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What Do Caregivers Tell Us about Infant Babbling?

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Abstract

Phonetic repertoires in babbling are an important marker of prelinguistic development. Typical phonetic development, however, is difficult to identify given variability within and across infants. Prior to 18 months of infant age, caregiver report of prelinguistic vocal development is often an important part of clinical practice for early intervention. As a first step toward understanding the utility of caregiver report of babbling, the purpose of this exploratory study was to determine how the phonetic makeup of sounds reported by caregivers in infant babbling would develop, in particular comparison to markedness theory and established norms. In a longitudinal design, caregiver report was tracked through weekly interviews from 7 to 18 months of infant age ($N = 15$). Reports were phonetically transcribed and examined in terms of the number of utterances; place, manner, and voicing for consonants; and tongue position for vowels. In general, the number of utterances and phonetic segments reported by caregivers increased significantly with infant age ($p < .05$) and phonetic feature patterns were similar to what one would expect in the vocal development of English-learning infants. Results support the notion that caregiver report of infant vocalizations may provide a valuable means for describing early infant babbling development.

Keywords

phonetics, phonology, caregiver/infant interaction, infant vocal development, babbling

1. Introduction

Early language experience is critical to infant and child development (Sosa, 2015). It can form foundations for later success throughout all aspects of life including academic, employment, social, and psychological wellbeing. For young children who have, or are at risk for delay or disorder, early intervention has been shown to positively impact developmental outcomes (Hebbeler et al., 2007). Accordingly, it is imperative to identify infants and toddlers in need of services as early as possible such that intervention is provided during pivotal developmental periods, when the brain is most capable of change due to plasticity (Hebbeler, 2009).

Infant vocal behaviors have been shown to be predictors of later language abilities (Fasolo, Majorano, & D'Odorico, 2008; Oller, Eilers, Neal, & Schwartz, 1999; Sotto, Redle, Bandaranayake, Neils-Strunjas, & Creaghead, 2014; Watt, Wetherby, & Shumway, 2006), but this knowledge has not been utilized to the full extent possible for clinical use. The clinical challenge lies in identifying infants and toddlers who may be at risk of future speech and language difficulties (Määttä, Laakso, Tovanen, Ahonen, & Aro, 2012). Identification is difficult because normal vocal development is variable and unstable both within and across children (Fenson et al., 2000). Adding further complication, the methodology used to study prelinguistic infant vocalizations has been cumbersome and tedious. Implementing more efficient procedures for documenting infant vocalizations has the potential to enhance the clinical utility of infant babbling as an important clinical marker. Anecdotally, when the first author recently visited the pediatrician for her son's well-child checkup, the pediatrician asked when he should refer infants/toddlers to speech-language pathologists. If researchers, clinicians, and pediatricians alike could determine the answer to such questions based on a simple caregiver report, children would benefit from earlier identification and treatment. Caregiver report of early infant sounds may be a sufficiently sensitive indicator of later phonological and vocabulary development, and therefore may provide an easier means of identifying infants at risk for later speech and/or language difficulties. Towards this end, establishing what caregivers tell us about babbling is an essential first step.

1.1 Typical Speech Development

Given universal principals related to markedness and developmental norms observed in speech sound production, there are expected phonetic patterns one should see in caregiver report of speech sounds in babbling. Early developing sounds are those most prevalent in babbling. Children with more diverse phonetic repertoires and/or children, who master more complex phonetic features early, may be more likely to develop speech early; with early speech development comes early language development (McCune & Vihman, 2001; Sotto et al., 2014; Stoel-Gammon, 2011).

Infants acquire the ability to produce speech sounds by means of a set of universal principles related to the markedness of particular sounds in their ambient language (Jakobson, 1968; Locke, 1983). Sounds that are easier to articulate and perceive, generally appear more frequently in languages and are considered unmarked (Shriberg & Kwiatkowski, 1980); these sounds are mastered earlier in development. Sounds that are more complex, or marked, may not appear consistently in productions until children are much older (e.g., 6 years of age). Further, Fikkert (2007) listed the acquisition of sounds as continuous; as one articulatory gesture is mastered, it becomes the foundation from which other more marked gestures are learned. The developmental sequence for vowels proceeds from front and central, to high and back vowel-like sounds (Chen & Irwin, 1946; Irwin, 1948; Irwin & Chen, 1946). With respect to consonants, stops, nasals, and glides are produced prior to fricatives and liquids; labials and coronals prior to dorsals and laryngeals; and voiced sounds prior to voiceless sounds (Stoel-Gammon, 1985). With respect to the phonemes of General American English: /m, n, p, b, t, d, w/ are mastered earliest between 1;6 to 2 years of age; /h/ is mastered by 2 to 2;6 years; /f, s, j, ŋ, k, g/ are produced consistently between 2;6 to 3;6 years; /v, z, l, ʃ, ʧ, ʤ/ emerge between 3;6 and 4;6 years; and /r, ʒ, θ, ð/ are mastered after 4;6 years (Poole, 1934; Prather, Hedrick, & Kern, 1975; Wellman, Case, Mengert, & Bradbury, 1931).

