Prosody of children with mild to severe to hearing loss.

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0. Previous studies have found young children's $f_0$:

1. is higher in natural environments compared with elicited speech—maybe because kids are mimicking the lower pitch of examiners (Hunter 2008; Baker et al 2008).

2. may not be well-captured by the mean or average (Hunter 2008).

3. shows complex development during preschool years (Snow 2006, 2002; D'Odorico & Franco 1991; Loeb & Allen 1993; Amano et al 2006).

4. may be used more often for falling contours, compared with rising or level contours (Kent & Murray 1982; Robb, Saxman, & Grant 1989; Loeb & Allen 1993; Snow 1998, 2002, 2006).
0. Previous studies, f0 in children with hearing loss: M. VanDam

1. Hearing loss may influence f0 in infants (Nathani-Iyer & Oller 2008) and older children (Ryalls & LaRouche 1992; McCleary, et al 2007), increasing overall f0 and variability.

2. But there are issues:
   A. Age-of-ID and intervention has been dramatically reduced in the last 30 yrs (Harrison, Roush, & Wallace 2003; Moeller, et al 2007).

   Earlier work reflects a different population (eg, Hudgins & Numbers 1942; Angelocci 1962; Nickerson 1975; Monsen 1978; Kent et al 1987).

   B. Studies use different methods.

   C. Studies have contradictory results/implications.

3. What is the f0 distribution in young children with HL in natural environments?
1. Research questions:

1. In natural speech, what is the distribution of \( f0 \) in children with HL?

2. Do young children with HL use a variety of \( f0 \) contours? If so, which ones are used more often than others?

3. Can new technology/methodology be used more widely (or cleverly) to ask new questions, or to give new answers to old questions?
2. Method, data collection

LENA (Language ENvironment Analysis)
16 hr passive recording; wearable

Output:  (1) wave file (16-bit, 16k, PCM)
(2) time-aligned talker-ID code

eg., SILENCE, KEY-CHILD, ADULT-OTHER-CHILD, FEMALE-&-OTHER-CHILD, etc.
2. Method, participants

All children in this study have mild to severe hearing loss

<table>
<thead>
<tr>
<th>child</th>
<th>age (mos)</th>
<th>sex</th>
<th>HL PTA (db)</th>
<th>age ID HL</th>
<th>record time</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD37</td>
<td>12</td>
<td>♂️</td>
<td>(cnt)</td>
<td>0</td>
<td>10h 46m</td>
</tr>
<tr>
<td>WH09</td>
<td>16</td>
<td>♂️</td>
<td>68</td>
<td>0</td>
<td>11h 59m</td>
</tr>
<tr>
<td>JA39</td>
<td>24</td>
<td>♂️</td>
<td>(abr)</td>
<td>&lt;20</td>
<td>13h 43m</td>
</tr>
<tr>
<td>HE47</td>
<td>26</td>
<td>♂️</td>
<td>50</td>
<td>0</td>
<td>8h 58m</td>
</tr>
<tr>
<td>SC42</td>
<td>33</td>
<td>♂️</td>
<td>35</td>
<td>18</td>
<td>12h 36m</td>
</tr>
<tr>
<td>SB51</td>
<td>37</td>
<td>♂️</td>
<td>47</td>
<td>0</td>
<td>12h 07m</td>
</tr>
</tbody>
</table>
3. Results: Distribution of $f0$ in child utterances

- **CD37, 12mo**: $\bar{f} = 340$ Hz, $\hat{f} = 328$ Hz, $\sigma = 79$ Hz
- **WH09, 17mo**: $\bar{f} = 367$ Hz, $\hat{f} = 359$ Hz, $\sigma = 75$ Hz
- **JA39, 24mo**: $\bar{f} = 377$ Hz, $\hat{f} = 373$ Hz, $\sigma = 73$ Hz
- **HE47, 26mo**: $\bar{f} = 386$ Hz, $\hat{f} = 382$ Hz, $\sigma = 73$ Hz
- **SC42, 33mo**: $\bar{f} = 353$ Hz, $\hat{f} = 348$ Hz, $\sigma = 79$ Hz
- **SB51, 37mo**: $\bar{f} = 355$ Hz, $\hat{f} = 346$ Hz, $\sigma = 71$ Hz
3. Results: Distribution of $f0$ contour types in child utterances
4. Conclusions

1. New methods of whole-day recording are possible and may reveal unexpected patterns in speech production of children.

2. F0 in children with HL is (a) highly variable and (b) not normally distributed, right skewed.

3. Children with HL make heavy use of complex f0 contours—possibly producing more complex-falling contours than other types.

4. Results for phonology:
   - child directed speech
   - prosodic identification
   - lexical use & linguistic memory
   - acquisition in special populations

5. Future work:
   - duration of utterances
   - range & variance of f0
   - developmental changes
   - environmental acoustic effects
   - populations with HL
   - longitudinal observations
   - turn-taking
   - methodological improvements