

INTRODUCTION

- The speech of children with cochlear implants (CIs) is in general less intelligible and less accurate than the speech of normally hearing (NH) children.
- However, there is limited research on the production of contrast between speech sounds by children with CIs.
- Production of contrast between sounds is related to the ability to discriminate between sounds (Perkell et al., 2004).
- The auditory discrimination ability of individuals with CIs is poorer than that of NH individuals due to the poor frequency resolution provided by CIs and due to pathologies related to deafness.
- Production of /s/ by children with CIs may be especially different from that of NH children since perceptual identification of /s/ is difficult for individuals with CIs.
 - /s/ is a high frequency sound and the filter banks of CIs are broader in higher frequencies, and furthermore, CIs do not provide listeners with information about sounds above 8000 Hz.
- Therefore, we hypothesized that children with CIs will show less contrast between their productions of /s/ and /ʃ/ than NH children.

PARTICIPANTS

- 4- to 9-year old children with bilateral CIs (n=33)
 - 2- to 7-year old NH children (n=43)
- All children spoke English as a first language and were from larger studies. The children with NH passed a hearing screening. Only children who produced /s/ and /ʃ/ correctly at least some of the time during the experimental task were included in the analysis.

Two comparisons were made:

(1) The children with CIs were compared to NH children of the same chronological age.

Group	N	Mean age (SD)	Mean hearing age (SD)	M/F	Age of implantation (SD)
CI	21	5.2 (0.9)	3.9 (0.9)	10/11	1.3 (0.4)
NH	21	5.2 (0.9)	5.2 (0.9)	10/11	N.A.

(2) The children with CIs were compared to NH children of the same hearing age (amount of auditory experience).

Group	N	Mean age (SD)	Mean hearing age (SD)	M/F	Age of implantation (SD)
CI	32	5.8 (1.2)	4.3 (1.0)	15/17	1.5 (0.8)
NH	32	4.3 (1.0)	4.3 (1.0)	16/16	N.A.

STIMULI

	/a/	/i/	/u/
/s/	soccer	seashore	super
	sauce	sister	soup
	sun	seal	suitcase
/ʃ/	shark	sheep	chute
	shop	shield	shoe
	shovel	ship	sugar

