

Exploring quantitative differences in mothers' and fathers' infant-directed speech to Australian 6-month-olds

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Abstract

Children vary greatly in the rate at which they acquire language in the first years of life (1). A growing body of research indicates that the quantity of parental speech input significantly influences individual differences in child language development (2-7). This study uses the Language Environment Analysis System (LENA) to explore the relationship between the quantity of mothers and fathers speech input and infant language development in a group of Australian infants. Results from 10-14 hour recordings of 11 6-month-old infants reveal that turn-taking quantity is positively related to the quantity of child vocalisations.

Index Terms: infant-directed speech, mothers, fathers, language development, pre-linguistic communication, LENA

1. Introduction

Infants show a remarkable ability to acquire language in their first years of life, often without strict instruction. A growing body of literature indicates that a key factor in this early social environment is the quantity of speech input provided to young children. In fact, speech quantity has long-term influences on their language development and subsequent school readiness (2-7). In the seminal work of Hart and Risley (2), the quantity of parental speech input recorded in hour long recordings was directly related to the child's academic success and intelligence. Furthermore, the quantity of parental speech input was more important than parent education and socioeconomic status in predicting intelligence, vocabulary and language-processing abilities.

Other studies examining the influence of mothers' speech on child language outcomes show that *reciprocal* vocalisations between mother and child positively influence child language (6). Specifically, caregivers who engaged more frequently in reciprocal communication episodes with their children promoted better vocabulary development. More recently, the quantity (amount) and quality (diversity) of parental speech input to 21-month-olds was shown to positively influence child language outcomes at 27 months of age (5).

Many studies examining how factors in the early language environment are related to subsequent language development are conducted with older infants and toddlers to determine how environmental factors influence normed speech and language measures, which generally include vocabulary production. The recent development of the LENA (Language ENvironment Analysis System) makes it easier to examine the speech input and early vocalisations of very young pre-linguistic infants. The LENA is a small recording device that can be worn by an infant or child and record up to 16 hours of audio recordings in the home environment. The recorders are then connected to patented software developed by the LENA Research Foundation to measure the amount of parental

speech and other auditory input in a child's natural environment, in addition to the child's vocal output. A recent longitudinal study examining parental speech input to American infants at birth (before leaving the hospital), 44 weeks postmenstrual age, and 7-months used the LENA to evaluate differences in an infant's language environment according to whether the infant was male or female, as well as whether the caregiver was the mother or father. Johnson and colleagues found that mothers provided more overall language input (average word count) than fathers (7). Furthermore, infants showed preferential vocal responses to their mothers in the first months of life (7). Therefore variation in the quantity of speech input is already evident from birth.

With consensus that the quantity and quality of speech input play a crucial role in shaping infant language outcomes, it is necessary to examine precisely how speech quantity and quality affect early language. Focusing on the pre-linguistic period will provide an opportunity to detect where early differences occur so that children can be given ample opportunity to receive speech input that will promote the best start to life. This study explores whether quantitative differences in the infant's language environment accounts for individual differences in the early vocal behaviours of pre-linguistic Australian infant's. The present study addresses two research questions:

1. Is there a difference in the quantity of maternal and paternal language input to pre-linguistic infants?
2. Are individual differences in early infant vocalisations associated with quantitative aspects of parental input including total number of words the infant hears and frequency of turn-taking episodes?
3. It was hypothesized that mothers would produce more speech input than fathers (7), and the quantity of speech would be positively related to the amount of infant vocalisations (2-7).

2. Method

2.1 Participants

The current sample consists of 12 families (mother, father and infant) that were recruited from the MARCS Institute Baby register at Western Sydney University and currently participating in a longitudinal study examining the influence of qualitative and quantitative factors on individual differences in word learning in the first two years of life. All infants were delivered full-term (38-42 weeks gestation), had an average birth-weight of (3.51 kilograms), and had no major birth or postnatal complications. At the time of testing all infants were 6 months of age, and were reported to be healthy with no history of ear infections or any hearing loss. All mothers

included in the study had a university degree and had an average age of 33 years. On average, all fathers had graduated high school and completed some type of post school qualification and had an average age of 35 years (see Table 1 for further details). All families spoke English at-home and were monolingual. However, it should be noted that one father had a British accent. Families received a \$30 travel reimbursement, a Baby lab degree and an age appropriate gift for the infant in return for their participation in the study.

