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PARENTAL VERBAL RESPONSIVENESS DURING PRELINGUISTIC VOCAL DEVELOPMENT:
VARIABILITY AND ASSOCIATION WITH LANGUAGE OUTCOMES

by

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A thesis submitted in partial fulfillment of the requirements
for graduation with Honors in the Psychology

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Variability and Association with Language Outcomes

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Mother and Father Verbal Responsiveness during Prelinguistic Vocal Development:
Variability and Association with Language Outcomes

Parents have a significant impact on the development of children. They can affect their children's socio-emotional, personality, attachment, and cognitive development. In particular, language development is significantly affected by interactions with parents, specifically when children are very young, because at this time they are learning language, cognitive, attentional, and social skills quickly and these are the foundations for later development (Pancsofar & Vernon-Feagans, 2006). Early language development occurs within a variety of contexts, and in familial and nonfamilial environments, but according to the ecological systems theory, social interactions with parents are most clearly linked to early language development (Bronfenbrenner & Morris, 1998). Therefore, in this study, we explored parent-infant interactions to examine relations to language development and communication abilities.

Previous studies have shown that children's gains in linguistic abilities are correlated with the amount of adult speech directed to their children (Barnes, Gutfreund, Satterly, & Wells, 1993; Hart & Risley, 1995). Barnes found that the amount of adult speech was significantly associated with early language skills. Specifically, the diversity, complexity of maternal vocabulary, and frequency of mother's questions are a strong predictor of later language development and literacy. Similarly, a recent study by Hirsh-Pasek and colleagues demonstrated that it is not only the quantity of speech that infants are exposed to, but the quality of interactions involving speech that is most important for language development (Hirsh-Pasek et al., 2015).

One aspect of the quality of interaction that has been shown to facilitate language development is parents' responsiveness to infant behavior and communication, which strengthens the communication abilities of infants before they can produce standard words

(Tamis-LeMonda, Kuchirko, & Song, 2014). As a recent study showed, parents' responsiveness predicts the size of their children's vocabulary, communicative variability, and the timing of language milestones (Tamis-LeMonda et al., 2014). Researchers tracked vocabulary growth from 9 to 21 months and coded mothers' responsiveness during infant-mother interactions at 2 timepoints. Infants who had high-responsive mothers at 9 and 13 months acquired language abilities including first words, vocabulary spurt, and speech, four to six months earlier than infants who had low-responsive mothers (Tamis-LeMonda, Bornstein, Kahana-Kalman, Baumwell, & Cyphers, 1998; see also Tamis-LeMonda, Bornstein, & Baumwell, 2001).

Timing of responses

Beyond overall responsiveness being important, those responses that are directly related to what the infant is focusing on (termed sensitive/ follow-in; Bornstein, 1989; Baldwin, 1991) facilitate language development, whereas redirective responses hinder language development (Tomasello & Farrar, 1986). A recent study found that responses that are both contingent on infants' communicative behavior (gesture, vocalizations), and about what infants are focused on, are the best predictor of language outcomes. Specifically, the researchers found that only vocal responses that were both semantically and temporally contingent to infants' communicative behavior predicted infant vocabulary at 18 months. This type of response, termed semantically contingent, supports vocabulary learning because it makes it easier for the infant to match the word with its function (McGillion, Berert, Pine, Keren-Portnoy, Vihman, & Matthews, 2013). Other studies in the U.S. have found that mothers who used more semantically contingent talk had children with larger vocabularies (Carpenter, Nagell, Tomasello, Butterwoth, & Moore, 1998). These findings argue for the need to consider the interaction between infant communicative behavior and parents' responses.

It has been suggested that responsive language enhances statistical learning, which helps infants recognize words that are most pertinent to them (Tamis-Lemonda et al., 2014). In this view, infants can match specific words with specific objects and events, which improves accuracy of word-to-object mappings. An experimental study by Goldstein and colleagues (2010) further supports the view that vocal response to infant vocalizations helps with word-object mappings. In this study, infants learned the association between an object and its label when they received a label response that was contingent on their object-directed vocalization. By contrast, infants did not learn the label-object association if the label was only contingent on a look (Goldstein, Schwade, et al., 2010)

Types of responses

Researchers have also examined the content of responses more specifically and explored which kind of responses best support language learning. Research conducted by Hoff-Ginsberg (1985), involving 22 mother-child dyads, suggested that the mother's use of questions was significantly associated with children's increased use of auxiliary verbs. Also, the frequency of mothers' yes/no questions was a significant facilitator of greater language growth in children during the 2nd year. In another study, researchers coded mothers' verbal responses as referential or regulatory (Tamis-LeMonda et al., 2014). Referential responses were references or descriptions of objects or events; e.g., "Yellow Pooh bear." On the other hand, regulatory responses were statements that direct infants' actions; e.g., "Come here." The results showed that infants increased their vocalizations, gestures, and object explorations after referential language, whereas these decreased after regulatory language. Masur, Flynn, and Eichorst (2005) also found that directive responses were negatively related to infants' language development.

To date, research has focused more on mothers' interactions with their infants, but as family structure and gender roles have changed over the last 40 years, more women work outside the home and the roles of men in families have changed. In this regard, we need to explore the role of fathers to better understand the social influences on children's development (Pancsofar, Vernon-Feagans, 2006). Studies that have investigated whether mothers and fathers differ in their verbal responses have found that fathers tend to attune to their children's developmental level when they talk to them as do mothers; fathers use simplified speech with high pitch, and they adjust their verbal responses to their children's changes in verbal abilities. However, fathers speak less overall, use less "supportive language," less "negative language," and more "directive language" than mothers (Fernald, Taeschner, Dunn, & Papousek, 1989). Furthermore, fathers' often request clarification more frequently and ask more open-ended questions rather than yes/no questions (Rowe, Coker, & Pan, 2004), suggesting that they are more challenging communication partners (Gleason, 1975).

