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Listening difficulties in children with language impairment

CCHMC research seminar 12/05/2016

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Sweden, northern Europe

Uppsala, the cradle of Sweden

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Uppsala (1286), Uppsala University (1477)

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Outline - specific

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Neural coding of consonants in noise

What is listening difficulties?

Overlap

Children with language impairment

Current postdoc project

Wishlist☺

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Barnen i Bullerbyn

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Main message

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- Neural processing of consonants in noise is fundamental for language and reading development
- Tests used in the clinic need to capture
  1. The nature of perceptually challenging speech sounds
  2. Characteristics of everyday listening situations
  – Realistic
  – Quick
  – Methodologically precise

White-Schwoch et al., 2015,

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What is listening difficulties?

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- According to ASHA (2005)

  "Difficulties in the processing of auditory information in the central nervous system"

- The diagnosis is given
  - when functional listening difficulties are observed in the presence of normal peripheral hearing and the child demonstrates deficits in one or more auditory skill areas that include discrimination, pattern recognition, temporal integration and ordering, dichotic listening, and the perception of degraded stimuli

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What is listening difficulties?

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- The established term (C)APD
  = Central Auditory Processing Disorder

- Current diagnosis has several limitations
  - Diagnostic Test batteries differ among clinics
  - Protocols specifying type and number of failed tests for a diagnosis differ
  - Normative data for children are lacking
  - Listening in noise problems are not always supported*

Ludwig et al., 2014
Ferguson et al., 2011*
Ptok, Miller & Kuhn, 2016

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What is listening difficulties?

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- Depending on the criteria used, the rates of the diagnosis of (C)APD may range from 7.3 % to 96.0%.
- So, an APD diagnosis hardly says anything about the actual deficits a child is suffering from, unless a reference is made about the criteria being used.
- It is recommended not using APD as a global label for any kind of listening problems.

Wilson & Arnott, 2013

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Overlap

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- Close relationship between APD and other developmental disorders

  – Language Impairment (Dawes and Bishop 2009; Sharma et al. 2009; Ferguson et al. 2011)

  – Dyslexia (King et al. 2003; Dawes and Bishop 2009; Dawes et al. 2009)

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Alternative explanation

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- Auditory processing difficulties are perceptual rather than sensory, i.e. they involve decreased organisation, identification and interpretation of sensory information
- However, auditory sensory information is important
  - High frequency hearing loss associated with reduced spatial hearing
    - This may co occur in children with neurodevelopmental challenges

Cameron & Dillon, 2008
Moore et al., ongoing project

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Language impairment

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(Specific) language impairment

Språkstörning

Sprachstörung

Trouble d'acquisition de language

Језичко оштетување

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Language impairment

Alfhild Tamm, 1912:

- "Hearing muteness" (hörstumhet)
  - Undeveloped sense for word timbre = "word muteness"

- Separated hearing muteness (hörstumhet) from deafness (dövstumhet)
  - Motor
  - Sensory