1.2 Tracking Vocal Development

Traditionally, in studies of vocal development, researchers have utilized phonetic transcription to assess the syllabic repertoire of babbling and early words (Davis & MacNeilage, 1995; Locke, 1983; Stoel-Gammon, 1992; Vihman, 1986). In laboratory settings, one typically listens to infant utterances repeatedly, noting all detail. This presumed “attention to detail” can lead to lack of inter-rater agreement in phonetic transcription of young children’s output (Oller & Ramsdell, 2006) and may lead to over-estimation of phonetic categories. To limit overestimation, repertoires have been reduced by including only sounds in transcribed samples that occur some minimal number of times (Rvachew, Creighton, Sauve, & Feldman, 2005; Stoel-Gammon, 1988); at some minimal proportion (Vihman, 1992); and/or according to presumed phonetic principles (MacNeilage, 2008). These practical criteria reduce the level of detail observed when transcribing infant vocalizations, but do not provide a means to determine the infant’s *functional* repertoire (Ramsdell, Oller, Buder, Ethington, & Chorna, 2012).

If one were to attend to infant vocalizations the way caregivers do (i.e., listening only once to each utterance and paying attention only some of the time) far less detail and fewer syllables are attributed to the infant (Ramsdell et al., 2012). This type of listening may provide a more natural means of tracking vocal development. In addition, caregiver report can be gathered in a timelier manner than recordings and transcriptions of infant vocalizations. Ultimately, the potential of caregiver report to provide improved documentation of infant vocal development is worth exploring.

Parent report has been shown to be a reliable and valid means of tracking speech and language development (Feldman et al., 2005; Heilmann, Ellis, Weismer, Evans, & Hollar, 2005; Oller, Eilers, & Bassinger, 2001). In addition, it has been well-documented that caregiver response to early communicative behaviors can be indicative of both typical and atypical development (Brady, Marquis, Fleming, & McLean, 2004; Goldstein & Schwade, 2008; McDuffie & Yoder, 2010). Exploration of variables for early identification of late-talkers, using mainly expressive language measures such as vocabulary size, has been conducted with parents whose children are as young as 18 to 32 months of age (Rescorla, 2002). Given that caregiver report can be used to reliably track various aspects of development, it seems logical to postulate that caregivers can provide us with a more accurate and functional means of tracking vocal development earlier than previously explored.

Caregiver report of early vocalizations is important in more ways than simply enabling tracking of development; caregiver report directly influences interaction with infants. Parent response to child production varies dependent upon whether or not the production is perceived as phonetically accurate versus inaccurate (Julien & Munson, 2012) and familiar versus non-familiar (Olson & Masur, 2012). Responses tend to phonetically enhance inaccuracies by making the immature productions well-formed, to facilitate future correct productions. Responses also tend to imitate and repeat non-familiar words produced by children, to provide additional examples and input to reinforce these productions. Further, when children produce familiar words, word approximations, or even consonant-vowel syllables, parents are likely to expand upon those productions, thus encouraging language growth (Gros-Louis, West, Goldstein, & King, 2006). Consider, for example, a 9 month old repeating [ɡʌɡʌ] as he eats his eggs. To this babbling, his parents respond "yes, eggs" and "good eggs", following from their son's velar cues and expanding upon the canonical syllables he babbles. Given that caregiver response to early communication influences later development, it seems logical to posit that caregiver response to vocal development, even from 6 through 18-month-old infants, can influence and perhaps predict later speech and language development. Further, given that caregiver input is influenced by the accuracy and familiarity of the child's production, it also seems logical to posit that caregiver input will be directly influenced by the sounds they perceive their infant to be producing.

The "Parent Questionnaire" of the *Communication and Symbolic Behavior Scales Developmental Profile* (Wetherby & Prizant, 2001) and the *MacArthur-Bates Communicative Development Inventories* (Fenson, Marchman, Thal, Dale, Reznick, & Bates, 2007) are available to quickly track caregiver report of infant speech and language abilities, but these measures do not provide a profile of the sounds infants are producing in their babbling. It is known that the phonetic characteristics of sounds produced in early babbling inform about later expressive language abilities (McCune & Vihman, 2001; Sotto et al., 2014; Stoel-Gammon, 2011). Therefore, one should develop a means of gathering information about the phonetic makeup of sounds infants produce.

