Child-directed speech to preschoolers who are hard-of-hearing

Mark VanDam, Paul DePalma, William E. Strong, Enna Kelly

Washington State University

mark.vandam@wsu.edu

Linguistic Society of America

Portland, OR | 10 January, 2015

WASHINGTON STATE UNIVERSITY
HEALTH SCIENCES SPOKANE

Research Questions

1. Does child-directed speech (CDS) differ between parents of children who are hard-of-hearing (HH) and parents of children who are typically developing (TD)?

2. Overall, does speech differ between:

a. fathers of HH children vs. TD children?

b. mothers of HH children vs. TD children?

Background

Studies of child-directed speech have shown that when talking to children, parents systematically use altered linguistic forms: simplified syntax, elided morpho-phonological forms, and exaggerated duration and prosody. Notable among these is increased fundamental frequency (f_0; Ferguson, 1964; Fernald, 1989, 1991; Kuhl, et al, 1997). Similarly, the Lombard effect (Lombard, 1911; Fairbanks, 1954; Lane & Tranel, 1971) occurs when talkers alter speech production characteristics based on perceived deficiencies of the listener. Notably, increased f_0 has been documented when a talker addresses a person with a hearing loss (Summers, et al, 1988; Patel & Schell, 2008). Thus, f_0 increases have been documented when talking to children *and* when talking to a listener with a hearing loss. One study shows that mothers of young children with cochlear implants modify f_0 according to the hearing experience of the children (Bergeson, Miller, & McCune, 2006). No studies to date have looked at parental speech to children with mild-to-severe hearing loss. There is also a dearth of research on father's CDS to children with hearing loss.

Method

Participants

TD Families
11 families with a typically developing preschooler.
HH Families
22 families with a preschooler with mild-severe hearing loss.

Sample included boys and girls (mean age of ~30 months) who wore hearing aids and had no other disabilities. All children were involved in a larger longitudinal study.

Materials

▪ Data was collected using the LENA system (Language ENvironment Analysis; LENA foundation, Boulder, CO):

1. Digital Language Processor (DLP)

A small acoustic recording device which records up to 16 hours of raw audio on a solid state drive.

2. Automatic Speech Recognition (ASR) software

▪ Custom software for analysis of f_0 developed in MATLAB.

Procedure & Data Analysis

Each family contributed whole-day audio recordings during a typical family day. The DLP was placed in a chest pocket at a fixed position from the child's mouth (7-10cm). 491.2 recorded hours were collected and processed by ASR software. Recordings were automatically segmented at centisecond resolution, and statistical likelihood techniques of the ASR assigned one of about 60 a priori labels to each segment. Labels include *adult male, adult female, key child vocalization, other child vocalization, overlapping vocals, noise, silence,* and *TV/electronic media*. f_0 was collected from segments labeled as parent vocalizations. *t*-tests were used to evaluate difference between groups.

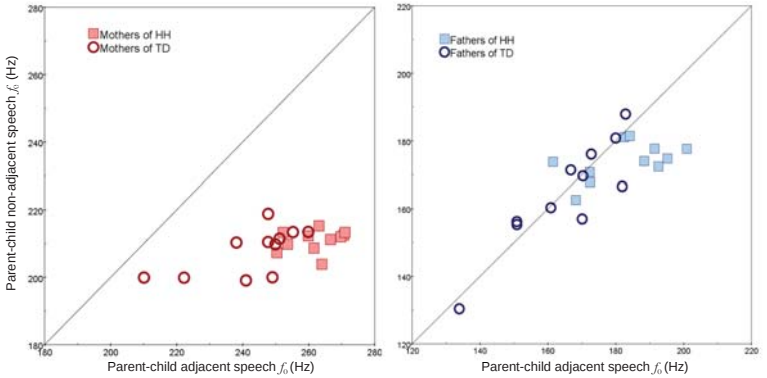

Figure 1. In the two panels above, Parent-child non-adjacent speech is plotted on the ordinate and Parent-child adjacent speech is plotted on the abscissa. Mothers are plotted in the left panel in red markers and fathers in the right panel in blue markers. An observation on the bisector indicates equal f_0 in both conditions, and an observation below or above the line indicates equal f_0 increases in the Parent-child adjacent or the Parent-child non-adjacent condition, respectively.

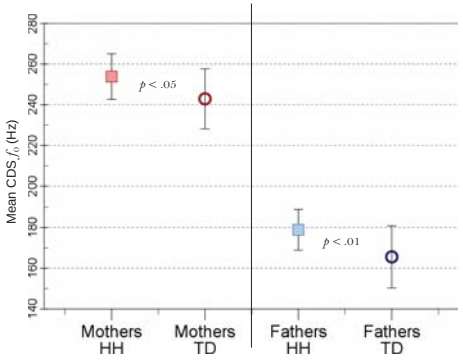

Figure 2. The figure displays mean difference in CDS speech f_0 between mothers of hard-of-hearing children with mothers of typically-developing children (left) and fathers of hard-of-hearing children with fathers of typically-developing children (right).

