The Listen-Say Test in Children: Phonetic discrimination and reproduction

American Auditory Society March 4th 2017

Cecilia Nakeva von Mentzer

David Moore

Unit for Speech Language Pathology

Dept of Neuroscience Uppsala University

SWEDEN

Communication Sciences Research Center

Cincinnati Children's Medical Hospital

USA

Children with language impairment (LI)

- Affects 7% of the population

- Heterogeneous condition
  - Reading disorders, 1.9-6.2 x risk (Pennington & Bishop, 2009)
  - 61% of children who had severe LI at 3 years had a neurodevelopmental disorder (ADHD or Autism Spectrum) at school entry (Westerlund et al., 2002)

Hearing and Language

An auditory sensory cause for language impairment (LI)?

Temporal processing (Benasich & Tallal, 2002)

Phonological representations (Sussman, 1993, 2001)

Neural encoding of consonants in noise
(White-Schwoch & Kraus, 2013)

Current practice

- Face to face assessments

- Lack of knowledge how speech perception contributes to language and learning

- Too little interdisciplinary work

  No reliable, validated and standardized tests are available to assess discrimination and reproduction of phonetic information in children who struggle with language and learning

Aims

- Standardize the Swedish version of the Listen-Say Test

- Examine perception of phonetic contrasts in quiet and in speech noise in Swedish school children.

The Swedish Listen-Say test

- 63 Swedish children 7-9 years of age
    1. 27 mainstreamed children
    2. 10 children with LI
    3. 26 mainstreamed children*

- 62/29* minimal word pairs
  (e.g. **Sol** – Pol, Sal, Sot, **Cat** – Hat, Kit, Cap)

- Signal: Seven consonant contrasts, (70 dB SPL)

- Condition: Quiet, Four Talker Babble

- Fixed signal-to-noise ratio (+5 dB)

Overall hypotheses

Overall good discriminatory skills in quiet

Children with LI will be more affected by noise

Larger variation in performance

Speech production influences perception

Temporal acoustic cues most affected by masker

Voicing and place of articulation of stop consonants

Kuhl et al., 2014,
Ross et al., 2015
Vance & Martindale, 2012
Bradlow   et al., 1999
Nishi et al., 2010

Phonetic categories

Category	Phonetic contrast	IPA transcription	Example
A	Place	/t-k, d-g, n-ŋ/	/ˈtɵna/ – /ˈkɵna/ (barrel/thin – can)
B	Manner	/b-m, d-n, g-ŋ/	/bʉ/ – /mʉ/ (boh – moo)
C	Voicing	/b-p, d-t, g-k, j-ç, v-f/	/ˈbeta/ – /ˈpeta/ (beet/feed – pick)
D	Manner	/l-r-j/	/le/ – /je/ (smile – give)
E	Place	/s-ç-ɦ/	/sɑl/ – /ɦɑl/ (hall – shawl)
F	Manner	/s-t/	/sɑl/ – /tɑl/ (hall – speech)
G	Syllable complexity	/b-bl, f-fl, p-pr, f-fr, g-gn, k-kn, t-tv, k-kv, s-sl, s-sn, s-st, s-sv/	/ˈbʊma/ – /ˈblʊma/ (miss the mark – flower)

Design

The child holds a USB dual-button control (red/blue)

Presses a button after each word (target/contrast)

DISCRIMINATION   REPRODUCTION

Minimal word pair	Listen to...	1	2	3	Say the word...
/ˈtɵna/ – /ˈkɵna/ (thin – can)	/ˈkɵna/	/ˈtɵna/	/ˈtɵna/	/ˈkɵna/	

Mainstreamed children high scores

Phonetic category	n	Quiet			Babble		p (2-sidig)
		M	SD		M	SD	
A	27	93.6	11.4		87.0	9.0	0.000***
B	27	94.1	8.3		92.8	8.0	0.145
C	27	92.8	9.9		88.4	10.8	0.001**
D	27	79.8	9.8		80.5	11.1	0.934
E	27	90.5	11.7		88.1	11.6	0.202
F	27	91.8	16.8		89.3	19.6	0.295
G	27	90.8	14.0		84.0	12.7	0.001**