1.3 Purpose

Accordingly, we present a first step toward incorporating caregiver report into procedures for tracking early vocal development. We do not provide new information about what infants are producing. Rather, the purpose of this exploratory study was to determine how the phonetic makeup of sounds reported by caregivers in infant babbling would develop, in particular comparison to markedness and established norms. It is projected that caregivers may play a key role in early identification of atypical infant speech and language development and thereby may impact our measurement and knowledge of speech and language development. Prior to exploring atypical development, however, we need to gauge the ability of caregivers to report sounds in babbling for typically developing infants. Given that traditional means of tracking vocal development are cumbersome and may not provide the most functional perspective, caregiver judgment may highlight particularly functional phonetic features in development, therefore increasing the potential for translation of basic research to clinical practice. Herein, we report our findings from a cohort of 15 infant/parent dyads followed over a longitudinal period of 12 months while the infants were 7 to 18 months of age. The research question was: What is the effect of infant developmental stage on phonetic complexity of caregiver report? Again, based on established norms, we hypothesized that more types of phonetic features would be reported with increasing infant age; place of articulation would develop from anterior to posterior sounds; voiced consonants would proceed voiceless consonants; stops, nasals, and glides would be present to a greater degree before fricatives, affricates, and liquids; and front and central vowel-like sounds would present prior to high and back vowel-like sounds.

2. Method

2.1 Participants

Participants included 15 parent/infant dyads. For the purpose of this project, we explored data from 7 through 18 months of infant age to obtain even developmental stages (to be described below). Flyers advertising the study were sent to addresses (obtained from Register of Deeds records at the Pitt County Court House, Greenville, NC) of families with infants. Parents interested in participating with their infants were interviewed, and details of the study, along with informed consent, were discussed. Inclusion criteria for the study consisted of caregivers who experienced normal pregnancies and no significant history of prenatal or perinatal problems; families where English was the primary language spoken in the home; families who were able to travel to the laboratory monthly; families who did not expect to move away from the surrounding area within 2 years of beginning participation in the study; and infants not at risk for developmental disorders. Infants considered at risk would have been those who had experienced one or more of the following conditions prior to 7 months of age: pre- and/or perinatal problems; ear, nose, and throat problems; swallowing/sucking problems; and/or a family history of speech and/or language problems (Brady et al., 2004; Goldstein & Schwade, 2008; McDuffie & Yoder, 2010). See Table 1 for participant information. Infant ages are presented in three developmental stages given linguistic considerations. The prelinguistic stage, from 7 to 10 months of infant age, is thought to represent mostly immature prelinguistic vocalizations (e.g., marginal syllables). The early linguistic stage, from 15 to 18 months of age, is thought to represent mostly canonical and early linguistic productions (e.g., well-formed syllables and first word forms). The canonical stage, from 11 to 14 months of infant age, is thought to represent an overlap of both prelinguistic and linguistic vocalizations, with more established canonical vocalizations.

Table 1. Participant Information

Infant	Gender	Number of Interviews Per Developmental Stage		
		Prelinguistic	Canonical	Early Linguistic
1	F	5	5	5
2	F	10	10	5
3	F	3	4	2
4	F	10	8	3
5	M	8	3	4
6	F	10	9	5
7	M	13	8	8
8	M	8	10	3
9	F	8	13	2
10	M	10	11	2
11	F	11	9	4
12	F	11	3	3
13	M	3	11	8
14	M	9	7	7
15	F	8	7	1

Six of the 15 infant participants were male, and nine were female. One female infant was African American, one male infant was Asian American (father of East Indian descent and mother of Vietnamese and Hawaiian descent), and one male infant was Palestinian. One male infant was from a home where English and Arabic were spoken, and a second male infant was from a home where English, Indian, and Vietnamese were spoken. All infants were normal hearing; they all passed an automated auditory brainstem response newborn screening (ALGO 3 or ALGO 5 Newborn Hearing Screener System) to click stimuli presented at 35 dB nHL. In addition, full hearing evaluations including tympanometry, transient evoked otoacoustic emissions, and visual reinforcement audiometry were conducted at 6 and 18 months of age, with follow-up testing as needed for instances where results were abnormal (i.e., middle ear dysfunction) or testing was incomplete. Two of the infants received bilateral myringotomy and pressure equalization tubes during their enrollment in the study. Regardless of language background or hearing status, all infants demonstrated typical speech and language development during the recording period, a point supported by speech and language abilities within normal limits on follow-up testing conducted with each child at 3 ½ years of age.

2.2 Procedure

Parent/infant dyads were followed over a 13-month longitudinal period through weekly interviews and monthly recordings (vocalizations from audio and video recordings are pertinent for future projects). Caregiver report of early infant vocalizations was documented via a weekly interview administered over the phone or face-to-face with a trained laboratory staff member. The interview took approximately 5 minutes to complete. The study duration provided 58 weeks of interview opportunities. On average, interviews were gathered 23.9 times from each of the families depending upon caregiver availability each week (ranging from 15 to 29 total interviews). The main interview question for the purposes of this study was "What sounds/words is your infant producing?" Responses were phonetically transcribed. As the infants grew, caregiver responses began to contain early word forms.

Caregivers were not trained in how to respond to interview questions. We did not expect caregiver report to sound like infant sounds, simply because adults are not easily able to reproduce infant vocalizations. Further, sounds exotic to the English language were expected to be limited in caregiver report given lack of phonetic training. The intention of this study was to acquire an unbiased, untrained, natural, intuitive response from caregivers, to measure how those responses relate with our current knowledge of development.