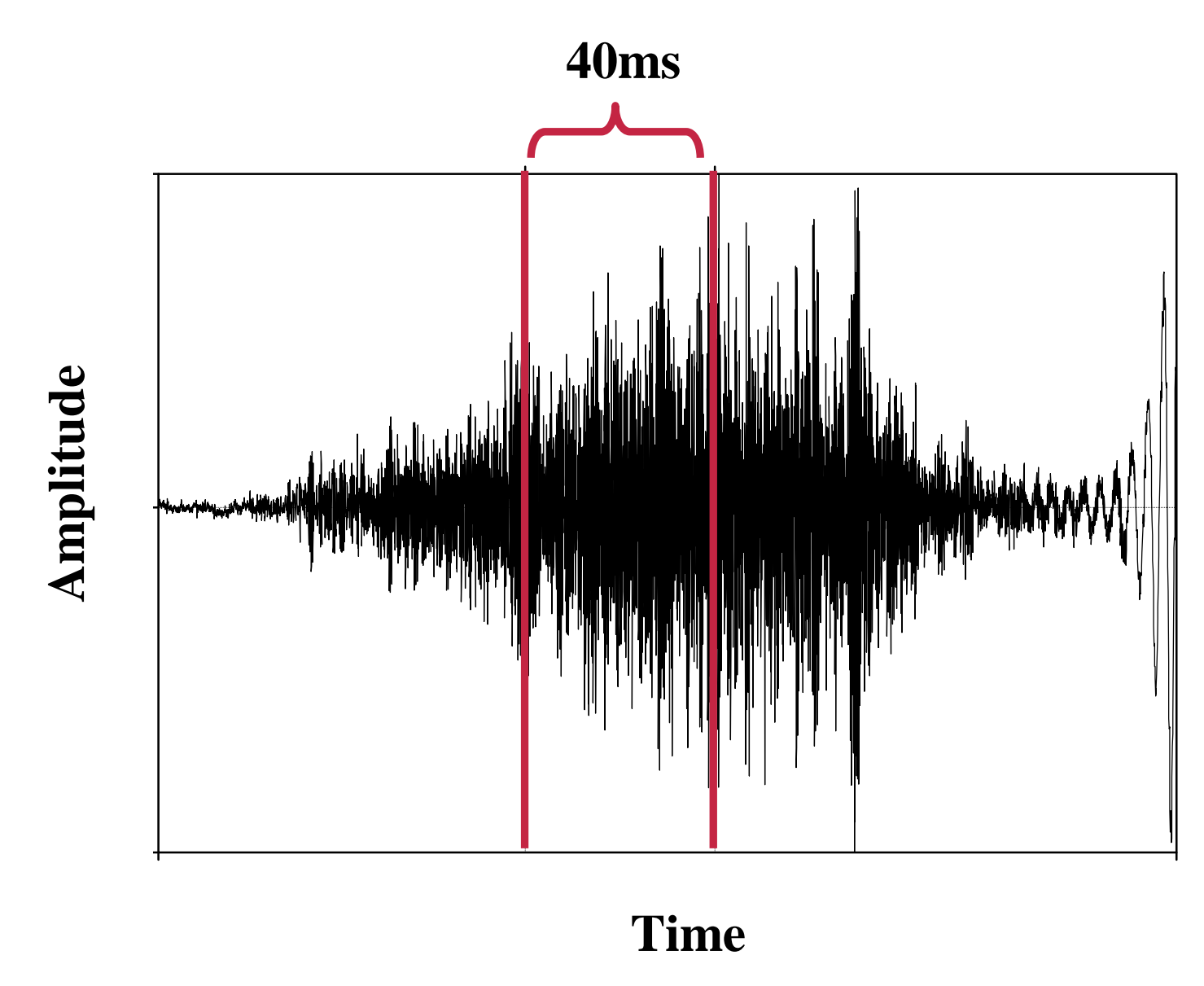


“sister”

PROCEDURE

- The children participated in an auditory word-repetition task.
 - The children saw pictures and heard digitized productions of the stimuli.
 - The children were asked to repeat the stimulus word after the audio prompt.
- The children’s productions were recorded for later analysis.

ANALYSIS



- Each initial consonant was transcribed by a trained native-speaker transcriber.
- The middle 40 ms of correct productions of /s/ and /ʃ/ were extracted for spectral analysis.
- The spectra (sones by ERB) were calculated from the 40 ms wave files.
- The ERB with the highest loudness was noted.

RESULTS

Do children with CIs produce less contrast between /s/ and /ʃ/ than NH children of the same **chronological age**?