Other studies have found contradictory results in terms of whether parents differ when speaking to their infants. Many studies have found that fathers' total verbal output is less than mothers when interacting with their children. However, research conducted by Golinkoff and Ames (1979), on interactions between parents and infants in 10-minute free play sessions found that mothers and fathers produced similar verbal output in dyadic situations; whereas, in triadic situations, fathers spoke less than mothers. Hladik and Edwards (1984) found exactly the opposite result. In triadic situations, mothers and fathers showed no differences on any variables, but in dyadic situations, fathers produced fewer utterances than mothers.

Studies that have examined the complexity of language of mothers and fathers also show little consensus (Pancsofar et al., 2006). Some researchers (Rondal, 1980; Malone and Guy,

1982) found that fathers have a shorter MLU (Mean Length of Utterance) than mothers. Other studies found that fathers and mothers show no differences in utterance complexity. In terms of vocabulary diversity, though there have been very few studies, O'Brien and Nagle (1987) and Rowe et al (2004) found that there were no significant differences between mothers and fathers.

Prior studies that have focused on parent-infant interactions, parent responsiveness, and language development, suggest that parents' contingent responses to infant communication facilitate language development. In addition, certain parent responses are more supportive than others, such as responses that follow-in to infants' attentional focus and certain types of speech acts. Yet, previous studies have found contradictory results in terms of whether fathers and mothers differ in their responses, particularly when considering all of these important variables for language development. Therefore, the aim of this study is to examine maternal and paternal responses to infant vocalizations, focusing on different types of responses (sensitive and redirective) and specific speech acts. In addition to exploring these behaviors, we examined the impact of parents' responses on infants' language development.

Method

Participants

Seven infants (3 male and 4 female) aged 8 months and their parents participated in this study when infants were 8-12 months of age. All infants were first born. Infants started the study when they were 8 months ($M=7.93$, $SD=.04$, range = 240-243 d). Participants were recruited through county birth records or a volunteer child research participant registry if they had participated in studies previously. Based on demographic data collected before starting the study, all participants self-reported as Caucasian. The average age of mothers was 29 years old (range = 26-32). The average age of fathers was 32 years old (range = 27 -36). One mother and one father

did not report their age. All but one father had at least a college degree and all mothers had at least a college degree. Two fathers and four mothers held higher degrees. Participants were part of a larger study on infant communication development.

Procedure

We instructed parents to record 30 minutes per month of normal free-play in the home, behaving naturally with their own toys. We gave Sony flip-cameras to participants to record their interactions. The study started with when infants were 8 months old and continued until they were 12 months old. Parents were instructed to record mothers' and fathers' interactions separately each month, so they recorded a total of ten interactions. We also asked them to fill out MCDI: words & gestures questionnaires (Fenson et al., 1994) every month and when the infants were 18 months old to measure their language development.

Coding and reliability

Materials. We coded the interactions using ELAN (EUDICO Linguistic Annotator: Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands; Lausberg & Sloetjes, 2009; <https://tla.mpi.nl/tools/tla-tools/elan/>), which is a free software program that allows frame-by-frame video coding. The coding focused on: (i) infants' vocalizations and (ii) parents' responses to infants' vocalizations.

Parents Responses.

Verbal and behavioral responsiveness. Parental responses were defined as the first verbal or behavioral response that occurred within 2 seconds after the offset of infant's vocalization. These responses were divided into three categories. The first category is 'No Response', when parents do not show any verbal or behavioral responses. The second category is 'Sensitive Response' and the third category is 'Redirective Response.'

Sensitive responses. Sensitive responses include “Sensitive Vocalization (SV),” “Sensitive Vocalization and Behavior (SVB),” “Sensitive Behavior (SB).” The first sub-category “Sensitive Vocalization (SV)” is when a parent comments on or talks about what the infant is playing with, holding, or looking at. The second one is “Sensitive Behavior (SB),” in which a caregiver manipulates, picks up, or plays with an object that the infant is playing with, holding, or looking at. “Sensitive Vocalization and Behavior (SVB)” is when the caregiver combines those actions.

Redirective responses. Redirective responses involve “Redirective Vocalization (RV),” “Redirective Behavior (RB),” and “Redirective Vocalization and Behavior (RVB).” The first sub-category is “Redirective Vocalization (RV),” when a caregiver comments on or talks about something that is not related to what the infant is holding, playing with, or looking at and specifically about something outside of the infant’s attention. “Redirective Behavior (RB)” is when the caregiver manipulates, picks up, or plays with an object that is not what the infant is holding, playing with, or looking at; it is specifically about something outside the infant’s attention. For example, the parent gets a new toy, and manipulates or plays with a toy that the infant is not currently playing with or focused on. The last category is “Redirective Vocalization and Behavior (RVB),” in which the caregiver combines both actions, however, he/she comments on or talks about and manipulates, picks up, or plays with an object that is not what the infant is holding, playing with, or looking at (see Table 1).

Specific verbal response. Specific parental verbal responses were defined as the first utterance that occurred within 2 seconds after the offset of the infant’s vocalization. To assess mothers’ and fathers’ specific verbal responses and their differences, we adapted the speech act coding schemes that were used in prior studies (see Wu & Gros-Louis, 2014). First, the exact

contents of parents' verbal responses were transcribed using ELAN, then they were classified based on pragmatic features, which include questions, prohibitions, directives, naming, descriptions, imitations, acknowledgements, affirmation, play, exclamation, and unknown if the response was inaudible (see Table 2).