Table 1. *Demographic information*

| | |
|---------------------|---|
| Infant Age | 6.2 months (range 5.65-6.71 months) |
| Sex | 6 female; 6 male |
| Birth weight | 3.5 kilograms (range 2.9-4.0 kilograms) |
| Parent age | Mothers (28-39 years) Fathers (27-42 years) |
| Infant Nap duration | 2 hours, 20 mins day (range 1.20-4.20 hours) |
| LENA duration | Mothers (10-14 hours) Fathers (10-14 hours) |

2.2 Materials

The LENA digital language processor (DLP) is a large unobtrusive recording device that is worn by the infant in a specialized vest. The vest enables the child to comfortably wear a small digital audio recorder for up to 16 hours in the child's natural speech environment. After a full day of recording, the LENA DLP is plugged into the LENA computer software program that is designed to automatically segment and analyse the audio recordings and provide quantitative reports on specific measures of the child's language environment. See <https://www.lena.org> for further information.

2.3 Procedure

Parents were instructed to record a full day of their infant's natural environment using the LENA DLP on a typical day in which the mother was the primary caregiver, and another day when the father was the primary caregiver, with few noisy day outings (e.g., birthday parties, live sports matches) planned. They were shown how to use the recording device following a laboratory visit and asked to ensure that they began the at home recordings from the time that the infant awoke in the morning until the time that the infant was being placed in bed for the evening. Infants wore a LENA recorder in a specialized vest on one day with their mother, and one day with their father. As the LENA DLPs are not waterproof, the LENA recorder and vest was removed (while still recording) and placed close by, out of the infant's reach during daytime naps and baths. Parents were also given a daily logbook where they noted the infant's routine and daytime naps on the days of the LENA recordings, and could note if any outings took place like going to the grocery store or having a visitor over. All recordings were conducted on

days when the families were home for more than 65% of the recording period.

2.4 Measures

For this study reports on the following measures were extracted from the LENA recording devices with LENA automatic speech recognition software:

1. Parent word count (mother primary caregiver)
2. Parent word count (father primary caregiver)
3. Quantity of conversational turn-taking episodes (mother primary caregiver)
4. Quantity of conversational turn-taking episodes (father primary caregiver)
5. Quantity of child vocalisations (mother primary caregiver)
6. Quantity of child vocalisations (father primary caregiver)

The LENA software automatically classifies conversations and noise (TV/other), obtains *word counts* (nearby male/nearby female/ infant/ distant male/distant female), and calculates the number of *conversational –turns* (child or nearby adult initiates a conversation and the other responds within 5-seconds).

3. Results

Preliminary t-tests of demographic variables indicated that there was no difference in parent age; infant birth weight, parents' education or hours spent napping during the day long recordings, all p 's > .05.

T-tests were conducted to determine whether there were any differences between the quantity of adult speech on the day that the mother was the primary caregiver compared to the father, the number of conversational turns with mothers compared to fathers, and the quantity of infant vocalisations to mothers or fathers. No statistical differences were evident, all p 's > .05 (see Table 2 for descriptive statistics).

Pearson correlation coefficients were produced to examine the relationship between the quantity of parental speech input and infant vocalisations, and the quantity of conversational turn-taking episodes and infant vocalisations. As shown in Table 3, the analysis revealed significant positive correlations with conversational turn-taking with the mother and number of infant vocalisations, and between conversational turn-taking with the father and number of infant vocalisations. That is, as the frequency of conversational turns increased (calculated by the LENA software as a parent's response to infant speech), the infant produced more vocalisations.