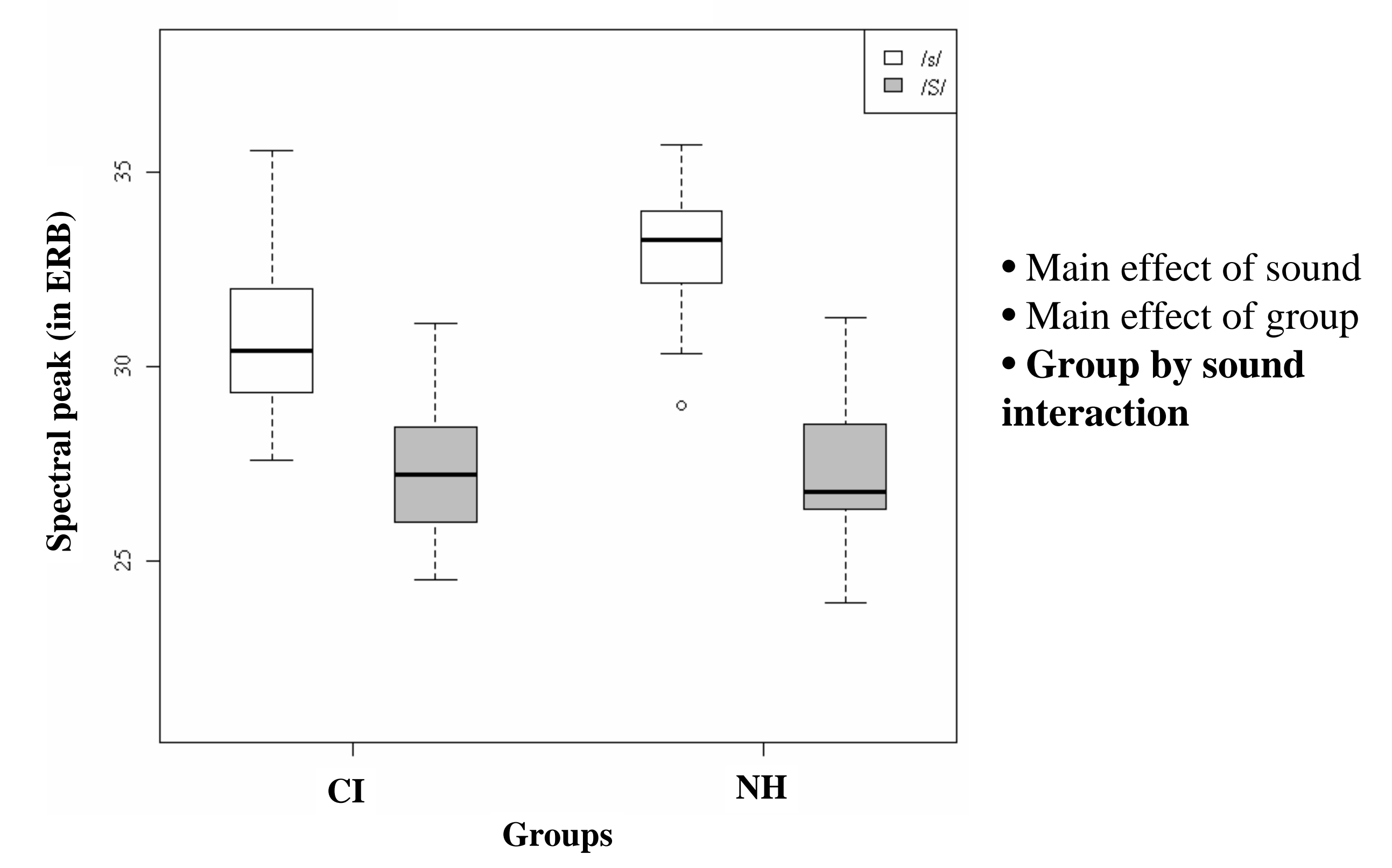


Figure 1: The children with CIs are compared to normally hearing (NH) children of the same chronological age.

Do children with CIs produce less contrast between /s/ and /ʃ/ than NH children of the same **hearing age**?

