should include at least 30 participants; the present study had a sample size of 17. Future research should consider nonparametric measures when analyzing volubility.

Conclusion

The volubility of typically developing infants at 12 months of age does not significantly differ across social conditions. However, it does appear to be associated with two sociodemographic variables, sex and language status. Establishing normative values of volubility could prove difficult due to the amount of individual variability observed. Future research should focus on different types of vocalizations seen in each condition (e.g., number of words) and infants from disordered populations. It should also further examine suspected associations with social condition and sociodemographic variables using a larger sample of infants.

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