Measures

Infant vocalization. Every vocalization was coded except for laugh, distress sounds (cries, whines), and vegetative sounds (cough, burp, sneeze). Their vocalizations were classified as Vowel (V) or Consonant Vowel (CV). Vowel vocalizations include any sound that only contains vowel approximations (a,e,i,o,u) and no consonant. On the other hand, consonant-vowel vocalizations includes any sounds that contain a consonant and vowel. However, if the infant started to vocalize with vowel sound, but then changed their vocalization to a consonant-vowel sound, it was coded as a consonant-vowel vocalization.

Directedness of vocalization

Each vocalization was coded as directed or undirected (Goldstein, Schwade, Briesch, & Syal, 2010; Gros-Louis et al., 2014). Object-directed vocalizations were coded when an infant vocalized while looking at a toy. Parent-directed vocalizations were coded when an infant vocalized while looking at the parent (Miller & Gros-Louis, 2013). Parent-object and object-parent directed vocalizations were vocalizations accompanied by a gaze shift between parent and object, and object and parent, respectively. Undirected vocalizations were coded when the infant vocalized while looking around without a clear focus.

Results

Preliminary Analysis

Due the small sample size, data were collapsed across gender. First, we examined infant's vocal production (amount, vocal type, and directedness of vocalizations) and parents' responses. Then, we investigated parents' specific verbal responses to infant's vocalizations and their association with language outcomes.

Infants Vocal Production

Infants vocalization. Infants produced roughly the same number of vocalizations per month when playing with mother or father ($M = 480.7$, $SD = 199$ and $M = 655.4$, $SD = 287$, respectively), $p = .178$. From 8 to 12 months, infants showed a decrease in the proportion of vowel-like vocalizations ($M_{V8} = .76$, $SD = .18$ vs. $M_{V12} = .63$, $SD = .17$) and an increase in the proportion of consonant-vowel vocalizations ($M_{CV8} = .24$, $SD = .18$ vs. $M_{CV12} = .37$, $SD = .17$; $t(6) = 2.712$, $p < .04$) (See figure 1). Also, infants produced nearly similar number of consonant-vowel like vocalizations (CV) when interacting with mother or father ($M = .29$, $SD = .15$ and $M = .33$, $SD = .14$, respectively), $p = .570$ (See figure 1).

Proportion of vocalizations in each directedness category. There were significant differences in the number of infants' directed vocalizations in each category $F(4, 24) = 80.208$, $p < .001$, $\eta_p^2 = .930$. Infants' object-directed vocalizations were much more frequent than all other categories (all p 's $< .004$). In addition, parent-directed vocalizations were more frequent than parent-object/object-parent vocalizations ($p < .003$) (See figure 2).

Parent Responsiveness

Mother vs father response. The proportion of infants' vocalizations that were responded to by mothers and fathers did not differ significantly. That is, there was no significant difference

in a total number of responses between mothers and fathers ($M = .76$, $SD = .10$ and $M = .67$, $SD = .17$, respectively), $p = .154$.

Responsiveness to V vs CV vocalizations. Mothers responded slightly more than fathers to V vocalizations ($M = .77$, $SD = .11$ and $M = .67$, $SD = .17$, respectively) and to CV vocalizations ($M = .74$, $SD = .09$ and $M = .67$, $SD = .17$, respectively); however, a repeated measures ANOVA with parent response to V and CV as the dependent variable did not find a main effect of parent $F(1, 6) = 2.986$, $p = .135$, but revealed a trend for a main effect of vocal type $F(1, 6) = 5.197$, $p = .063$, $\eta_p^2 = .464$. Bonferroni corrected analysis showed that parents tended to respond more to V than CV vocalizations ($p = .063$).

Mother vs father sensitive response. There were no significant differences in the number of sensitive responses between mother and father ($M = .88$, $SD = .04$ and $M = .80$, $SD = .11$, respectively), $p = .122$. Also, although fathers showed slightly lower proportion of sensitive responses compared to mothers throughout the study, but the differences between mother and father from the start to the end of the study did not differ (all p 's > .1).

Different types of response by mother vs father. A repeated measures ANOVA with proportion of different types of sensitive and redirective responses found a main effect of response style $F(1, 6) = 83.243$, $p < .001$, $\eta_p^2 = .933$ and a main effect of response type $F(2, 12) = 5.174$, $p = .024$, $\eta_p^2 = .463$. Bonferroni corrected post-hoc analysis found that sensitive responses (SV) were more frequent than redirective responses (RV) ($M_{\text{sensitive}} = .20$, $SD_{\text{sensitive}} = .04$ vs. $M_{\text{redirective}} = .04$, $SD_{\text{redirective}} = .01$, $p < .001$). In addition, verbal responses were more frequent than combined verbal-behavioral responses ($M_{\text{verbal}} = .16$, $SD_{\text{verbal}} = .04$ vs. $M_{\text{verbal-behavioral}} = .10$, $SD_{\text{verbal-behavioral}} = .04$, $p = .028$). There was also an interaction between response style and response type $F(2, 12) = 28.961$, $p < .001$, $\eta_p^2 = .828$. Post-hoc tests found significant differences for sensitive

responses; SV were more frequent than SB ($M_{SV} = .30$, $SD = .09$ vs. $M_{SB} = .12$, $SD = .06$), $t(6) = 3.204$, $p = .018$, and SVB ($M_{SVB} = .16$, $SD = .07$), $t(6) = 3.990$, $p = .007$. By contrast, RV were less frequent than RB ($M_{RV} = .01$, $SD = .01$ vs. $M_{RB} = .07$, $SD = .04$), $t(6) = -3.718$, $p = .010$, and RVB ($M_{RVB} = .03$, $SD = .02$), $t(6) = -2.499$, $p < .05$ (See figure 3).

