Early identification of hearing loss improves temporal properties of children's speech

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Child Phonology Conference 2008
Purdue University, West Lafayette, IN
June 3, 2008

Main Point

It is unknown if the development of temporal speech properties are different for children if they are identified earlier in life as hearing impaired. This longitudinal work contributes evidence that earlier identified children performed more like normal hearing children on specific temporal speech production measures. This result is evidence in favor of newborn hearing screening.

Background

Incidence of hearing loss. Hearing loss affects about 3 per 1000 live births in the U.S. Dramatic advances in newborn hearing screening in the last 20 years have reduced the age of identification from an estimated 30 months to less than 4 months. Currently, a non-invasive, cost effective (<$50/infant) hearing screening test is normally conducted in the first few days of life. About 95% of babies in the U.S. are initially screened. For babies with hearing loss, the goal is to enroll in intervention by 6 months (Connolly et al 2005).

Benefits of early ID. Early identification and intervention have been reported to improve children's emotional development, psychosocial behavior, cognitive abilities, educational achievement, and language abilities (Apuzzo & Yoshinago-Itano 1995; Donahue 2007; Moeller 2007; Durieux-Smith et al 2008).

Public Policy. Although there is no de jure federal US policy regarding newborn hearing screening, 42 U.S. states have legislation addressing the issue, most mandating routine screening. The (federal) Newborn Infant Hearing Screening and Intervention Act of 1999 directly provides funds for establishing increased screening, and it has resulted in steady increases in screening rates.

Despite reported benefits of early screening, a high rate of de facto screening, and a literature addressing the issue (Yoshinago-Itano 1998), early identification of hearing loss has not received full support (cf, Bess & Paradise 1994). Directly weighing in on the issue, the current stated position of the U.S. Department of Health and Human Services is that "the evidence is insufficient to recommend for or against routine screening of newborns for hearing loss" (USDHHS 2001).

Present Work

The present work shows children with hearing loss identified earlier perform differently from children identified later on speech timing measures. This evidence suggests early identification is important for understanding the development of language and speech and will likely inform improvements in intervention techniques and technology.

Research Question

Are temporal properties of hearing impaired children's speech more like normal hearing children's speech if hearing impairment is identified earlier rather than later?

Methods

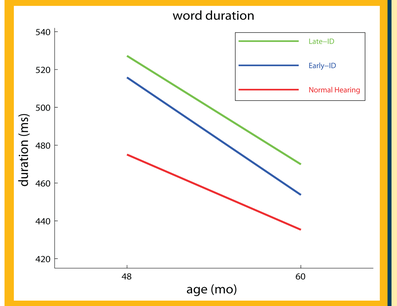
Subjects.
Children with normal hearing (NH, n=13), early-identified hearing loss (EHL, n=6), and late-identified hearing loss (LHL, n=4) participated at 48- and 60-months of age.

	Normal Hearing	Early-ID		Late-ID	
number children	13	6		4	
age ID (mean months)	(n/a)	2.5		30.3	
age aided (mean months)	(n/a)	4.7 *		31.5	
PTA (mean dB HL, left | right)	(n/a)	91.3	83.8	34.8	43.5

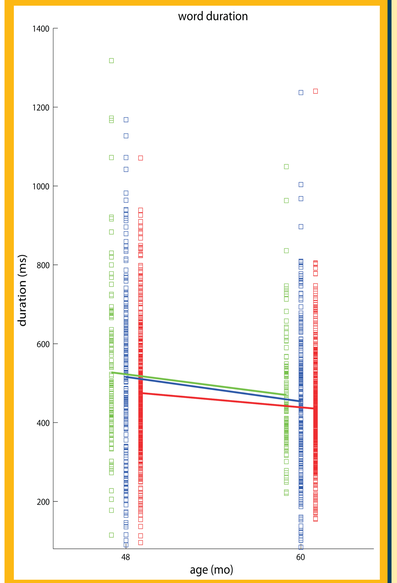
* EHL includes 4 subjects who eventually received cochlear implants. Mean age of implant for this subgroup is 20.25 months, although all had amplification before implant.

Results

Word

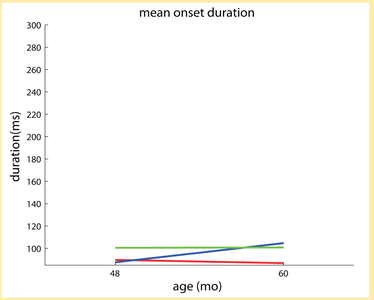


Mean word duration is different for all groups.

