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Perception of spectrally degraded reflexives and pronouns by children

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Cochlear implantation and language development

- Early detection of language problems due to hearing impairment is important
- Clinical practice
  - Questionnaires: e.g. Reynell's Developmental Language Scales (Reynell & Gruber, 1990)
  - Behavioral tests: speech perception tests with pre-recorded syllables, words or sentences (e.g. Nilsson et al., 1996)

→New behavioral test to measure language comprehension in children with CI

Comprehension of reflexives and pronouns

- Pronouns emerge around age 2/3; reflexives are much more infrequent than pronouns
- Delay of Principle B Effect (DPBE) in comprehension;

  Example: "The penguin is hitting himself/him with a pan."
  - Children's comprehension of *reflexives* is adult-like at age 5 (Chien & Wexler, 1990; Van Rij et al., 2010)
  - Children's comprehension of *pronouns* is adult-like at age 10 (Koster, 1993; Philip & Coopmans, 1996)

→ Test based on DPBE may be more sensitive to atypical or delayed language development than standard clinical tests

Acoustic simulation of CIs

- Amplitudes of selected channels preserved in CIs (Shannon et al., 1995)
  - 4- to 8-channel degradation of speech
    - Speech perception of normal-hearing adults matches pediatric and adult CI users (Dorman et al., 2000; Friesen et al., 2001)

Normal 8-channel 4-channel

- Children's perception of spectrally degraded speech materials
  - Different cues in spectral degradation cause lower performance in children (Nittrouer et al., 2009)
  - Younger children < older children = adults (Eisenberg et al., 2000)

Goals

1. New behavioral test to measure language comprehension in children, focusing on reflexives and pronouns

2. What is the effect of spectral degradation of CI speech transmission using a simulation with normal-hearing children?

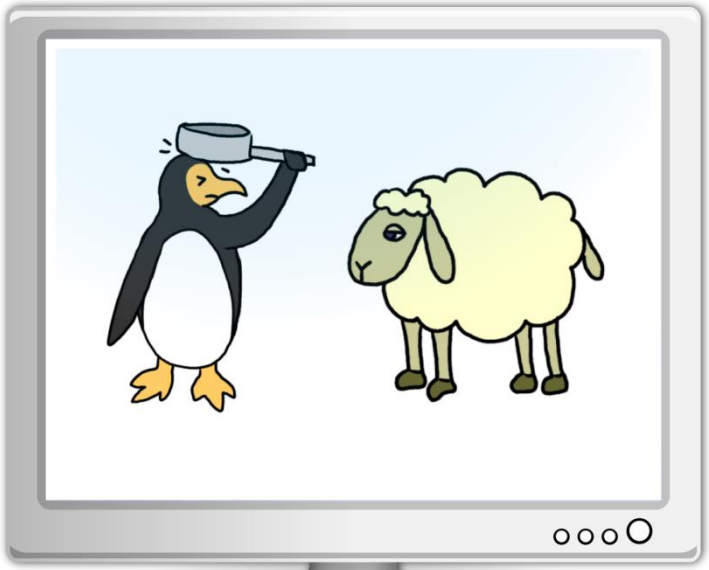
3. Comprehensive baseline data on reflexive and pronoun perception for CI children

Method

- Participants
  - Three age groups:
    - 56 younger children (range 5;0-8;1)
    - 15 older children (range 10;1-11;6)
    - 22 adults (range 19-26)
  - Native monolingual speakers of Dutch
  - No known speech, language or development problems
  - No hearing problems in either ear
    - Tested with audiometer and sound-insulating headset

Method (2)

- Task
  - Picture Verification Task (Van Rij, van Rijn & Hendriks, 2010):
  - Reflexives/Pronouns
  - Normal speech + degraded speech (4- or 8-channel)
  - “Is the sentence you heard a correct description of the picture you see on the screen: yes or no?”