Results

1. **Parents have increased f_0 during CDS**
   M_{CDS} = 212Hz, SD = 12Hz; M_{nonCDS} = 192Hz, SD = 8Hz; $t(31) = 3.59$, $p < .01$

However,

- **The effect of increased f_0 for CDS holds for mothers but not for fathers**
  MOTHERS: M_{CDS} = 250Hz, SD = 13Hz; M_{nonCDS} = 211Hz, SD = 5Hz; t = 18.6, $p < .01$;
  FATHERS: M_{CDS} = 174Hz, SD = 13Hz; M_{nonCDS}= 173Hz, SD = 11Hz; t = .55, $p > .05$

Comparison from nonCDS to CDS:

	Mother	Father
TD Child	Increase f_0 (M_{CDS} = 242; M_{nonCDS} = 207; $p < .01$)	No change (M_{CDS} = 166; M_{nonCDS} = 164; $p > .05$)
HH Child	Increase f_0 (M_{CDS} = 253; M_{nonCDS} = 212; $p < .01$)	No change (M_{CDS} = 179; M_{nonCDS} = 178; $p > .05$)

2. HH parents have a higher f_0 overall, regardless of CDS/non-CDS.

	CDS Speech	Non-CDS Speech
Mother of TD	M = 242; SD = 14	M = 207; SD = 7
Mother of HH	M = 253; SD = 11	M = 212; SD = 4
	$t(32) = 2.38$, $p < .05$	

	CDS Speech	Non-CDS Speech
Father of TD	M = 166; SD = 15	M = 164; SD = 15
Father of HH	M = 179; SD = 10	M = 178; SD = 6
	$t(32) = 3.01$, $p < .01$	

Conclusions

1. **Overall, mothers increase f_0 while fathers show no changes during CDS. Mothers of HH and TD children both show increases in f_0 during CDS; fathers of both HH and TD children fail to show an effect of CDS.**
2. **When looking at parental speech as a whole, (a) fathers of HH children have a higher overall f_0 than TD fathers and (b) mothers of HH children have a higher overall f_0 than TD mothers.**

Future directions

- Do other factors influence how mothers or fathers talk to their children (degree of hearing loss, age or sex of child, etc.)?
- What are the developmental consequences of asymmetry in parental CDS?
- These results and further research could inform how automatic speech recognition can be used in theoretical and applied language research.

References

Bergeson, T., Miller, R., & McCune, K. (2006). Mother's speech to hearing impaired infants and children with cochlear implants. *Infancy, 10(3)*, 221-240.

Fairbanks, G. (1954). Systematic research in experimental phonetics: 1. A theory of the speech mechanism as a servosystem. *Journal of Speech & Hearing Disorders, 19*, 133-139.

Ferguson, C. A. (1964). Baby talk in six languages. *American Anthropologist, 66(6_PART2)*, 103-114.

Fernald, A., Taeschner, T., Dunn, J., Papousek, M., de Boysson-Bardies, B., & Fukui, I. (1989). A cross-language study of prosodic modifications in mothers' and fathers' speech to preverbal infants. *Journal of child language, 16(03)*, 477-501.

Fernald, A., & Mazzie, C. (1991). Prosody and focus in speech to infants and adults. *Developmental psychology, 27(2)*, 209.

Kuhl, P. K., Andruski, J. E., Chistovich, I. A., Chistovich, L. A., Kozhevnikova, E. V., Ryskina, V. L., ... & Lacerda, F. (1997). Cross-language analysis of phonetic units in language addressed to infants. *Science, 277(5326)*: 684-686.

Lane, H., & Tranel, B. (1971). The Lombard sign and the role of hearing in speech. *Journal of Speech, Language, and Hearing Research, 14(4)*, 677-709.

Lombard, E. (1911). Le signe de l'élévation de la voix. *Maladies Oreille, Larynx, Nez. Pharynx, 37*, 101–119.

Patel, R., & Schell, K. W. (2008). The influence of linguistic content on the Lombard effect. *Journal of Speech, Language, and Hearing Research, 51(1)*, 209-220.

Summers, W. V., Pisoni, D. B., Bernacki, R. H., Pedlow, R. I., & Stokes, M. A. (1988). Effects of noise on speech production: Acoustic and perceptual analyses. *The Journal of the Acoustical Society of America, 84(3)*, 917-928.

VanDam, M. & Silbert, N. H. (2013). Precision and error of automatic speech recognition. *Proceedings of Meetings on Acoustics, 19*. 060006.