Examining redirective responses revealed that both mothers and fathers showed very few redirective responses; however, a repeated measures ANOVA with proportion of response as the dependent variable found a main effect of response type $F(2, 12) = 10.475$, $p = .002$, $\eta_p^2 = .636$ and an interaction between response type and parent $F(2, 12) = 6.482$, $p = .012$, $\eta_p^2 = .519$. Bonferroni corrected post-hoc analyses showed that RB was more frequent than RV ($p = .023$). In addition, fathers showed a trend to produce more RB than mothers, $t(6) = 2.285$, $p < .07$ (See figure 3).

Specific Speech Acts by Parents

We classified mothers' and fathers' responsiveness as ten specific speech acts, and one category for 'unknown' when parents were not audible (these were very few, and were excluded from analyses). A repeated measures ANOVA with proportion of speech act type as the dependent variable found a significant difference among speech acts $F(9, 54) = 10.568$, $p < .001$, $\eta_p^2 = .638$. Questions were also more frequent than exclamations, and prohibition, p 's $< .05$. Naming was more frequent than affirmations, exclamations, and prohibitions (all p 's $< .01$). Play sounds and descriptives were also more frequent than affirmations, exclamations, and prohibitions (all p 's $< .05$). There was also a trend for an effect of parent $F(1, 6) = 5.253$, $p = .062$, $\eta_p^2 = .467$, with mothers tending to produce more speech acts than fathers. There was no interaction of parent and speech act type $F(9, 54) = .546$, ns (See figure 4).

Specific speech acts by parents to V. We examined the specific speech acts when parents responded to V or CV. A repeated measures ANOVA with proportion of speech act type in

response to V as the dependent variable found a main effect of speech acts $F(9, 54) = 11.586$, $p < .001$, $\eta_p^2 = .659$. Specifically, Bonferroni corrected post-hoc analyses found that play vocalizations were more frequent than prohibitions, affirmations, naming, and exclamations (all p 's $< .04$). Secondly, questions were more frequent than exclamations and prohibitions (all p 's $< .05$). Thirdly, descriptives were more frequent than affirmations, prohibitions, and exclamations (both p 's $< .03$). Lastly, directives were more frequent than prohibitions, $p = .038$, (See figure 5).

Specific speech acts by parents to CV. A repeated measures ANOVA with proportion of speech act type in response to CV as the dependent variable found a main effect of speech acts $F(9, 54) = 8.375$, $p < .001$, $\eta_p^2 = .583$. Specifically, imitations were more frequent than naming ($p = .037$), directives were more frequent than prohibitions, $p = .035$, and questions were more frequent than exclamations, $p = .050$ (See figure 6).

Specific speech-act comparison between V and CV.

Based on prior studies that have found a difference in play and imitation responses to V and CV vocalizations (Gros-Louis, West, Goldstein, & King, 2006), we examined differences for these speech act responses to V and CV for mom and dad. A repeated measures ANOVA with proportion of speech act as the dependent variable found a significant interaction effect of type of vocalization and speech act $F(1,6) = 27.437$, $p = .002$, $\eta_p^2 = .821$. Specifically, parents imitated CV more than V [$M_{imitate} = .25$, $SD_{imitate} = .18$ vs. $M_{play} = .08$, $SD_{play} = .07$, $t(13) = 3.719$, $p = .003$].

MCDI Results

There was a significant positive correlation between mother's overall responsiveness and infants increase in comprehension from 8-12 months of age ($r = .757$, $p < .05$). There was a significant correlation between father's sensitive responsiveness and an increase in infant's productive vocabulary between 8-12 months of age ($r = .774$, $p < .05$).

Discussion

The current study explored infants' prelinguistic vocalizations with mothers and fathers, in addition to how parents responded to infants' vocalizations. In particular, we were interested in determining if mothers and fathers differed in their level of responsivity, or in specific types of responses. In addition, we examined the relation between parents' responsiveness and language development. The main findings of this study are that: 1) infants did not differ in their vocal production when interacting with mothers and fathers; 2) mothers and fathers did not differ in overall responsiveness or responsiveness to vowel-like (V) or consonant-vowel (CV) vocalizations.

Infants' vocal behavior did not differ in play session with mothers and fathers. First, infants produced roughly the same number of overall vocalizations per month when playing with their mother or father. Also, infants did not differ significantly the number of vowel-like (V) or consonant-vowel (CV) vocalizations when interacting with their mother or father. As expected based on typical developmental changes to more advanced vocalizations (Oller, 2000), infants decreased vowel-like vocalizations (V) and increased consonant-vowel vocalizations (CV) from 8-12 months. Based on prior studies, it is suggested that parents' responsiveness relates to changes in CV production (Gros-Louis et al., 2014; Barnes, Gutfreund, Satterly, & Wells, 1993). Barnes and colleagues showed that parents' responsiveness and the amount of adult speech correlated with early language skills. Therefore, our study suggests the possible impact of parental responsiveness on children's language development, but more studies are needed to confirm this, as we did not explore this in the current study.

In terms of directedness of infants' vocalizations, infants' object-directed vocalizations (DO) were significantly more frequent than all other categories, with the next highest category of

parent-directed vocalizations occurring more frequently than parent-object/object-parent vocalizations.

Mothers and fathers were both highly responsive to infants' vocalizations. There were no significant differences in the total number of mothers' and fathers' contingent responses after infants' vocalizations. Also, mothers and fathers did not differ significantly in response to infants' V or CV vocalizations. Surprisingly, we found that parents tended to respond to proportionally more V vocalizations than CV vocalizations, although during this period of development, parents are sensitive to the differences between V and CV vocalizations (Oller, Eilers, & Basinger, 2001) and previous studies have found no differences in responses to V vs. CV vocalizations (Gros-Louis, West, & King, 2016).