Children with LI more affected by babble

Phonetic Category	N	Quiet			Babble		p (2-side)
		M	SD		M	SD	
A	10	84,6	13,6		70,4	10,8	0,008**
B	10	85,2	12,8		85,2	12,2	0,633
C	10	82,6	11,7		75,6	11,2	0,066
D	10	86,7	15,7		83,3	12,3	0,261
E	10	85,2	8,0		77,9	12,2	0,044*
F	10	92,2	9,1		73,3	23,5	0,024*
G	10	88,6	6,7		77,7	12,7	0,024*

Improvements Swedish test

- Ceiling effects

- Testing time

- Memory load

- Balancing

- Order effects

Connected to **place of articulation**

93.3% / 83.3%

Shorter version

Balancing of test order and phonetic categories

Mainstreamed school children

N=26, 8.9 years

An overall effect of noise on discrimination accuracy

Acc: 93.2% / 91.7%,

z = -2.4, p = .015

No difference for RTs

RTs: 2.02 s / 2.00 s

American Listen-Say

- Detection of phonetic discrimination in quiet and in noise in preschoolers

- Early intervention

- More rigorous method in controlling the acoustic and phonetic variables

Aims

- Develop an improved US English version

- Relate phonetic speech skills to hearing ability and cognitive performance

Procedures

- Speech Discrimination and Reproduction
- Hearing
  - Tone Audiometry (1, 4, 8, 12.5 and 16 kHz)
  - Tympanometry
  - Middle Ear Reflexes
  - DPOAEs
- Cognition
  - Vocabulary
  - Reading
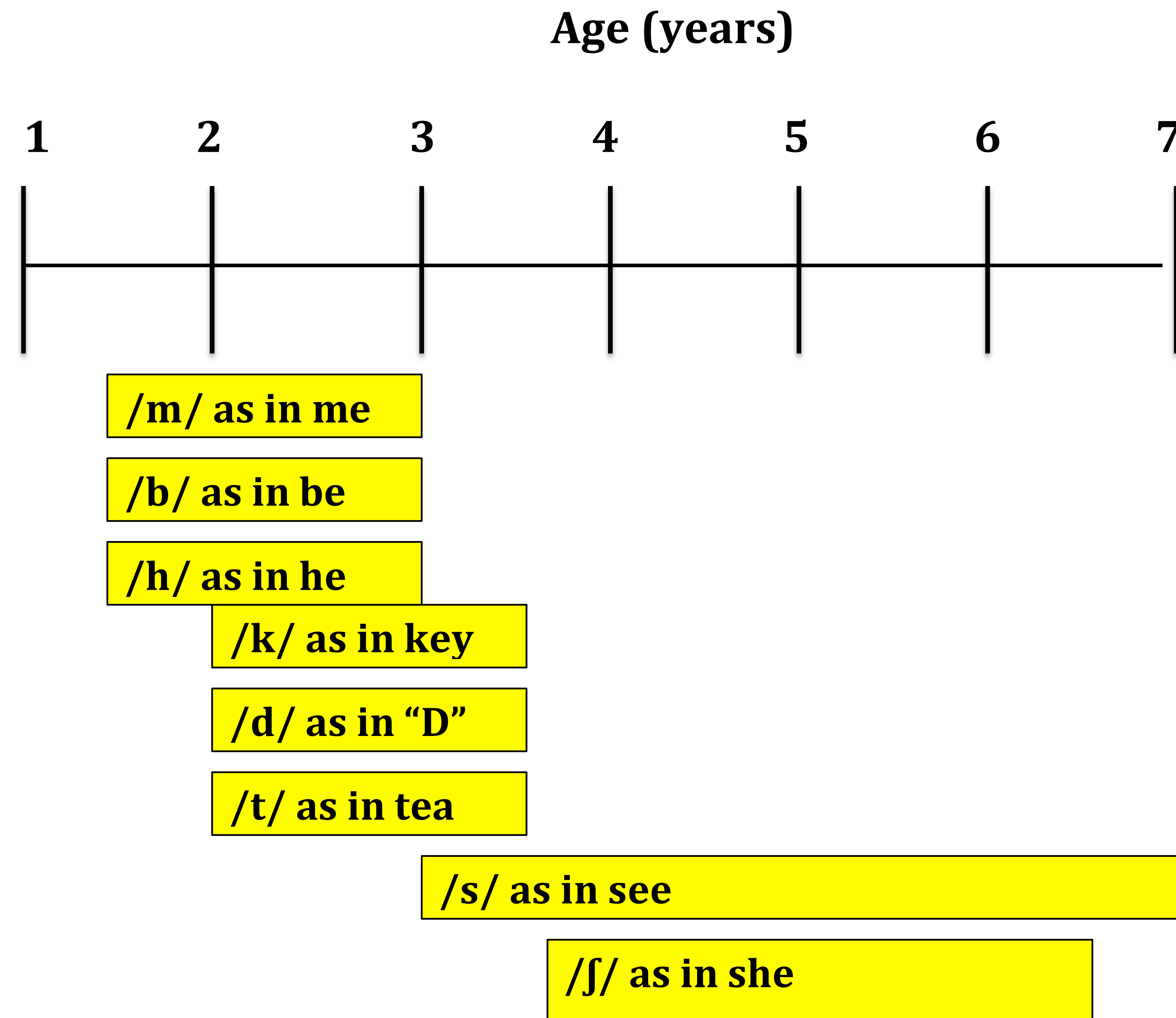 - General Processing Speed