The quantity of conversational turn-taking was also positively correlated with the quantity of mothers' speech to her infant. Surprisingly, the overall quantity of speech produced by mothers and fathers was not associated with the number of words infants produced. Although it should be noted that the correlation between the amount of infant vocalisations and mothers word counts was stronger than the correlation between the amount of infant vocalisations and fathers word counts. Figure 1 illustrates the relationship between turn-taking and infant word count during interactions with mothers (top) and fathers (bottom).

Table 2. Descriptive statistics for adult and infant word counts

| | Mean | Min | Max |
|---------------------------------|---------|--------|---------|
| Word Count mother | 14674.9 | 9550.0 | 21250.0 |
| Word Count father | 14414.3 | 9542.0 | 29521.0 |
| Turn-taking mother | 428.3 | 277.0 | 784.0 |
| Turn-taking father | 379.7 | 194.0 | 509.0 |
| Child vocalisations with mother | 1631.3 | 820.0 | 2237.0 |
| Child vocalisations with father | 1598.5 | 678.0 | 2534.0 |

Table 3. Pearson correlation coefficients for maternal, paternal and infant word counts, and parent-child turn-taking episodes derived from 10-14 hour long LENA recordings. ** Correlation is significant at the 0.01 level (2-tailed)

| | 1 | 2 | 3 | 4 | 5 | 6 |
|-----------------------------------|---------|-------|--------|--------|-------|-----|
| 1. Word Count mother | 1.0 | | | | | |
| 2. Word Count father | 0.181 | | | | | |
| 3. Turn-taking mother | 0.805** | 0.064 | | | | |
| 4. Turn-taking father | 0.436 | 0.424 | 0.487 | | | |
| 5. Child vocalisation with mother | 0.532 | 0.189 | .816** | 0.330 | | |
| 6. Child vocalisation with father | 0.239 | 0.197 | 0.316 | .822** | 0.386 | 1.0 |

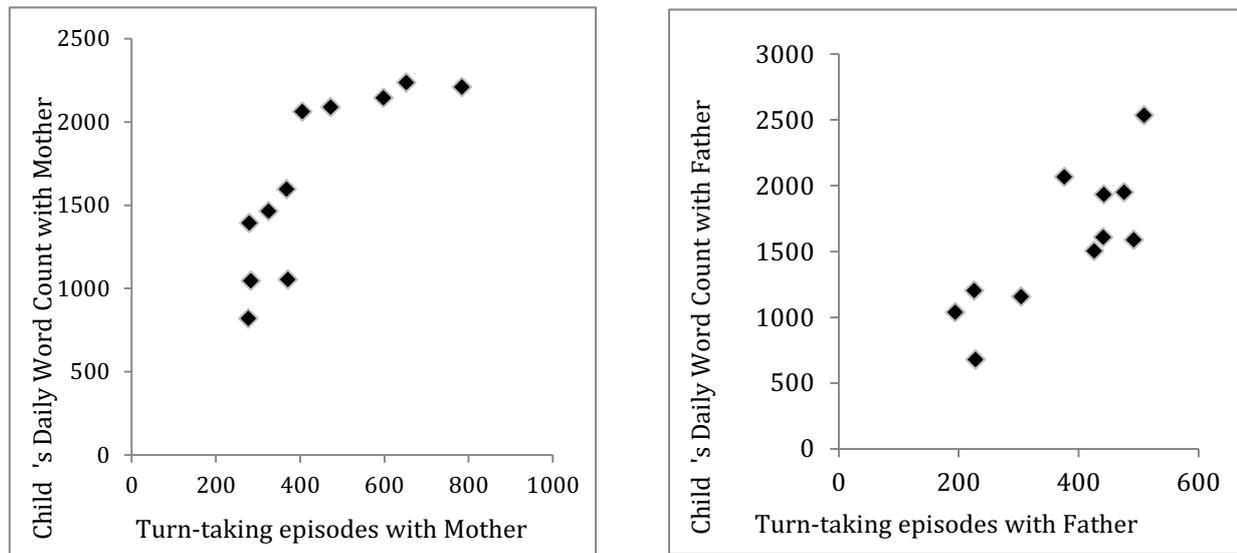


Figure 1: Correlation between quantity of mother (top) and father (bottom) speech input and infant vocalisations during a day-long LENA recording