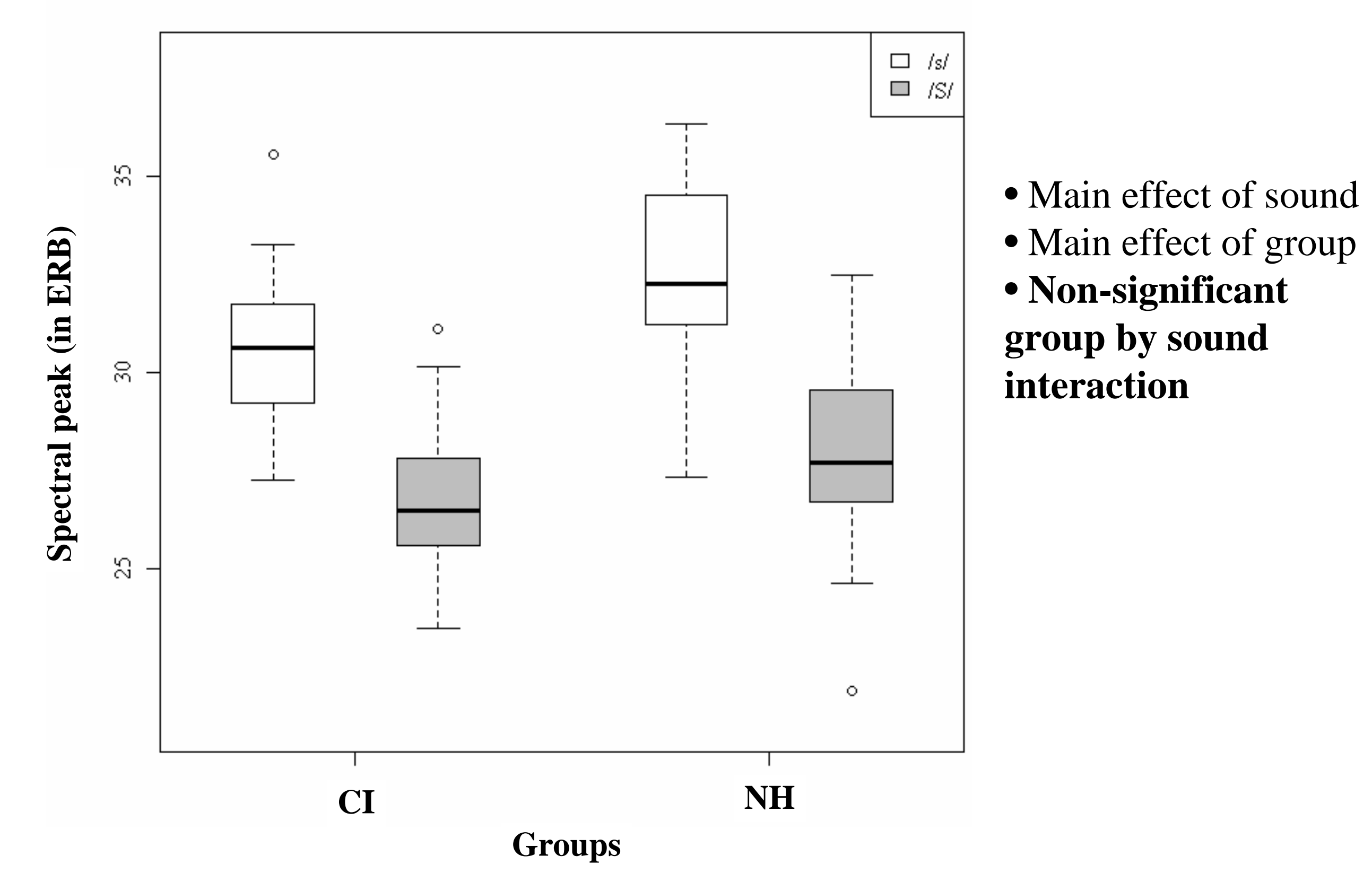