Stimuli

Place		
Front	Stimuli	/b/, /f[2]/, /m/
Mid		/s/, /t/, /d/, /n/
Back		/k/ /g[1]/, /ʃ/, /h/
Voicing	Voiced	/b/, /d/, /g/ /m/, /n/
	Voiceless	/p/, /t/, /k/, /f[2]/, /s/, /ʃ/, /h/

Speech stimuli: 24 monosyllabic age-appropriate familiar words

Phonetic contrasts: perceptual confusion and typical speech development

	Vowel	STOPS				FRICATIVE			NASAL
1	/i/	Bee	D	Tea	Key	See	She	He	Me
2	/ɛ/	Bear	Dare	Tear	Care	Fair	Share	Hair	Mare
3	/oʊ/	Bow	Dough	Toe	Go	So	Show	Ho	No

Speech sound development

Age (years)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

/m/ as in me

/b/ as in be

/h/ as in he

/k/ as in key

/d/ as in "D"
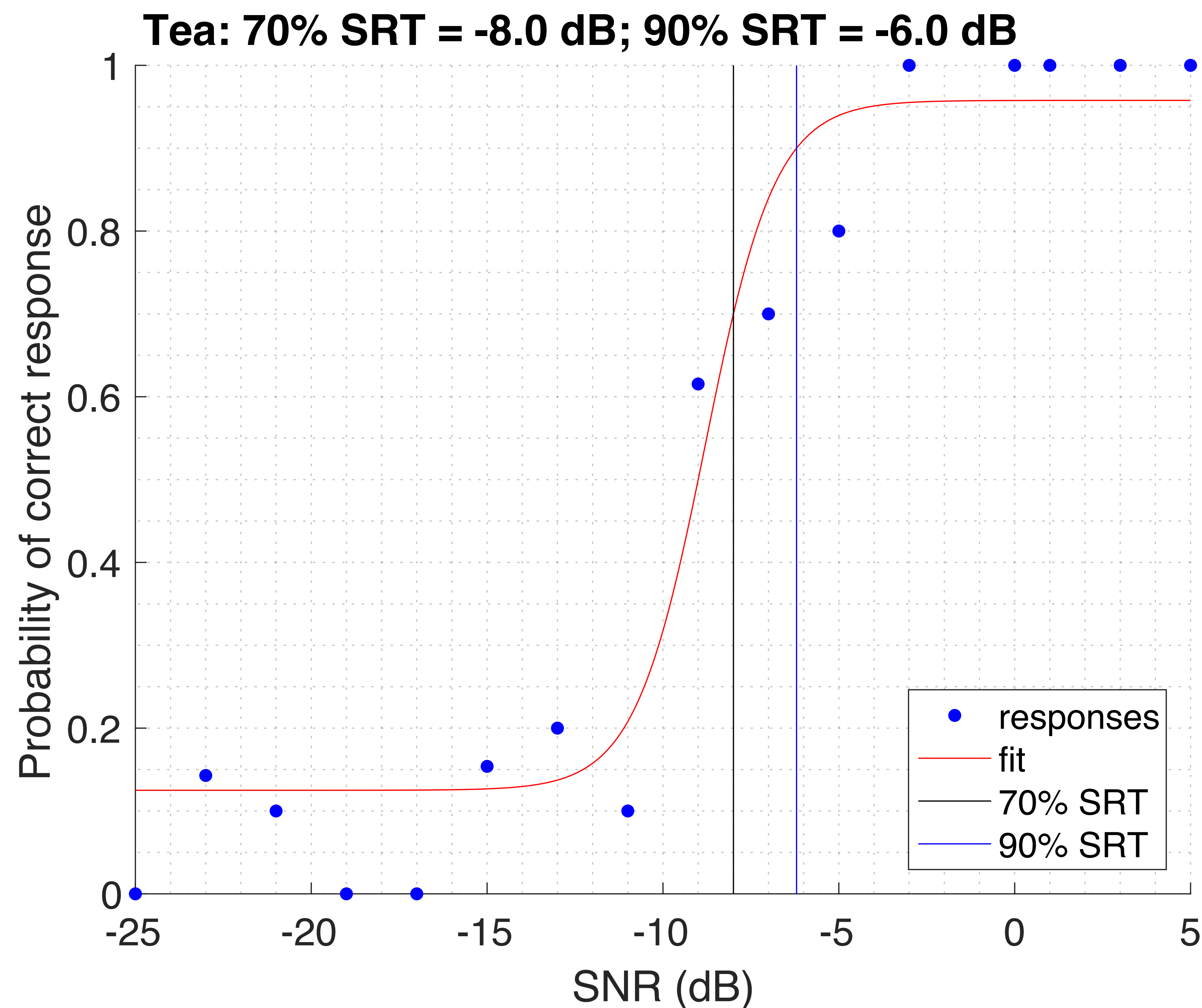
/t/ as in tea

/s/ as in see

/ʃ/ as in she

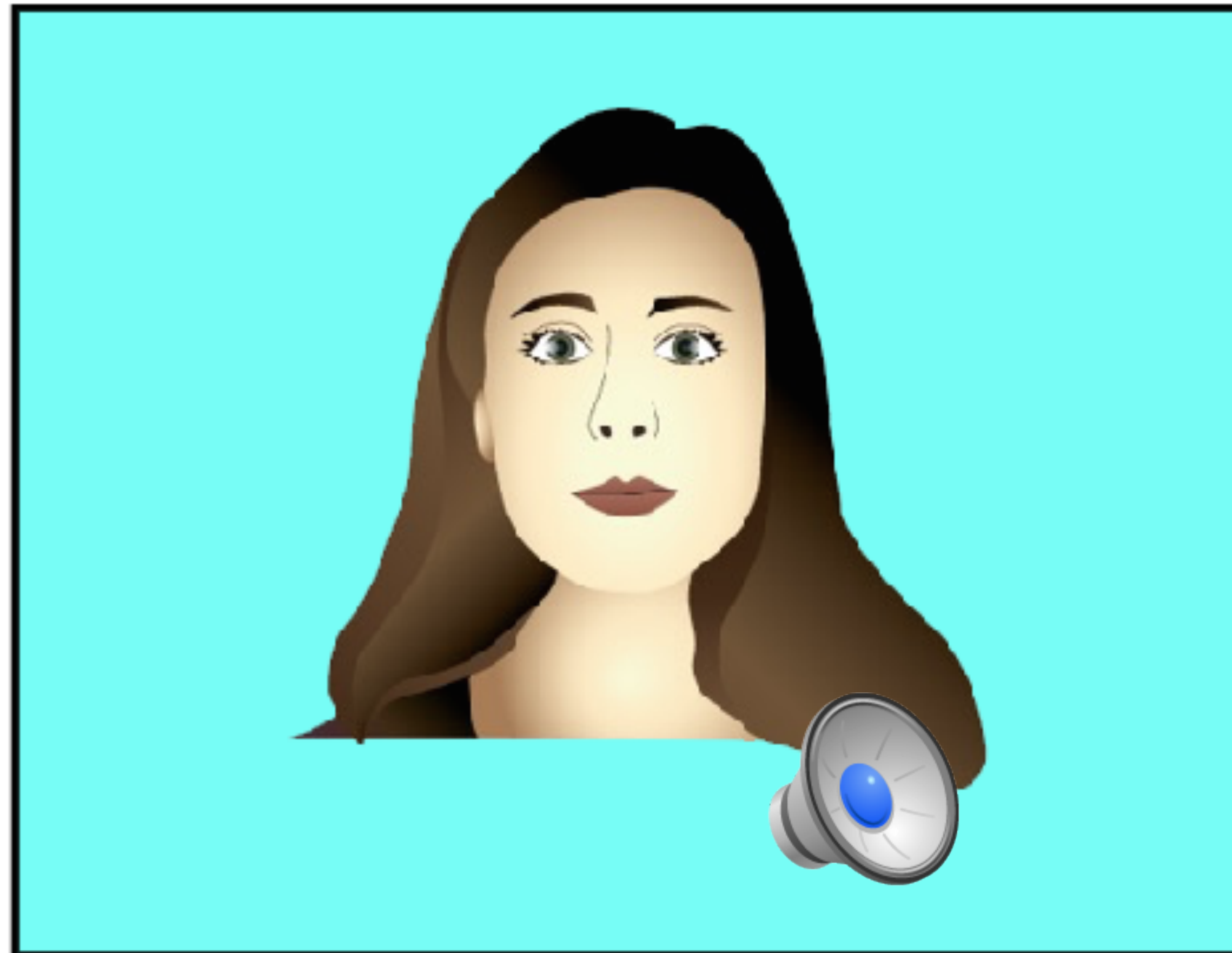Grunwell, 1981
Sander, 1972
Smit et al., 1990

