Using LENA to Examine Development of Children with Hearing Loss

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Outcomes of Children with Hearing Loss

Overview

Outcomes of Children with Hearing Loss (OCHL) is a large, multi-center, NIH-funded longitudinal study looking at developmental, behavioral, and familial outcomes in children with mild to moderate hearing loss.

Background, children with hearing loss

Every day, 33 babies (12,000 each year, or about 3/1000) are born in the United States with permanent hearing loss.
Incidence increases by school age to 6/1000 due to late identification, late onset, or progressive hearing losses.
930,000 children with mild to severe HL 6-19 years of age in US.
Children with a unilateral hearing loss are **ten times** as likely to be held back at least one grade.
Children with minimal losses:
   37% fail one grade
   8% don't have skills at grade level
   12-41% receive educational assistance
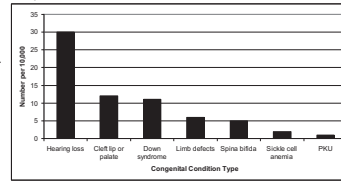
Phonemic and syllabic speech patterns are delayed even for children with mild to moderate HL.
Children are at risk for delayed: vocabulary, word learning, advanced syntax, morphology, social use of language, academics, socialization.
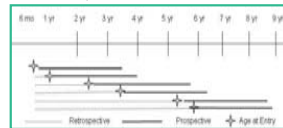
New practices in the HL population:
   1. Universal Newborn Hearing Screening (UNHS)
   2. Birth to three Early Childhood Education programs
   3. Technological advances in amplification (frequency compression HA, FM systems, increased bandwidth, directional mics, noise reduction)

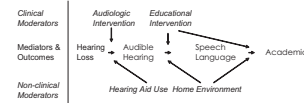### OCHL, study goals

Aim 1. Background characteristics
   Hearing and health: unaided audiology, aided SII, etiology , speech perception, birth history, general health, middle ear problems
   Family characteristics: siblings, SES, education, occupation, income, neighborhood/community
   Social intervention services (and variation in services):
      → History: newborn hearing screening status, age of initial hearing loss diagnosis,
         age and nature of initial hearing intervention, educational service receipt
      → At study entry (baseline): hearing aid and fit, hearing aid function
      → After Study Entry: hearing aid fit and function, hearing aid use, educational service receipt
Aim 2. Developmental, behavioral, & familial outcomes
   speech production, articulation, intelligibility
   language use (productive & receptive): syntax, narrative, vocabulary, morphology
   social reasoning (Theory of Mind)
   academic: spelling, word recognition, math skills, verbal reasoning
   psychosocial behavioral/cognitive: cognitive reasoning, social behavior, teacher reports
   family outcomes: parenting, quality of life & family life, satisfaction of service delivery
Aim 3. How variation in intervention and family background influence outcomes

OCHL, study details and characteristics

Mild to severe HL: PTA 25-75 dB HL @ 500, 1k, 2k, 4k Hz
Type of HL: high frequency, sensorineural, permanent conductive, mixed
Disabilities: no major secondary disabilities (eg., Downs Syndrome)
Age: enrolled at 6 months to 6 years, followed annually for 3+ years
Children: 400 mild to severe HL, 150 normal hearing
Sites: Boys Town National Research Hospital (Omaha, NE), University of Iowa (Iowa City, IA), University of North Carolina
      (Chapel Hill, NC)
Data: comprehensive, centralized, electronic data collection
Organization: protocol manuals, oversight by audiologist, SLP, National Advisory Board, Mary Pat Moeller & Bruce Tomblin (co-PI)

OCHL, LENA supplement

About 50 kids, entering study between 12 and 36 months of age, recording one day monthly for one year with LENA, about 600 recorded days.
The goal is to explore linguistic-phonetics of vocalizations using and building on LENA technology.

Preliminary data

Design.
   -6 kids with mild to severe HL (many more to come)
   -age: 12, 16, 24, 26, 33, 37 mos.
   -independent variables include: demographics, SES, PPVT, GFTA, etc.
   -dependent variables are acoustic from the WAV: $f0$ in CHN segments
      → will include LENA-generated output (eg, CHN-FAN contingency)
   -computational analyses:
   (lots of custom software)

Questions:
   (1) What is the overall distribution of pitch for a day?
   (2) What is the best way to capture pitch distributions?
   (3) What kinds of pitch contours are used most often?

Objective data collection for linguistic questions

1. **What are the basic acoustic-phonetic characteristics (amplitude, *f0*, duration) of whole day recordings for:**
      -children with hearing loss?
      -children one to four years of age?

2. **How is child-directed speech produced in terms of:**
      -frequency of turns/exchanges?
      -fathers' speech to children?
      -time, activity, environment, noise, etc.?

3. **How do fine phonetic details vary in a large samples of vocalizations (using automatic methods) by:**
      -time of day?
      -activity?
      -environment?

4. **Can new technological methods be practically evaluated or improved, such as:**
      -pitch determination algorithms (PDAs)?
      -voicing activity detectors (VADs)?
      -within-subject normalization?
      -during acoustically variable periods?
      -modeling?

5. **What are the long-term outcomes on speech by:**
      -developmental factors?
      -behavioral factors?
      -familial/social factors?

6. **How do audibility and amplification influence speech production and vocalization?**