2.3 Classification for Vocalizations Reported

Caregiver report was transcribed separately for each infant at each age, and tallies were calculated for the number of interviews conducted, the total number of utterances reported, and the total number of consonants and vowels in reported utterances. Further, within the Phon 2.1.7 platform, a software program designed to facilitate phonological and phonetic analysis of transcribed data (https://www.phon.ca; Rose et al., 2006; Rose & MacWhinney, 2014), the phonetic details of reported consonant and vowel sounds were analyzed. Consonant sounds reported were explored in terms of place of articulation (i.e., number of labial, coronal, dorsal, and laryngeal consonants), voicing (i.e., number of voiced and voiceless consonants), and manner of production (i.e., number of stop, fricative, affricate, nasal, liquid, glide, click, and trill consonants). Vowel sounds reported were explored in terms of tongue position (i.e., number of high front, low front, central, low back, high back, rising diphthong, and rhotic diphthong vowels).

2.3.1 General Details

After controlling for the number of caregiver interviews obtained, we asked, "What is the effect of infant developmental stage on phonetic complexity?" Therefore, the dependent variables of interest were the number of different phonetic features reported, and the independent variables were the within subjects factors of phonetic categories (i.e., consonant or vowel, places of articulation for consonants, voicing for consonants, manner of production for consonants, and tongue position for vowels) and infant developmental stage (i.e., prelinguistic, canonical, and early linguistic stages).

2.3.2 Analysis

Differing numbers of interviews were obtained from the caregivers at each age (see Table 1). Consequently, we could not state that caregivers reported 147 utterances at 7 months and 74 utterances at 18 months, because 42 interviews were conducted at 7 months, while only 4 interviews were conducted at 18 months. Accordingly, the numbers of interviews for each developmental stage were entered as a covariate in the analysis model. The assumption of equality of slopes was assessed by interacting the covariate with all other factors.

The multiple dependent variables were assessed using a general linear mixed model (PROC MIXED in SAS^{TM} software, Version 9.3), with each infant measured multiple times across the three developmental stages. The design of the analysis was a fully within subjects mixed model. The within subject factor was developmental stage, whereas the within subject time-varying covariate was number of interviews gathered. The interaction between developmental stage and number of interviews was tested for in all response variables (phonetic categories) and if found to be not significant, was removed from the model and only the main effects of age and number of interviews were considered. In addition, distributional normality was assessed using a combination of Shapiro-Wilk, Kolmogorov-Smirnov, Cramer-von Mises, and Anderson-Darling tests. If violations of normality were found, the response variables were transformed using a logarithmic or square root transformation. When a significant main effect for age was found, post-hoc pairwise comparisons were performed using a Bonferroni correction to the *p*-value. If there was a significant interaction, data were interpreted based on parameter estimates. Final model results are reported below, after transformations and removal of non-significant interactions.

3. Results

3.1 General Features

General features in caregiver report of infant utterances included the total number of utterances, and the number of consonants and vowels in those utterances. The raw values derived from vocalizations reported by caregivers, normalized according to number of interviews conducted and summed across the 15 infants from 7-18 months of age, are displayed in Figure 1.

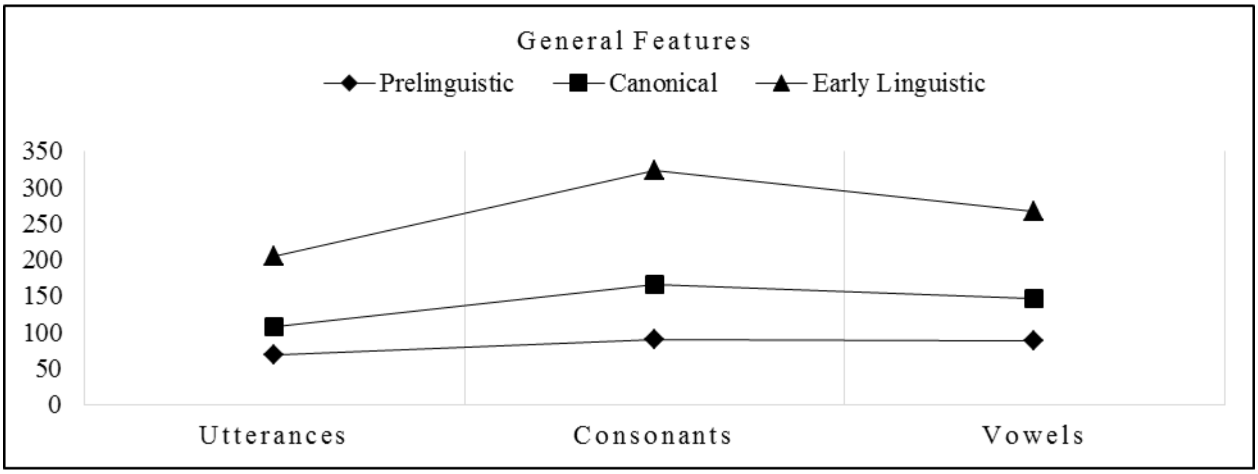

Figure 1. Raw Values for General Features Normalized according to Number of Interviews Conducted and Summed across Infants

3.1.1 Utterances

The main effects for developmental stage and number of interviews administered were significant ($p < 0.0001$), such that number of utterances increased across developmental stage, and for every one interview increases the square root counts of each utterance increased by 0.59. After a Bonferroni adjustment, all developmental stages were statistically significantly different from one another. In summary, the older infants were reported to babble more.