Homogenization results

- 10-13 NH adults
- 12 different SNRs (-3 to -25 dB)
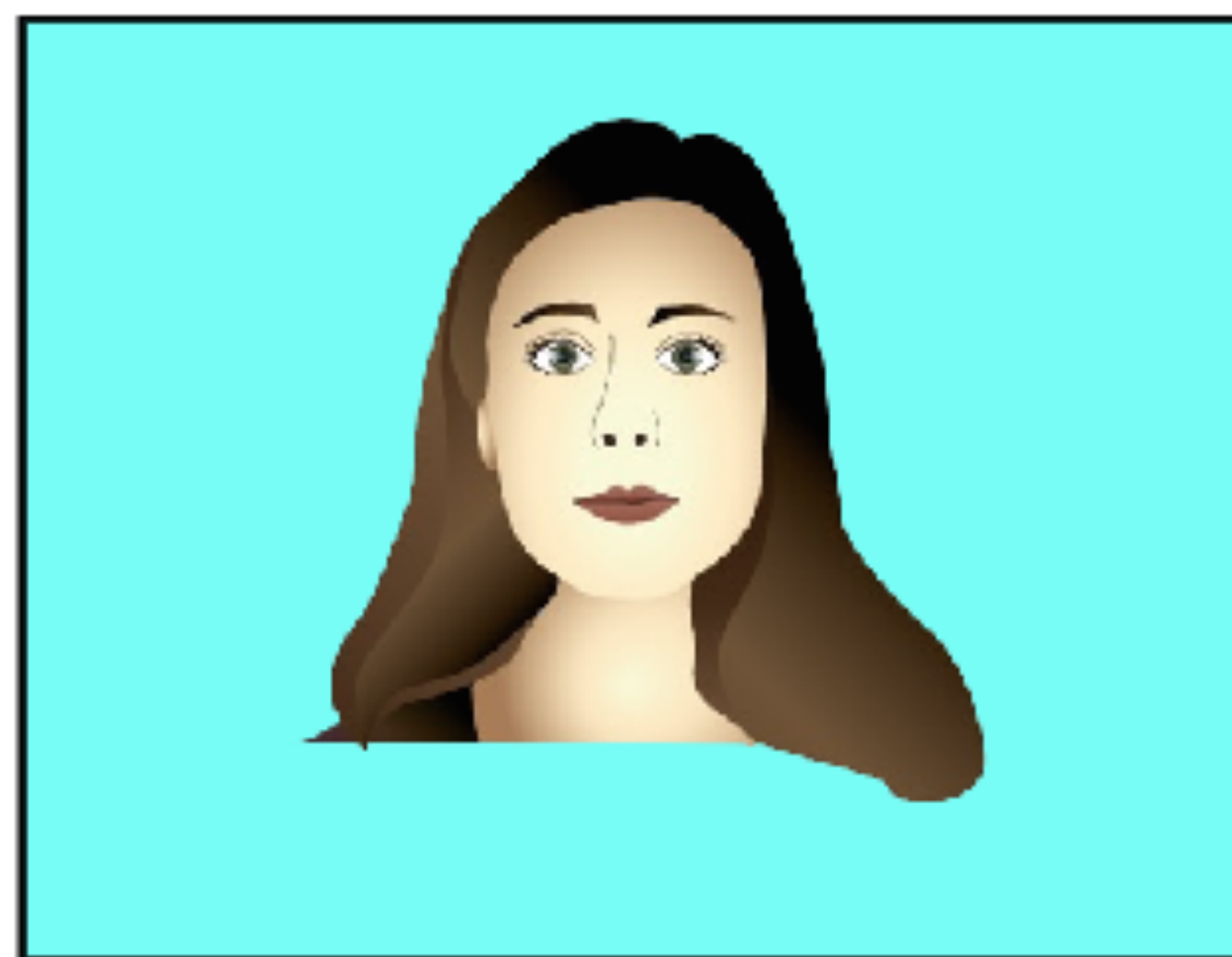- 90% and 70% SRT in noise for each word