The penguin is hitting **himself** / **him** with a pan

Method (3)

- Stimuli
  - 32 sentence-picture pairs: normal + degraded speech block
    - 8 pronouns, 8 reflexives: half match, half mismatch
  - 2 warm-up items (degraded speech), 2 practice items and 4 control items per block

- Procedure
  - Laptop, headphones and hand puppet in a quiet room
  - Two semi-randomly groups balanced on age, gender and block

Results

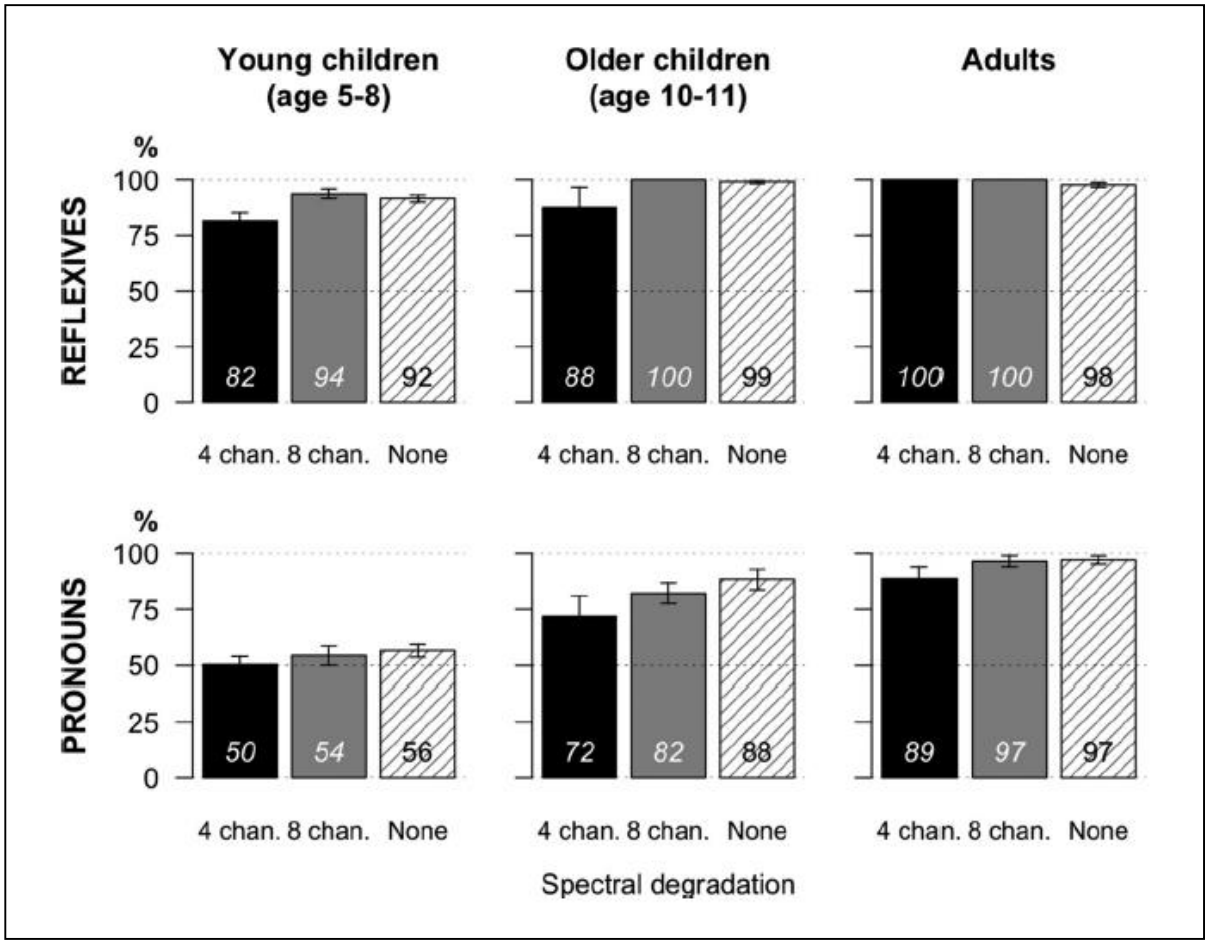


FIG. 2. Average mean percentage correct responses shown for all age groups for the comprehension of reflexives and pronouns, as a function of spectral degradation. The error bars denote one standard error of the mean.