3.1.2 Consonants and Vowels

The main effects for developmental stage and number of interviews administered were significant ($p < 0.0001$), and the main effect for segments was not significant ($p = 0.19$). For every one interview increase, the square root counts of each of individual segment increased by 0.64. After a Bonferroni adjustment, all developmental stages were statistically significantly different from one another.

3.2 Phonetic Features for Consonants

The phonetic features of consonant sounds present in caregiver report included the total number of different places of articulation (Figure 2), voicing (Figure 3), and manners of production (Figure 4).

3.2.1 Place of Articulation for Consonants

The two-way interaction between developmental stage and number of interviews administered was significant ($p = 0.01$). For every one-interview increase, the square root counts of each individual place count increased by 0.02 in the prelinguistic stage, and by 0.21 in the canonical and early linguistic stages. After a Bonferroni adjustment, the following significant results were present across developmental stages: labials were produced less often in the prelinguistic than early linguistic stage; coronals were produced less often in the prelinguistic than canonical, prelinguistic than early linguistic, and canonical than early linguistic stage; and dorsals were produced less often in the prelinguistic than early linguistic stage. Additionally, the following statistically significant results were present across places of articulation for consonants: labials were produced more often than dorsals and laryngeals in all developmental stages; coronals were produced more often than laryngeals in all developmental stages; and coronals were produced more often than dorsals in the canonical and early linguistic stages.

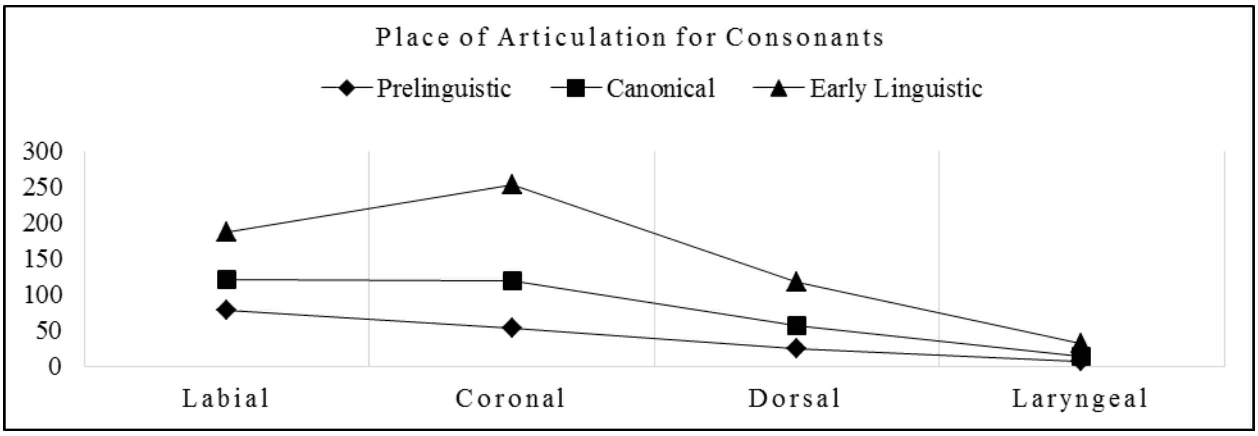

Figure 2. Raw Values for Consonant Place of Articulation Normalized according to Number of Interviews Conducted and Summed across Infants

3.2.2 Voicing for Consonants

The two-way interaction between voicing and number of interviews administered was significant ($p < 0.01$). The slope for voiced consonant sounds was substantially different than the slope for voiceless consonant sounds, such that the more interviews, the more voiced consonants derived from caregiver report. Voiceless consonants increased across caregiver report with increasing interviews also, but not to the same extent. For every one-interview increase, the square root counts for each individual segment increased by 0.56 for voiced sounds, and by 0.28 for voiceless sounds.