In terms of the a type of response that have been shown to be related to language outcomes (Tamis-LeMonda et al., 2001), we found that there were no significant differences in the number of sensitive responses between mothers and fathers. Yet, importantly, both mothers and fathers produced sensitive responses significantly more than redirective responses. Sensitive vocal responses (SV) were the most frequent type of response, occurring more frequently than sensitive behavior (SB) and sensitive vocalization and behavior (SVB). This means that parents are more likely to respond to their infant's vocalizations semantically and verbally rather than semantically and behaviorally. McGillion et al. (2014) showed that temporally and semantically contingent responses predict vocabulary development, which suggests that sensitive verbal responses may help support language development. In fact, we found that fathers' sensitive responses were related to an increase in infants' productive vocabulary and mothers' overall responsiveness (which was primarily sensitive), was associated with an increase in infants' receptive vocabulary.

Even though both mothers and fathers showed few redirective-related responses, interestingly, redirective behaviors (RB) were more frequent than redirective verbal responses (RV). Also, fathers showed a trend to produce more RB than mothers. This shows that when parents tried to shift infants' attention using redirective responses, they tended to respond to their infant with behaviors rather than verbal responses (which are the more frequent sensitive response category).

Given that parents' most frequent responses were sensitive verbal responses, we classified mothers' and fathers' responses as ten specific speech acts. Overall, the most frequent speech acts by parents were questioning, naming, imitating and descriptives, whereas the least frequent speech acts by parents were prohibiting, exclamation, and affirmation. Based on prior studies, it was suggested that using questions facilitates infants' language development (Hoff-Ginsberg, 1985), and using referential language (i.e., naming or descriptive) improved infants' vocalizations, gestures, and object explorations (Tamis-LeMonda et al., 2014). On the other hand, regulatory language (i.e., prohibitive or directive) decreased them. Therefore, parents in our study exhibit a pattern of responsiveness that is consistent with supporting language learning.

Prior studies have found contradictory results when comparing the total verbal output of mothers and mothers (Golinkoff and Ames, 1979; Hladik and Edwards, 1984). Although we did not examine the total verbal output of mothers and fathers, we investigated the verbal output immediately after infants' vocalizations. We found that there was a trend that mothers were more likely to produce speech acts than fathers. This means that mothers were more likely to respond verbally with specific speech acts than fathers.

Prior studies have found that parents respond differentially to less developmentally (V) and more developmentally advanced (CV) vocalizations. Therefore, we explored whether the

different speech acts varied depending on the type of vocalization infants produced. Results showed that when parents responded to V vocalizations, play vocalizations were more frequent response than prohibitions, affirmations, and exclamations. On the other hand, when parents responded to CV vocalizations, imitations and questions were most frequent responses. In addition, parents imitated CV more in response to CV than V. Previous research also showed that mothers were significantly more likely to respond with play vocalizations to V than CV, whereas they were more likely to respond with imitations to CV than V. Therefore, our study confirmed this finding (Gros-Louis, West, Goldstein, & King, 2006; Gros-Louis et al., 2014).

These findings suggest that it is important to explore how these results could improve the quality of infants' babbling and their language growth. Goldstein & Schwade (2008) showed the effect of social contingency on vocal learning and on caregivers' reactions to infants' vocal behavior (Goldstein & Schwade, 2008). They instructed mothers in the contingent condition to respond verbally to their infants. On the other hand, they instructed mothers in the non-contingent group to respond, but not in relation to infants' vocalizations. Results showed that only infants in the contingent condition adjusted their babbling to follow the phonological structure of their mothers' input. Additionally, another study by Goldstein and colleagues showed that the infants who were responded verbally and immediately after their vocalizations by parents increased their number of vocalizations and advanced their quality of vocalizations (Goldstein, King, & West, 2003). On the other hand, infants in the non-contingent condition, in which parents were instructed to give verbal input according to the directions of the experimenters, showed no effects on the development of the quality of their babbling. A recent study confirmed that contingent responses not only increase overall CV output, but the subsequent vocalization produced by infants following a parent's contingent response to a CV is

more likely to be a CV (Gros-Louis & Miller, under review). This shows that infants who get a contingent response are more likely to produce a CV right after the response.

There are a few potential limitations of our study. First, we had very small sample. In the future, we plan to include more participants in this dataset to see whether the results will be consistent with our current findings or make results that were only trends more significant. Second, the sample was homogeneous. All of the participants were Caucasian participants and all but one had attained at least a college degree. Exploring the relationships between infant prelinguistic vocal behavior and parents' responsiveness in a more diverse sample is necessary to generalize to a broader population.

In sum, the current study examined the differences in parental responsiveness and variability during prelinguistic vocal development and their association with language outcomes. Our study highlights that parental verbal responsiveness that is contingent and related to infants' focus or behavior, in particular, is associated with infants' language development. Sensitive responses are more effective in supporting vocabulary development than redirective responses (Tamis-LeMonda et al., 2001; Baldwin, Markman, Bill, Desjardins, Irwin, et al. 1996). A novel aspect of our study is that we not only examined maternal responsiveness but also paternal responsiveness to compare mothers and fathers and to investigate fathers' impact on infants' language growth. Fathers were similar to mothers in their production of sensitive verbal and behavioral responses; however, there was a trend that fathers produced fewer specific speech acts compared to mothers. Further studies are required to investigate how specific speech acts specifically relate to infants' language outcomes.

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Table 1.