Results (2)

- Two way interaction between *Age Group* and *Type* (reflexive/pronoun) ($p < 0.001$)
  - Reflexive items: younger children = older children = adults
  - Pronoun items: younger children < older children = adults

- Main effect for *Spectral Degradation* ($p < 0.001$)
  - 4-channel < 8-channel = normal speech in younger and older children

Discussion

1. Confirms DPBE literature that children reach adult-like comprehension of *reflexives* around age 5, of *pronouns* around age 10

2. Decrease in performance of younger and older children in 4-channel degradation condition, not in 8-channel degradation condition

Discussion (2)

- Nittrouer et al. (2009) found similar results:
  - Slight shift in performance of young and older children due to spectral degradation
    - However, no drastic change in overall linguistic milestone patterns

- Eisenberg et al. (2000) found different results:
  - Degraded conditions (4- and 8-channel):
    - Eisenberg et al. (2000): younger children < older children = adults
    - Our study: younger children have not yet acquired pronouns, but have acquired reflexives

  → Possibly due to speech materials used

Clinical implications

Test can characterize **slower language development** and ideally **minimal effects of impoverished signal delivery**:

- Delay in CI children, if:
  - Non-adult-like performance on *reflexives* above age 5; *pronouns* above age 10
- Spectral degradation slightly affects the results
- Comprehensive baseline data
- Behavioral method to look at potential delays

→ The comprehension of reflexives and pronouns can provide additional information on linguistic milestones for CI children

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Results – d' scores

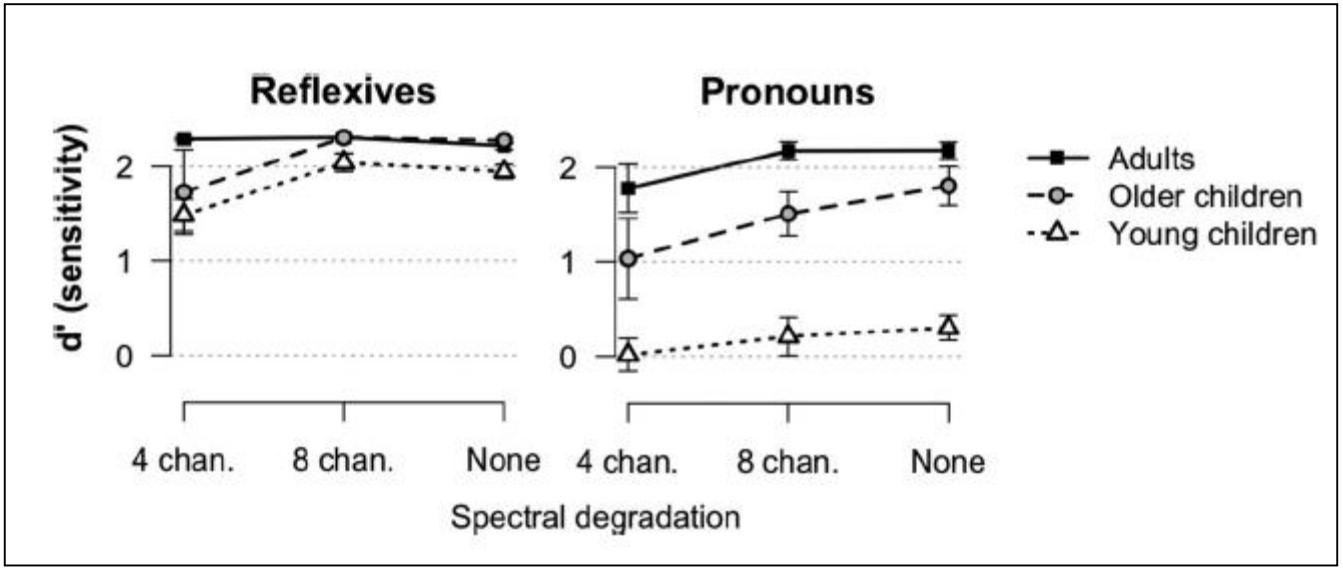

FIG. 3. Average d' scores shown for all age groups for the comprehension of reflexives and pronouns, as a function of spectral degradation. The error bars denote one standard error of the mean.