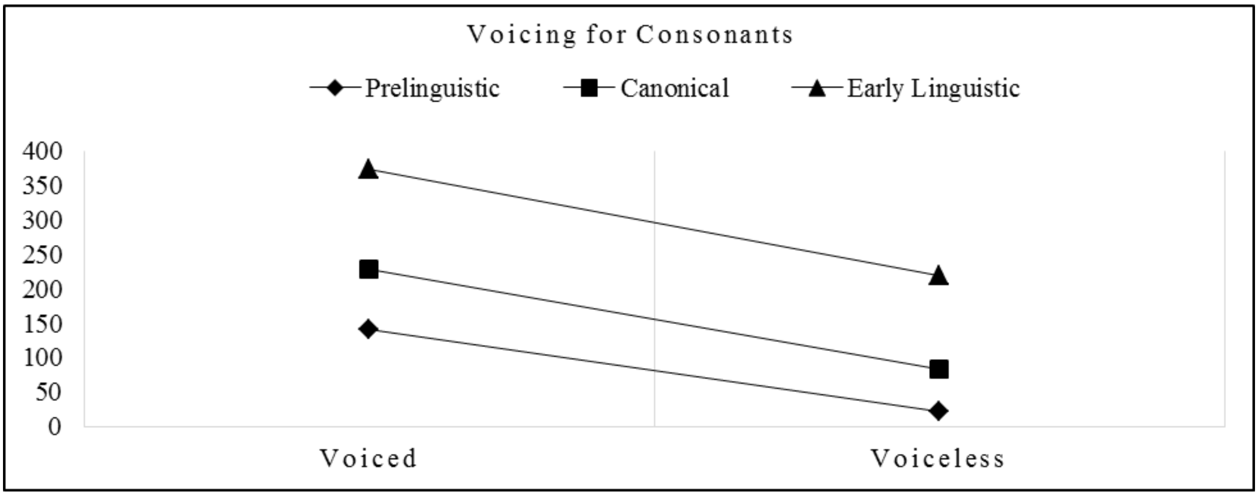

Figure 3. Raw Values for Consonant Voicing Normalized acording to Number of Interviews Conducted and Summed across Infants

3.2.3 Manner of Production for Consonants

The two-way interactions between manners of production and developmental stage (p < 0.01), manners of production and number of interviews administered (p < 0.01), and developmental stage and number of interviews administered (*p* = 0.01) were significant. Changes in slope by developmental stage are reported for the two-way interaction between manners of production and developmental stage. For every one-interview increase, the log transformation counts of each individual manner decreased by 0.06 in the prelinguistic stage, increased by 0.01 in the canonical stage, and increased by 0.30 in the early linguistic stage. After a Bonferroni adjustment, the following statistically significant results were present across developmental stages. Fricatives were produced less often in the prelinguistic than canonical, prelinguistic than early linguistic, and canonical than early linguistic stage; and stops, affricates, liquids and glides were produced less often in the prelinguistic than early linguistic stage. Additionally, the following statistically significant results were present across manners of production. Stops were produced more often than fricatives, affricates, liquids, glides, clicks, and trills in all developmental stages, and more often than nasals in the early linguistic stage. Fricatives were produced more often than affricates, clicks, and trills in the canonical and early linguistic stages; less often than nasals in the prelinguistic and canonical stages; and more often than liquids in the early linguistic stage. Affricates were produced less often than nasals in all developmental stages; less often than liquids in the canonical stage; less often than glides in the canonical and early linguistic stages; more often than clicks in the early linguistic stage; and more often than trills in the prelinguistic stage. Nasals were produced more often than liquids, clicks, and trills in all developmental stages, and more often than glides in the prelinguistic and canonical stages. Liquids were produced more often than clicks and trills in the canonical and early linguistic stages. Glides were produced more often than clicks and trills in the canonical and early linguistic stages.

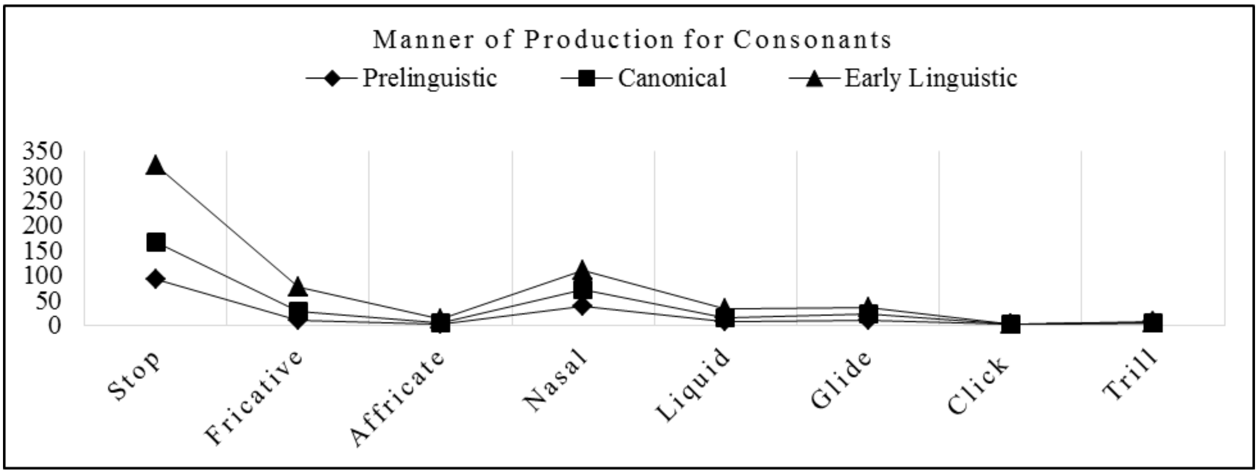

Figure 4. Raw Values for Consonant Manner of Production Normalized according to Number of Interviews Conducted and Summed across Infants