Different types of responses

Response style	Specific response type	Example
Sensitive	Verbal	A parent comments on or talks about what the infant is playing with, holding, or looking at
	Behavioral	A caregiver manipulates, picks up, or plays with an object that the infant is playing with, holding, or looking at.
	Verbal-behavioral	A caregiver combines those actions
Redirective	Verbal	A caregiver comments on or talks about something that is not related to what the infant is holding, playing with, or looking at and specifically about something outside of the infant's attention
	Behavioral	A caregiver manipulates, picks up, or plays with an object that is not what the infant is holding, playing with, or looking at; it is specifically about something outside the infant's attention.
	Verbal-behavioral	A caregiver combines both actions, however, he/she comments on or talks about and manipulates, picks up, or plays with an object that is not what the infant is holding, playing with, or looking at. It is specifically about something outside the infant's attention

Table 2.

Pragmatic Speech Coding Scheme

Type of speech act	Definition	Example
Question		
Wh-question	Wh-question framed with who, what, when, where, why, which or how.	“What are you doing?” “Where are you going?”
Request for clarification	Explicit request for the child to repeat; to ensure understanding	“What?” “Say that again?” “Huh?” “You want that bus?”
Yes-no question	Other questions requiring the child to answer with “yes” or “no”	“Is that a tiger?”
Prohibition	Prohibition expressed in the imperative/indirectly	“No”; “stop”; “wait a minute”; “don’t”; “be careful”; “you are not going anywhere”
Directive	Attempts to get the child’s attention, or get the child to perform an action; Commend expressed through imperative, or indirectly as a suggestion or question	“Give me the ball”; “Could you give me the ball?” “Look!” “Here it is.” “Come here” “Let me see” “Push that”
Naming	Name an object/objects explicitly and directly	“That’s a tiger”
Description	Make comments about something, describe something	“It’s red”. “That’s shiny”. “It’s interesting”. “You are excited!”
Imitation	Imitates the infant’s sounds	“baaaa”
Acknowledgments	Acknowledging infant saying something	“ah”, “hmm”, “yea”, “mmm-hmm”
Affirmation	Praise or noting that something was done	“good job! “You did it!”
Exclamation	Surprise/shock/	“thank you” “ta-da” “sorry”, “oh yeah”, “uh-oh”, “oh!”
Play	Sounds they make when they play; pretending to be like a puppet; animal sounds; making sound effects	moo moo; singing
Unknown	Cannot determine what the parent said exactly	