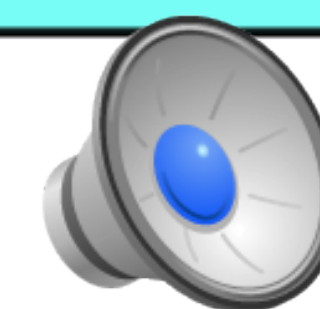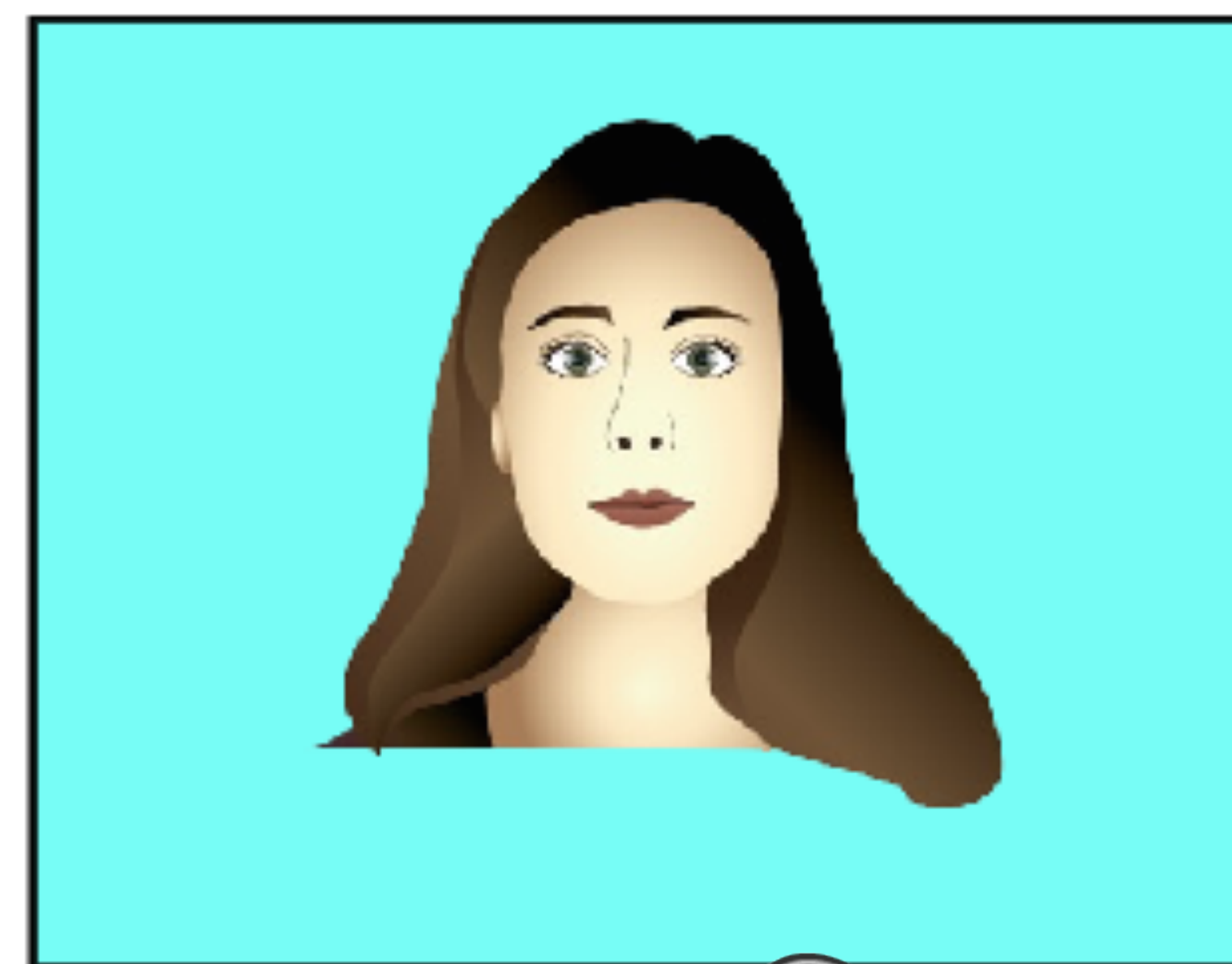Tea: 70% SRT = -8.0 dB; 90% SRT = -6.0 dB

XAB design

X

A

B

- **Touchscreen**

- **Quiet**

- **Speech shaped noise**
  90% SRT, 70% SRT

- **Phonological categories**
  Different recordings

- **Confusion matrices**

Summary

- First procedures in Swedish 7-9 year school children showed that noise affected place of articulation, voicing and syllable complexity

- Children with LI more affected by speech noise

- 4-5 year old American children with and without a diagnosed language impairment will be assessed with the improved version

- Phonetic discrimination skills will be analyzed in relation to hearing and cognitive performance

Acknowledgments

SLP- and Audiology students: Enqvist, Sundström, and Grandin.

Klaudia Ceder, SLP, Research assistant

Unit for SLP, Uppsala University, Sweden

Mathias Hällgren, technical audiologist

Linköping university, **Sweden**

David Moore – PhD

Lisa Hunter – PhD

Nicholette Sloat – Coordinator

Christopher Hursh – Videographer & Editor

Zhaowei Ren – Programmer

Allison Bradley – Research Fellow

Children's Auditory Research Lab (CARL)

Communciation Sciences Research Center

Cincinnati Children's Hospital Medical Center, USA

Acknowledgments

Välkommen till Stiftelsen Tysta Skolan!

The Silent School Stockholm

Cochlear Nordic

Svenska Dyslexiföreningen

The Swedish Dyslexia Association

FORTE:
Swedish Research Council for
Health, Working Life and Welfare

Forte COFAS; Marie Curie outgoing postdoc