  } Perception-action theories of speech perception

- Caused by reduced memory and attention

Kuhl et al., 2014. Analysis by Synthesis

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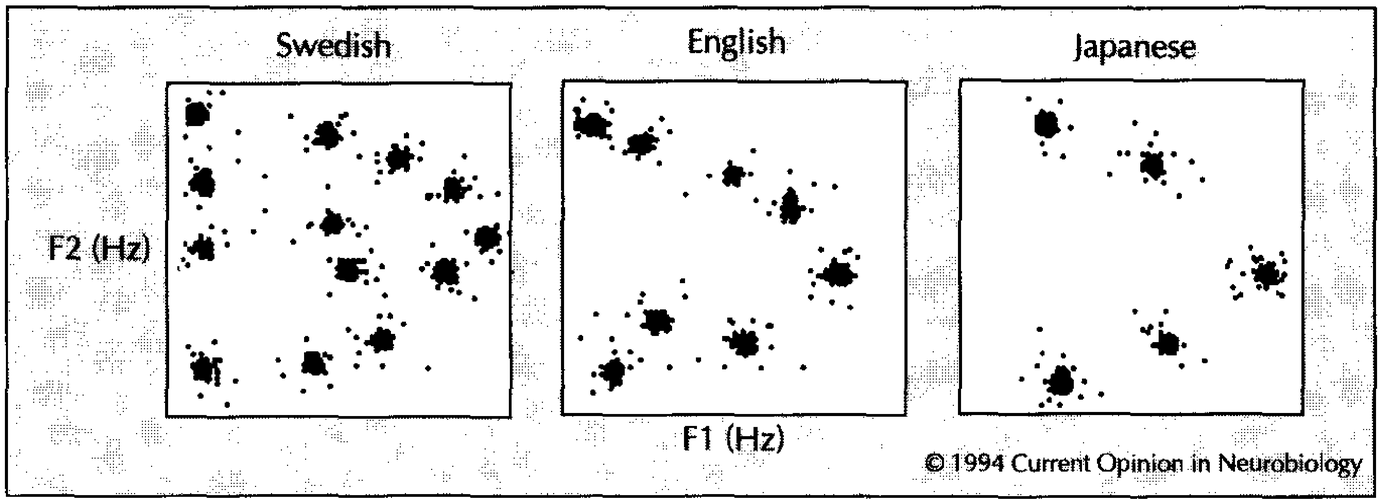
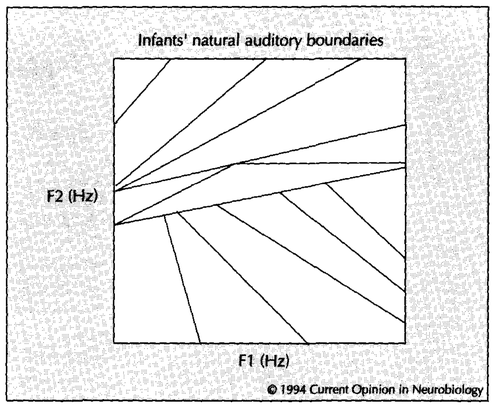
Broader window for perceptual differences within phonetic categories





Kuhl, P, 1994

Noordenbos et al., 2013

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Language impairment

Affects 7% of the population

As common as:

Dyslexia

ADHD

Much more common than autism

Most probably multifactorial

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Language impairment

- Late talkers
- Unintelligible
- Unattentive
- Slow learners
- Reading impaired

- Misunderstandings with peers
- Low self esteem
- Poor academic achievement
- School drop out
- Underemployment