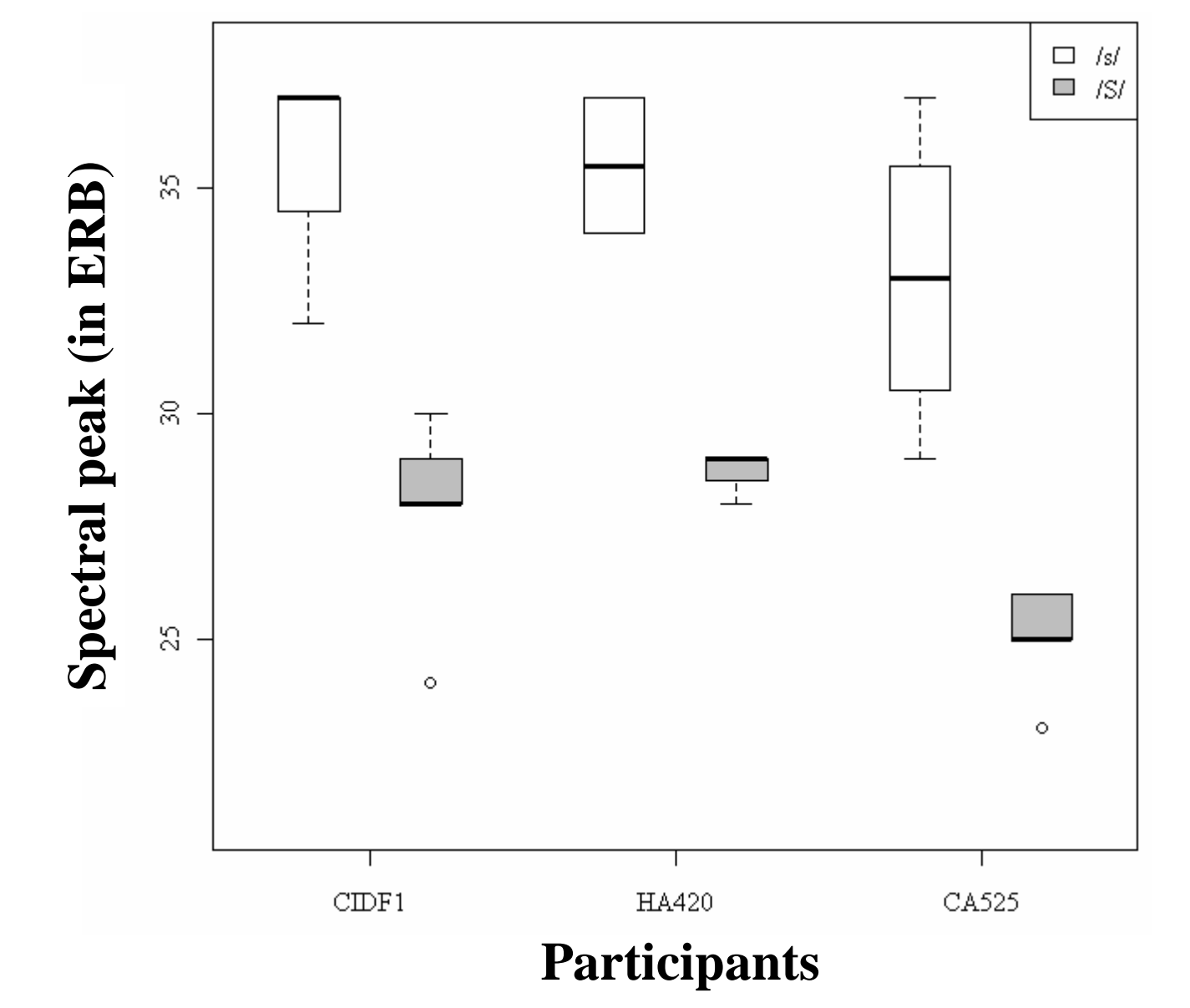