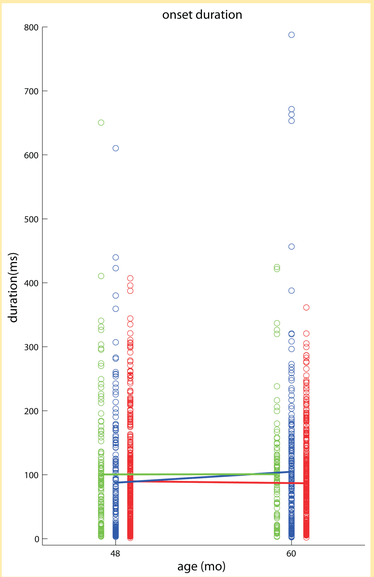


Word duration as a function of Hearing status and Age.

Onset

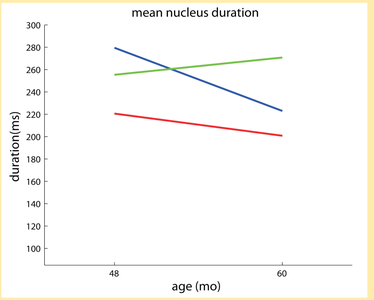


Mean onset duration is not different between groups.

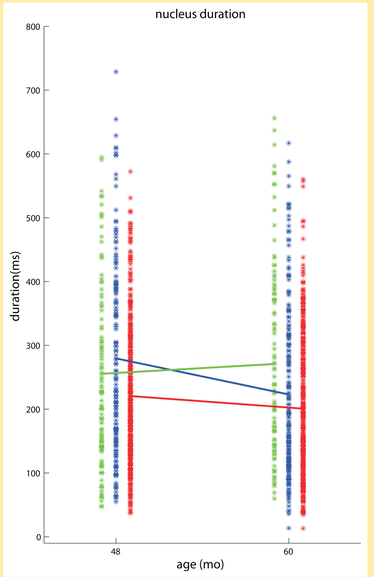


Onset duration as a function of Hearing status and Age.

Nucleus

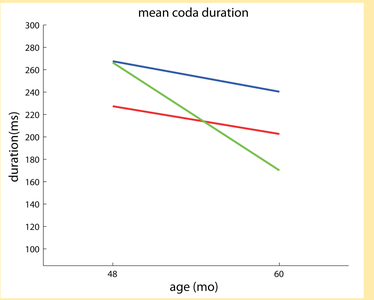


Mean nucleus duration for Normal Hearing and Early ID is similar.

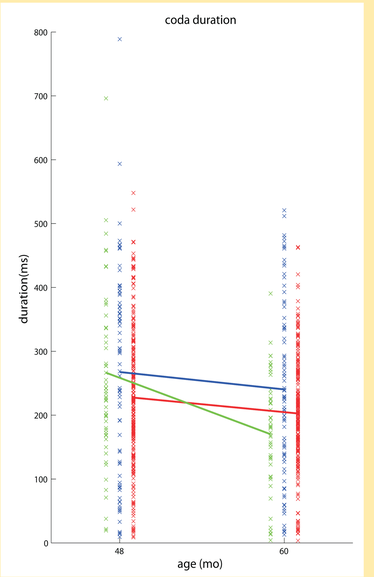


Nucleus duration as a function of Hearing status and Age.

Coda



Mean coda duration for Normal Hearing and Early ID is similar.



Coda duration as a function of Hearing status and Age.

TARGET WORDS

bat	*house*	*sick*
bay	*hoop*	*six*
beat	*key*	*spot*
buy	*kid*	*stick*
bye	*kids*	*tap*
cap	*pat*	*tea*
do	*pie*	*tie*
hat	*pot*	*tight*
hop	*see*	*zoo*

CSIT (Kent *et al* 1994)

Task. An experimenter and child played a single-word, listen-and-repeat game based on the experimenter's model word production to the child. Before the game, the experimenter explained that she would say a word then the child would repeat that word. As reward for participation in the game, plastic chips were offered to a purportedly hungry hand puppet. All children performed the task as expected.

Design & Analysis. Segment and word boundaries were marked for all children's productions using spectrogram, waveform, and audio playback generated in PRAAT. Up to three independent repetitions of a word were marked. Durations of about 3600 phones in about 1400 words were collected.

- Word duration factors:
  - word duration (ms)
  - identification of hearing loss (early, late, normal)
  - age (48-mo, 60-mo)
- Segment duration factors:
  - segment duration (ms)
  - identification of hearing loss (early, late, normal)
  - age (48-mo, 60-mo)
  - syllable position (onset, nucleus, coda)

Results & Conclusions

1. Children who are earlier identified as hearing impaired have word durations more like normal hearing children and less like later identified peers.

2. Onset duration does not change as a function of Age or Hearing status, while nucleus and coda durations do.

3. Early identified children in this work have more severe hearing impairment than later identified children. Although, increased auditory access (as in the later identified group) is positively correlated with more normal-like performance (Stelmachowicz et al 2004), earlier identification appears to be a better predictor of more normal-like temporal-linguistic outcomes.

   That is, later identified children had more hearing (ie, less loss) than their early identified peers. Despite this apparent bias, the later identified group performed more poorly.

References

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