4. Discussion

This paper aims to clarify the relationship between the quantity of parental speech input and early child speech output. Participants reported here consist of a subset of the

participants enrolled in an ongoing longitudinal study examining qualitative and quantitative factors shapes language development who have visited the laboratory for their first appointment. The hypothesis that mothers would produce a greater quantity of speech than fathers was not supported. The

quantity of speech produced by both parents was not directly related to the number of words produced by infants. Rather, quantity of conversational turn-taking between parents and child was positively related to the number of vocalisations produced by 6-month-old Australian babies. Taken together, these findings indicate that it is not simply the quantity of words spoken by mother or father is related to the number of vocalisations produced by the infant which has been shown in previous studies.

This study confirms previous findings (2-6) that infants speech output is affected by the quantity of parental speech input. Moreover, it extends our understanding by highlighting that it is not just the quantity of words that are provided, rather, it is the quantity of turns taken between parent and child that are positively related to the number of infant vocalisations at 6-months of age. This concurs with other studies that demonstrate that reciprocity between parental speech input and a child's vocalisations promotes child vocalisations and language development (5, 6). Thus it is not simply the number of words that an infant overhears on a day-to-day basis, rather it is the meaningful exchange of conversation between parent and child that promote the use of language in pre-linguistic infants.

Although we cannot determine whether the quantity of infant vocalisations encouraged more turn-taking on the part of the parent, or parent's encouraged a greater number of infant vocalisations by promoting vocal turn-taking, this study indicates that there is a critical link between parent feedback and infant vocalisations in the first 6-months of life (8). Further examination of the time series of vocalisations will help to clarify whether turn-taking episodes were instigated by the parent or infant. The results concur with evidence that the amount of quality speech input is a more potent predictor of infant language than quantity of speech input (9, 10).

This study did not find any differences in the overall quantity of words produced by mothers compared to fathers. Thus, did not support recent findings that mothers talk more than fathers with infants from birth to 7-months (7). Furthermore, infants showed no difference in the quantity of vocalisations they produced when their mother was primary caregiver, or their father was primary caregiver. However, there was a stronger positive correlation between the number of mother's words and infant vocalisations, in comparison to the correlation between father's word count and infant vocalisations. This trend will be clarified once the full sample has been tested.

This study was limited in several important ways. First, the sample was not nationally representative and therefore cannot be generalized to all Australian families. Furthermore, the data is based on a small sub-group sample of participants who had completed their initial visit in an ongoing longitudinal study examining the relationship between quantitative and qualitative measures of parental speech input and infant language development. Additional data is currently being collected to meet an adequate sample size.

Despite these limitations it is clear that it is not simply the quantity of parental speech input that predicts the extent to which infants vocalise in the first 6 months of life. Rather, it is the quantity of conversational turns between infant and parent (mothers and fathers) that promote infant vocalisations. This is an important factor that is being addressed in the longitudinal study. It is anticipated that the longitudinal follow-up of the infant's natural speech environment from the pre-linguistic to linguistic stage of development will identify how speech input

may be enhanced to populations that are at-risk of language delays.

5. Conclusions

In conclusion, the present findings concur with emerging evidence (e.g., 7, 9, 10) that the quantity of reciprocal vocalizations between parent and child are a key factor in promoting language development. In contrast to other studies with pre-linguistic infants, this study did not find any difference in the amount of speech produced by mothers and fathers, or by infant's according to the sex of their interlocutor (7). These findings indicate the importance of encouraging male and female caregivers to engage in turn-taking conversations with young pre-linguistic infants. Further work is currently underway to determine whether these findings are shown in a larger sample of infants currently enrolled in a longitudinal study examining factors that facilitate early word learning.

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7. References

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