Figure 2: The children with CIs are compared to normally hearing (NH) children of the same hearing age (amount of auditory experience).

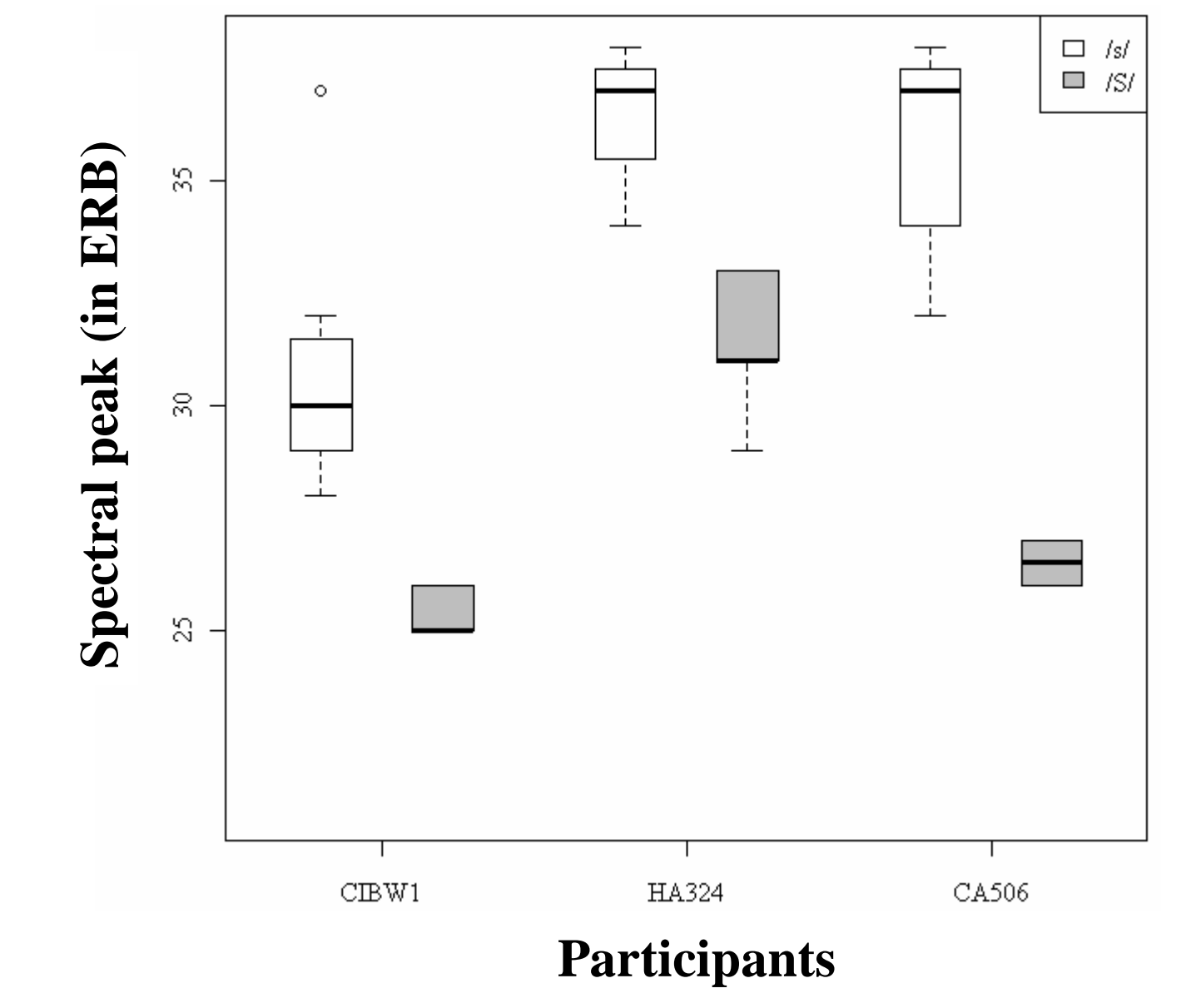
Data from individuals

The plots below illustrate the variability across the children with CIs.

- On the left of each x-axis is a child with CIs.
- In the middle is a NH child of the same hearing age as the child with CIs.
- On the right is a NH child of the same chronological age as the child with CIs.



The child with CIs (left) produces /s/ and /ʃ/ with spectral peaks similar to those of the NH children.



The child with CIs (left) produces /s/ with spectral peaks lower than those of the NH children.

CONCLUSIONS

- The children with CIs did *not* produce less contrast between /s/ and /ʃ/ than the NH children with the same amounts of auditory experience.
- The children with CIs produced less contrast between /s/ and /ʃ/ than the NH children of the same chronological age.
 - Reduced contrast between /s/ and /ʃ/ was the result of the children with CIs producing /s/ with lower spectral peaks than the normally hearing children.
 - This reduced contrast between /s/ and /ʃ/ may be due to poor auditory perceptual abilities, less auditory experience, or both.

ACKNOWLEDGEMENTS

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