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Interaction

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Top down

Bottom-up

Higher and lower levels interact in speech perception

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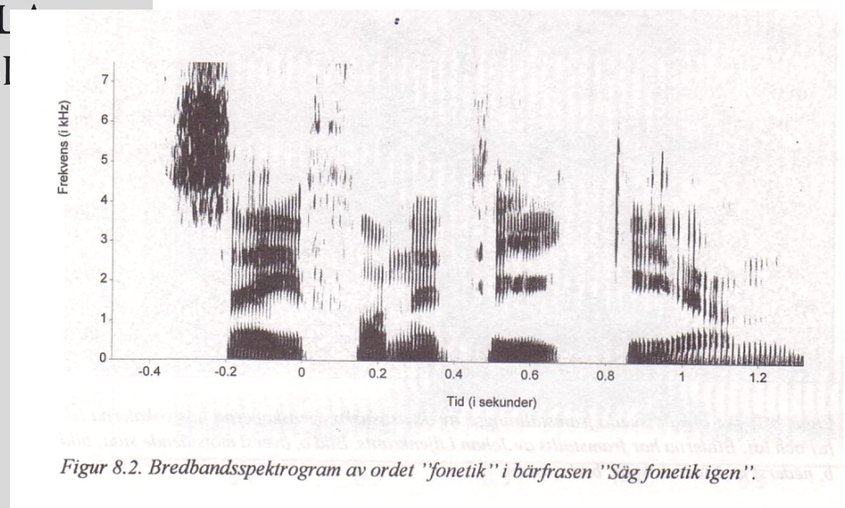
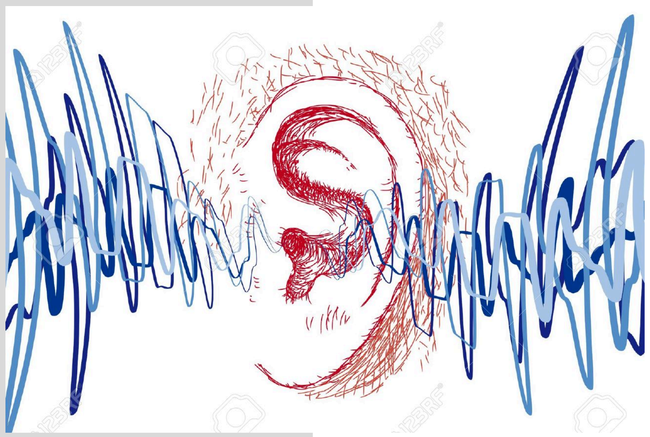
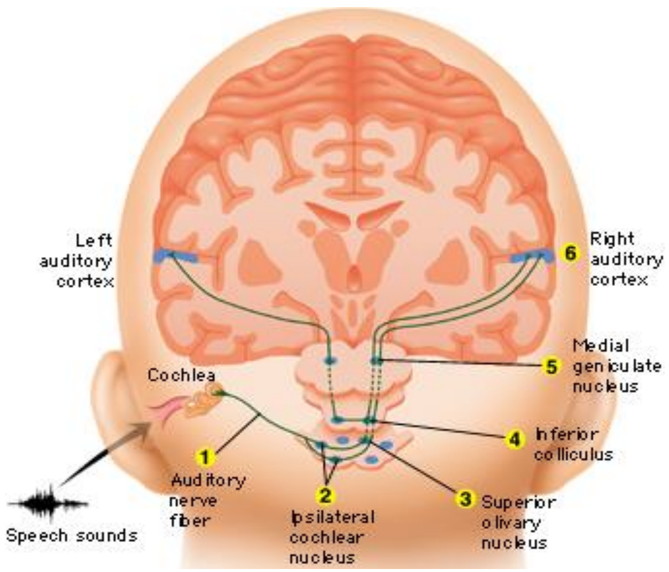
Background



Figur 8.2. Bredbandsspektrogram av ordet ''fonetik'' i bärfrasen ''Säg fonetik igen''.

[spiʧsaundz] [siləbəls][wɜrdz]





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Background

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GERKENS PROSODIC HYPOTHESIS
""WORD STRESS TEMPLATES"
OMISSIONS OF UNSTRESSED SYLLABLES

TALLAL'S TEMPORAL HYPOTHESIS
SPEECH SOUNDS OF SHORT DURATION ARE NOT DETECTED

LANGUAGE IMPAIRMENT

GRAMMATICAL COMPUTATION

MORPHO-SYNTAX

TENSE/AGREEMENT MORPHEMES
WORD ORDER

PHONOLOGICAL COMPUTATION

PHONOLOGICAL WORKING MEMORY

NONWORD REPETITION

LEONARD'S SURFACE HYPOTHESIS
ØMITS/CHANGES ACOUSTICALLY WEAK SEGMENTS THAT HOLDS GRAMMATICAL INFORMATION

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Current postdoc project

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EMIL

von Mentzer, 2005

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Swedish part

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- **Part 1** - Retrospective medical record study
  - Examine how speech pathologists assess, identify and treat listening difficulties in children with language impairment in the preschool years. Children born between 2006 and 2009. At present 7-10 years old.
  - At present ≈ 120 caregivers have given their consent
- **Part 2** - Questionnaire-based study
  - Addressed to the guardians of the same children as in part 1 using ECLiPS, Evaluation of Children's Listening and Processing Skills (Barry & Moore, 2015).

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American part

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1. Use an American-English version of a speech perception test with minimal word pairs, the Listen-Say test (Nakeva von Mentzer et al. Ongoing) for children from 4 years of age.
2. Use the Enhanced QuickSiN adapted for children
3. Use a kit of cognitive and auditory tests:

   Cognitive; vocabulary, oral reading and processing speed.