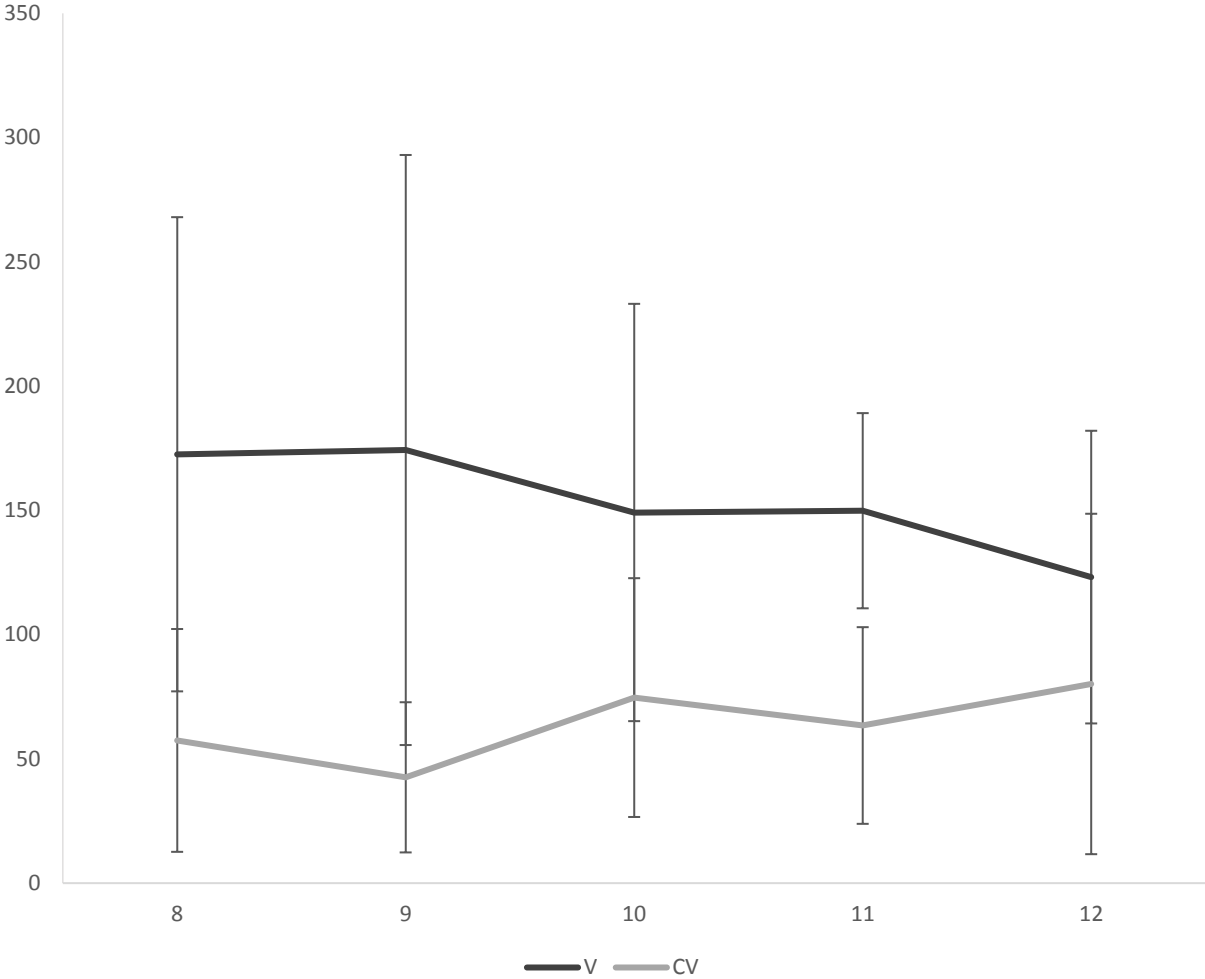


Figure 1) Average number of CV and V vocalizations per month

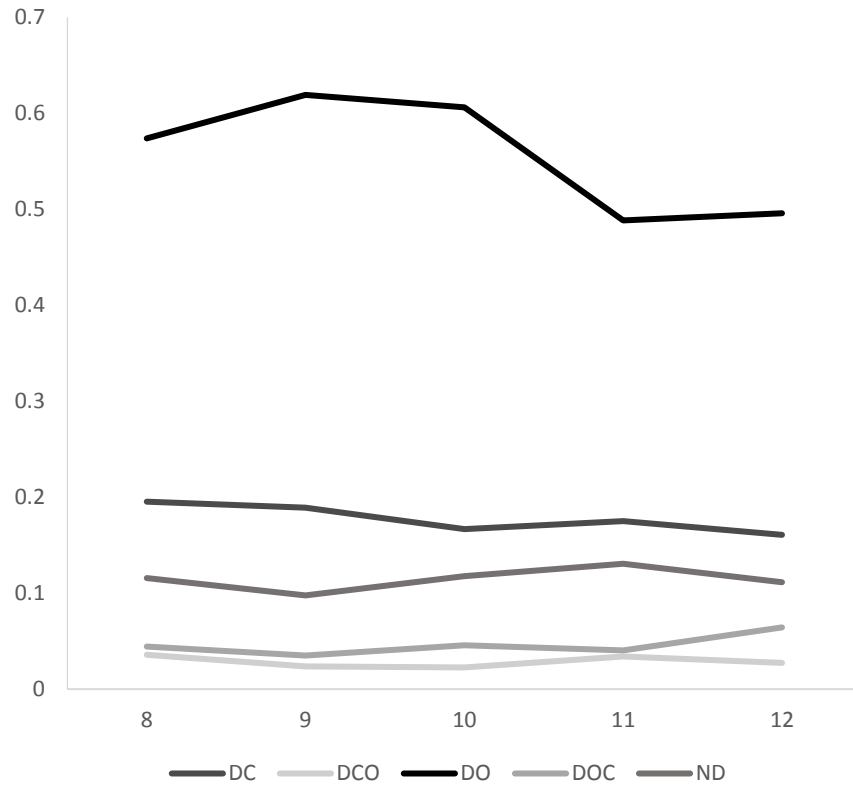


Figure 2) Proportion of vocalizations in each directedness category

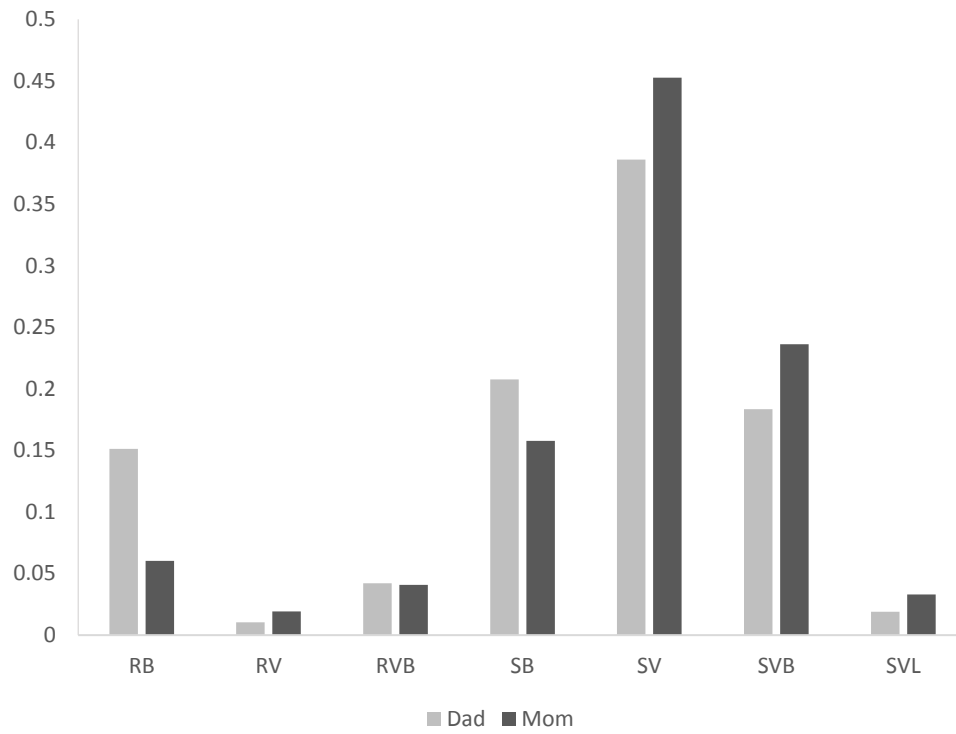


Figure 3) Proportion of different types of responses by mothers versus fathers