3.3 Phonetic Features for Vowels

The raw values for phonetic features of vowels in vocalizations reported by caregivers, normalized according to number of interviews administered and summed across the 15 infants from 7-18 months of age, are displayed in Figure 5. The two-way interaction between tongue positions for vowels and developmental stage was significant ($p < 0.01$). For every one-interview increase, the square root counts of each individual tongue position increased by 0.30. After a Bonferroni adjustment, the following significant results were present across developmental stages. High front vowels and rising diphthongs were produced less often in the prelinguistic than canonical, prelinguistic than early linguistic and canonical than early linguistic stage; and central and high-back vowels were produced less often in the prelinguistic than canonical stage. Additionally, the following statistically significant results were present across tongue positions. High front vowels were produced less often than low front vowels in the prelinguistic stage and less often than low back vowels in the prelinguistic and canonical stages. Low front vowels were produced less often than low back vowels in the prelinguistic and canonical stages; and more often than rhotic diphthongs in all developmental stages. Central vowels were produced less often than low back vowels in the prelinguistic and canonical stages; and more often than rhotic diphthongs in the canonical and early linguistic stages. Low back vowels were produced more often than high back vowels in the prelinguistic and canonical stages; more often than rising diphthongs in the prelinguistic and canonical stages; and more often than rhotic diphthongs in all developmental stages. High back vowels were produced less often than rising diphthongs in the early linguistic stage, and more often than rhotic diphthongs in the early linguistic stage. Rising diphthongs were produced more often than rhotic diphthongs in the canonical and early linguistic stages.

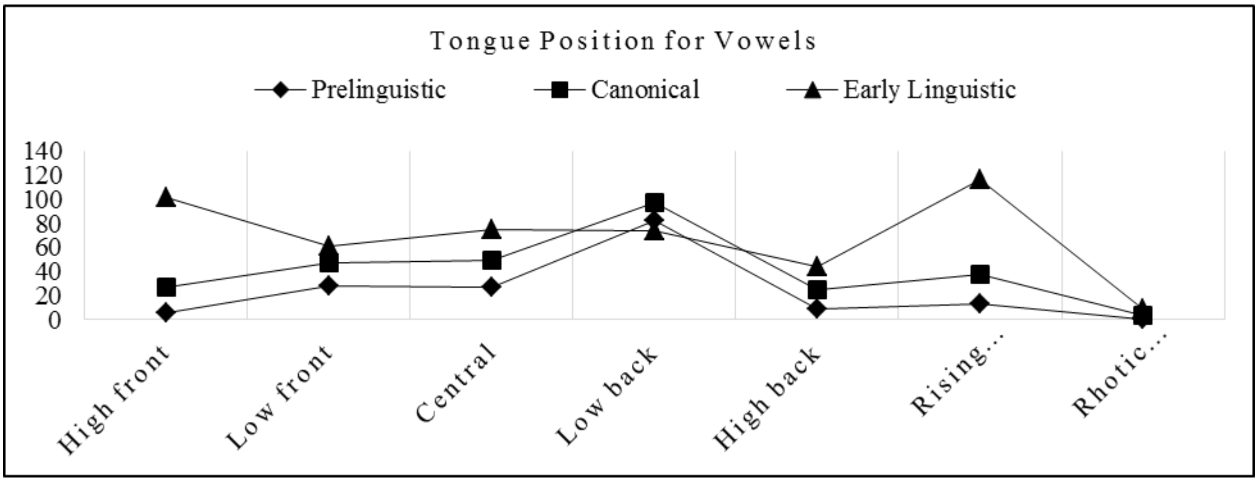

Figure 5. Raw Values for Tongue Position in Vowels Normalized according to Number of Interviews Conducted and Summed across Infants

4. Discussion

The purpose of this exploratory study was to determine how the phonetic makeup of sounds reported by caregivers in infant babbling from 7 to 18 months would develop, in particular comparison to markedness theory and established norms. The long-term goal of this research is to incorporate the caregiver's perspective into our knowledge of vocal development, in order to identify better clinical predictors for speech and language development at an earlier age. It is projected that caregivers may play a key role in early identification of atypical infant speech and language development, and thereby may impact our measurement and knowledge of speech and language development. Prior to exploring atypical development, however, we need to gauge the ability of caregivers to report sounds in babbling for typically developing infants.