   Auditory; pure tone audiometry including high frequencies (10-16 kHz), tympanometry, acoustic reflexes, Distortion product OAEs.

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The Listen-Say

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- The Listen-Say test in Swedish children

  - 62 minimal word pairs
  - Seven consonant contrasts
  - Fixed signal-to-noise ratio +5 dB
    - speech 70 dB SPL
  - Quiet, Competing speech

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Swedish Listen-Say

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Category	Phonetic contrast	IPA transcription	Example
A	Place	/t-k, d-g, n-ŋ/	/'tɵna/ – /'kɵna/ *(barrel/thin – can)* /sɔn/ – /sɔŋ/ *(such – song)*
B	Manner	/b-m, d-n, ɡ-ŋ/	/bʉ/ – /mʉ/ *(boh – moo)*
C	Voicing	/b-p, d-t, ɡ-k, j-ç, v-f/	/'beta/ – /'peta/ *(beet/feed – pick)*
D	Manner	/l-r-j/	/len/ – /ren/ *(smooth – clean)* /le/ – /je/ *(smile – give)*
E	Place	/s-ç-ɦ/	/sɑl/ – /ɦɑl/ *(hall – shawl)*
F	Manner	/s-t/	/sɑl/ – /tɑl/ *(hall – number/speech)*
G	Syllable complexity	/b-bl, f-fl, p-pr, f-fr, ɡ-gn, k-kn, t-tv, k-kv, s-sl, s-sn, s-st, s-sv/	/'bʊma/ – /'blʊma/ *(miss the mark – flower)*

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Swedish Listen-Say

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- Twenty-seven school children 7-9 years

- Overall, the children obtained high scores discriminating phonetic contrasts in both quiet (*Mdn* 95%) and against speech (*Mdn* 91%).

- A significant effect of 4T speech background was evident in three out of seven contrasts, connected to place of articulation, voicing and syllable complexity.

Nakeva von Mentzer et al., submitted

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Swedish Listen-Say

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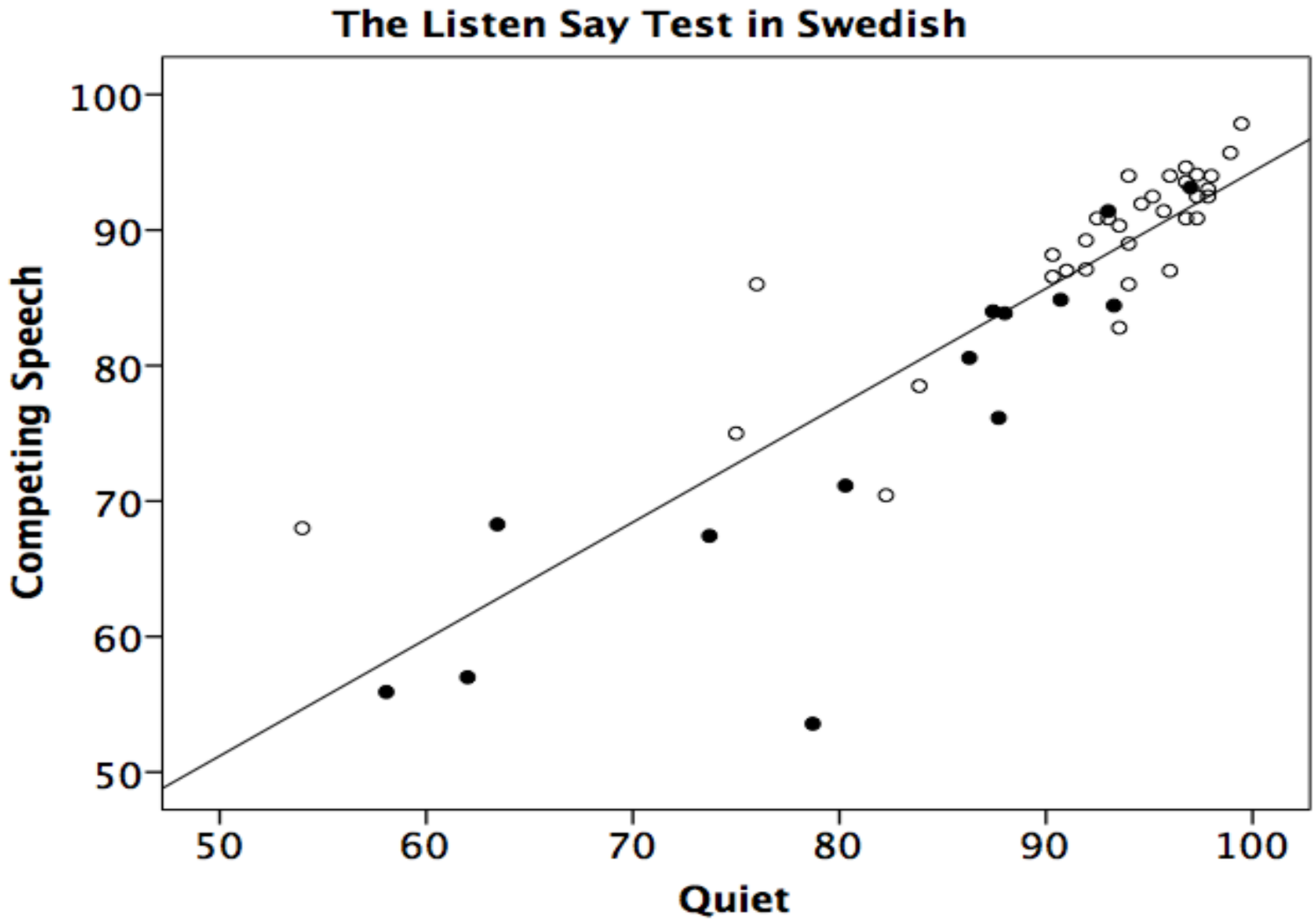