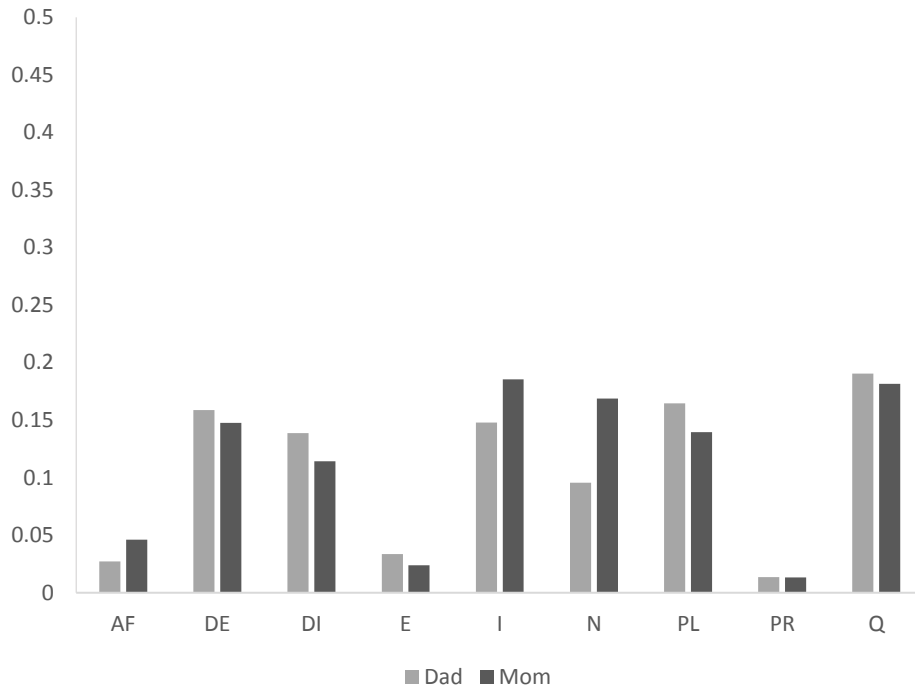


Figure 4) Proportion of overall specific speech acts by mothers and fathers

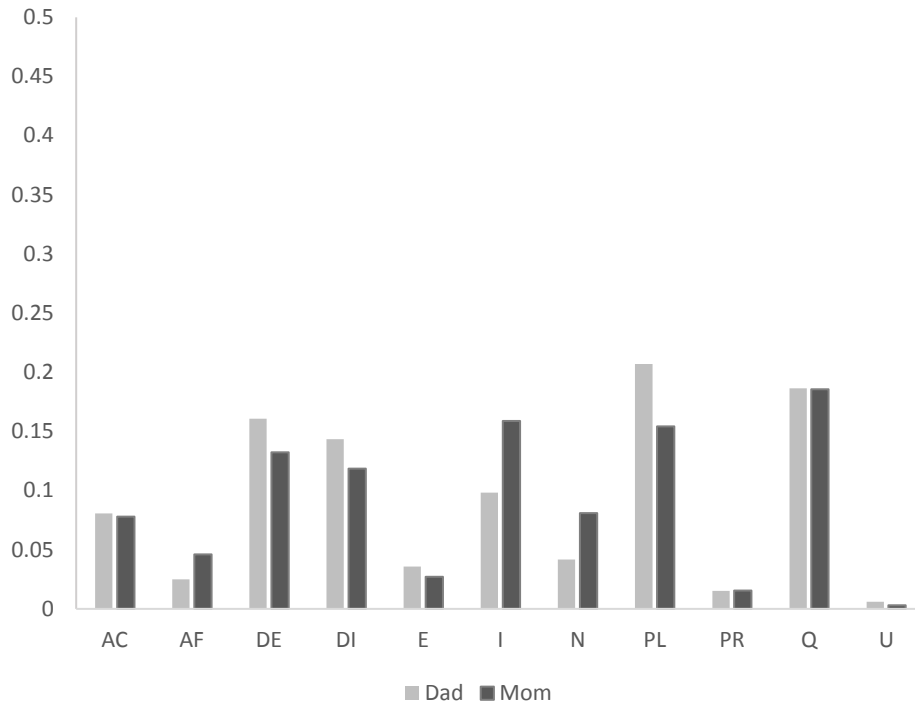


Figure 5) Proportion of Specific speech acts to V by mothers versus fathers

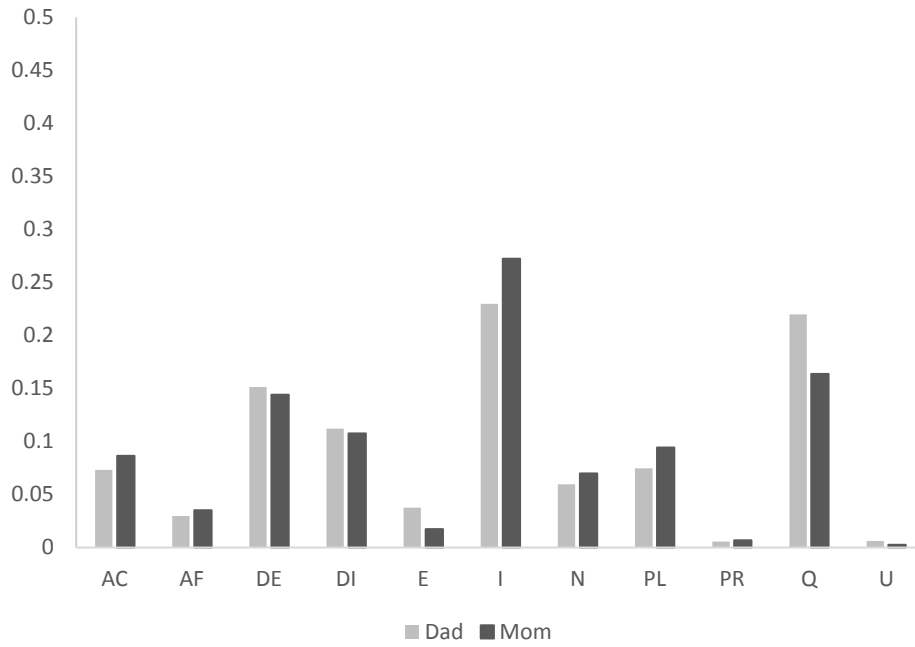


Figure 6) Proportion of Specific speech acts to CV by mothers versus fathers