Introduction

• Normal-hearing young children experience dramatically different quantities of speech input (Hart & Risley, 1995). Experiencing a higher quantity of input is related to better language outcomes (e.g., Curtin et al., 2013). Experiencing greater diversity in lexical items is tied to better language development (Schwab, Rowe, Cabrera, Lew & Buch, 2013).
• The quality of speech input also matters for normal-hearing children’s language development. An infant-directed (ID) speech style involves more variable and/or higher F0; distinct statistical distributions of formants for vowels (Kuhl et al. 1997; McMurray et al. 2013); slower rate; and structural changes (Christia & Staiti, 2014; Houston & Bergeson, 2014). Variability in ID speech has been tied to variability in language development outcomes (Li et al., 2003; Weisleder & Fernald, 2013).
• Prelingually deaf children with cochlear implants (CIs) must learn language via a highly degraded speech signal. Many factors have been identified as influencing language outcomes in children with CIs (Aubuchon et al., 2015; Hay-McCutcheon et al., 2018). Variation in language input has not yet been examined as a source of variability in children with CIs.

Question: How does variation in the quality and quantity of maternal language input to children with CIs predict variation in their clinical language outcomes?

Methods

• This study was based on 39 mother-child dyads consisting of an NH mother and an early-implanted child with a CI enrolled through Indiana University School of Medicine over a 10-year period.

• Predictor variables: maternal speech measures. Each mother completed lab recordings in an ID condition or an adult-directed (AD) condition consisting of spontaneous speech. Two minutes of each recording per condition were analyzed. Multiple speech quality measures were obtained for each mother’s speech:

1) Difference in areas of the vowel triangles based on first (F1) and second (F2) formant values for /i, u/ (ID – AD)
2) Difference in vowel dispersion in F1, F2 for /i, u/ (ID – AD)
3) Ratio of fundamental frequency (F0) median for ID vs. AD
4) F0 variability (inter-quartile range) in ID vs. AD, normalized by F0 median
5) Rate of ID speech (syllables per second)
6) Lexical diversity (i.e., type-token ratio in ID speech)
7) Lexical diversity (i.e., type-token ratio in ID speech)
8) We also examined quantity of words spoken in two minutes of ID speech.

• Predicted variables: child speech-language clinical outcomes. Each child who received a CI completed one or more of the following speech-language assessments at least twice between 6 months or ~7 years post-implantation:

• PPVT lexical quantity and diversity predicts PPVT
• PLS lexical diversity predicts PLS
• RDL-S-Receptive vowel triangle area predicts PLS
• RDL-S-Receptive lexical diversity predicts PLS
• RDL-S-Expressive vowel triangle area predicts PLS
• RDL-S-Expressive lexical diversity predicts PLS
• Statistical approach. For each child and assessment specified above, a line of best fit over time was calculated, from which we determined (a) predicted outcomes at two years and (b) language growth over two years. Backward elimination of predictors was then used to determine which, if any, significantly predicted (a) and (b) for each assessment.

Results. Infant and adult directed speech showed significantly different ID and AD speech.

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Mean Difference</th>
<th>p</th>
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<tbody>
<tr>
<td>Vowel dispersion (rate)</td>
<td>0.04</td>
<td>.001</td>
</tr>
<tr>
<td>F0 (kHz)</td>
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<td>.05</td>
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<tr>
<td>PPVT</td>
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<td>.01</td>
</tr>
<tr>
<td>PLS</td>
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<td>.05</td>
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<tr>
<td>RDL-S-Expressive</td>
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<td>.05</td>
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Table 1: Differences between ID and AD properties of speech.

(a) Quality and quantity predicted outcomes in children with CIs.

(b) Quality and quantity predicted language growth over 2 years.

Discussion

• These results showed that measures of the quantity and quality of speech taken from spontaneous speech of mothers recorded in the laboratory predicted clinical speech-language outcomes in children with CIs two years after implantation, as well as their clinical change over two years.
• This is the first evidence that the way mothers speak to their CI-implanted infants affects their children’s speech-language development.
• These results support the notion that caregivers’ use of a high-quality, ID speech style with children with CIs, as well as producing a greater quantity and greater lexical diversity in linguistic input, may foster enhanced clinical speech-language outcomes in children with CIs.

References


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