Given the purpose, we considered the phonetic makeup of parent judged early sounds. While the phonetic features in vocalizations reported by caregivers varied within and across infants, the relative profiles of features as perceived by caregivers across infants were strikingly similar, as manifested in the statistically significant results obtained. Despite variability, caregiver report generally indicated that vocalizations increased in quality (the different types of sounds produced) and quantity (the number of productions per type) across developmental stages. Further, place of articulation was reported to develop from anterior to posterior sounds; voiced consonants preceded voiceless consonants; stops, nasals, and glides were present to a greater degree before fricatives, affricates, and liquids; and front and central vowel-like sounds were present prior to high and back vowel-like sounds.

Ultimately, the reports provided exactly the picture that we would expect (based on typically developing infants), and therefore lend support to the possibility of utilizing caregiver judgment for future measurement of infant vocalizations. Parents have a wider range of observation opportunities, and different situations/times of day to interact with their infants than available to clinicians and researchers. This increased opportunity to hear their infants' productions provides caregivers with increased sampling of their infants' vocal abilities. The results show that engaged caregivers have continuity in their observations over time, which is important given the wide range of individual variability across (and within) infants in vocal development.

While infant vocal behaviors have been shown to be predictors of later language abilities (Watt et al., 2006), this knowledge has not been fully leveraged for clinical use. One complication stems from the fact that normal vocal development is variable and unstable both within and across children (Fenson et al., 2000). However, results from the present study suggest that caregiver report is robust in identifying patterns despite variability. Another complication is found in historically cumbersome and tedious methodological procedures, namely the use of phonetic transcription to document prelinguistic vocalizations. It seems reasonable to suggest that caregiver report could replace and/or be used as an adjunct to traditional methods for prediction of language outcomes from prelinguistic development. In support, and extension of current measures of child development like the Parent Questionnaire of the *Communication and Symbolic Behavior Scales Developmental Profile* (Wetherby & Prizant, 2001) and the *MacArthur-Bates Communicative Development Inventories* (Fenson et al., 2007), perhaps we can aim to develop a similar test for vocalizations through following this line of research. Consider, for example, a new inventory-like measure where the forms provided would be written in some orthographic way, similar to the types of transcriptions that newspapers utilize to introduce a new word to their readership. These pseudo-phonetic forms could also be accompanied with check boxes to encode repetition (e.g., [gʌgʌ]), or with lines where the parent could write down variegated forms containing suggested templates. Results of the reported project imply that with further exploration of caregiver report, it may be possible to develop better models of early phonology and better predictors of future speech-language outcomes and atypical patterns in development.

There are some potential limitations to this line of research that should be raised. A secondary purpose of incorporating caregiver report is to streamline infant vocal coding to make it easier and faster. Some might think that the weekly interviews conducted to gather caregiver report and transcription of reports by a trained research assistant were time consuming. Given the preliminary nature of this research, these methods are more time consuming than expected in the future, and still much more efficient than transcription of the infant vocalizations. Caregivers provide us with much less detail that is easier to transcribe, than the variable infant vocalizations themselves. Once we know what caregivers are reporting, and how their report differs for infants with typical versus atypical vocal development, we can streamline the procedure for caregiver report through means such as those described above, perhaps an inventory-like protocol that could take a short 5 minutes to complete.

Further, given the detailed nature of tracking speech sound development, some might argue that caregiver report may be hindered by their lack of phonetic training. On the contrary, we are trying to develop a more efficient means of tracking development, and relying solely on an untrained and intuitive report has the potential for quick and simple tracking. If such report can provide us with useful information, from which we, as trained professionals can attribute phonetic detail, then there will be no need to spend limited time resources on training caregivers and transcribing infant vocalizations.

While it is pertinent to observe that caregiver report of vocal and speech development from 7 to 18 months of infant age aligns with our current knowledge, it remains to be seen if caregiver report of early infant sounds is more predictive of future speech and language development than report from trained listeners/transcribers. There are many future directions for this research. We expect future findings to show that caregiver report of vocalizations from infants at risk will be different than vocalizations from infants who are typically developing in terms of the quantity and quality of phonetic features identified. Further, it is expected that the differences found will be present as early as 7 months of age, which is earlier than previously identified using more traditional methods. These results would have an important positive impact on clinicians and clients, enabling recognition of atypical patterns in speech and language development at an earlier age, and facilitating identification of those in need of early intervention by considering the caregiver's perspective.

The potential of the present findings, paired with future methodological comparisons (between caregiver report and transcription, between caregiver report of prelinguistic vocalizations and later speech and language development, and between caregiver report of vocalizations produced by infants at risk for speech and language disorders and infants who are typically developing) could facilitate the translation of basic research to clinical practice in a way that has not been made possible through the use of phonetic transcription of infant vocalizations alone. It seems imperative, therefore, to incorporate caregiver report of infant vocalizations into our research methods and clinical diagnostic procedures.

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Note

Note 1. According to Tabachnick and Fidell (2007), the appropriate transformation for moderate negative skewness is the square root transformation, whereas the appropriate transformation for severe negative skewness is the logarithmic transformation. For each response variable, the transformation resulting in distributional normality was used.