- Black = LI, n = 14
- White = TD, n = 33

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Swedish Data

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- Statistically poorer performance in both conditions by children with language impairment

- Degree of LI was the only significantly associated factor with percent correctly discriminated contrasts in babble, rs= 0.675, p = 0.032 (*n*=10)

Nakeva von Mentzer et al., ongoing

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The American Listen-Say

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Assess children's speech perception thresholds of 10 phonetic contrasts.

- 36 minimal word pairs
- Target words have been carefully selected with respect to
  - Phonetic features , CV words, /i, ɛ, oʊ/
  - Acoustic features
  - Visual confusion
  - Speech sound development
  - Age of acquisition
  - Word frequency

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The Enhanced QuickSiN for children

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Rationale

- The inability of current speech tests to capture the complexity in real-world speech communication is a huge problem in the assessment and treatment och people with hearing loss

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The Enhanced QuickSiN for children

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1. Competing speech.

   The listener listens to speech in four-talker babble noise.

2. Audiovisual presentation

   The listener listens and watches a video of speech in four-talker babble noise

3. Spatial cues.

   The listener listens to sentences that have been manipulated, so that they seem to be coming from different locations in the room.

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The Enhanced QuickSiN for children

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- Compare children's data to adult data
  - 50% Speech Reception Thresholds:
  - Babble = +2 dB
  - Audiovisual = -3 dB
  - Spatial = +1 dB

Brungart et al., 2014

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Wish list for the Children of NV

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Wish list

- Early detection
  - More rigorous methods in detecting troubles with basic skills

- Rich language at home
  - Motherese
  - Shared book reading
  - Thirty million words
  - Phonological awareness
  - Letter knowledge

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Wish list

- Audability in educational settings
- Improve teacher's voice quality?
  - Lyberg et al. 2015
- Training of executive functioning
  - Diamond, Barnett, Thomas & Munro, 2007

Fig. 2. A child demonstrating a tae-kwon-do stance. [Photo credit: Haiou Yang]

Fig. 3. Walking meditation in Montessori can be simply walking on a line (which required focused attention and concentration for young children) or walking on it without spilling water in a spoon or without letting your bell ring. [Photo credit: K. L. Campbell for Cornerstone Montessori School]

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