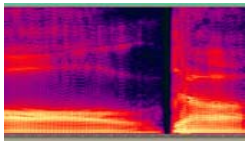
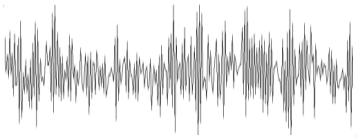

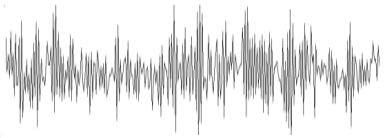
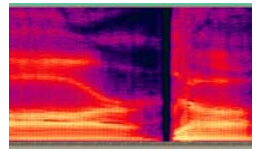

Phonetic context effects in adults with cochlear implant

Radhika Aravamudhan, Ph.D

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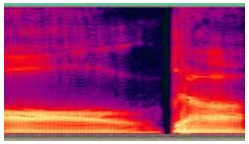
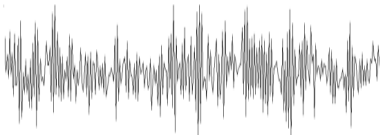
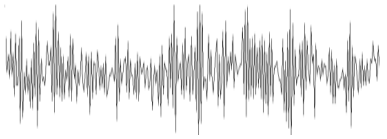
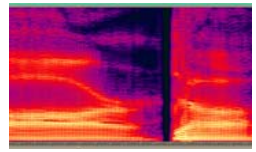
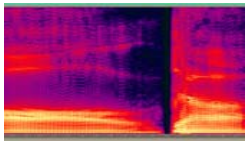
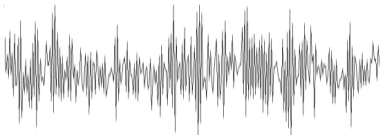
Boys Town National Research Hospital

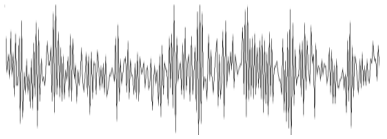
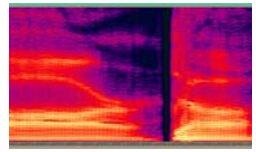



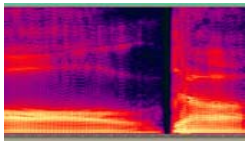
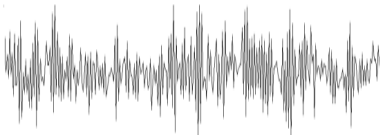
INTRODUCTION

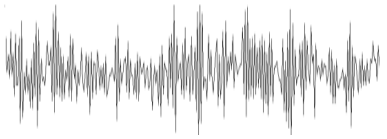
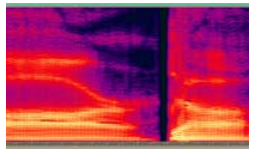
- Perception of a phoneme can change as a function of the characteristics of preceding or following phonemes. These changes in percept are referred to as phonetic context effects.
- Experimentally this effect is measured in terms of a shift in phoneme identification (ID) boundary or a change in the percentage of phoneme ID that occurs when the same ***target*** stimuli are presented with different ***context*** sounds.

- Phonetic context effects are considered to be indications of the ability of listeners to compensate for coarticulation in speech production and to normalize perception in the face of varying characteristics of speakers. As such, lack of normal context effects may be detrimental for everyday speech communication.
- Previous research (e.g., Lotto & Kluender, 1998) has demonstrated that many of these context effects are the result of interactions between the spectral patterns of the context and target sounds. It is likely that if the spectral representation of speech sounds are changed (as happens with cochlear implants), phonetic context effects will be affected.

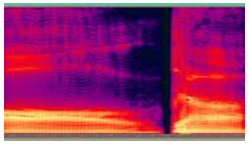
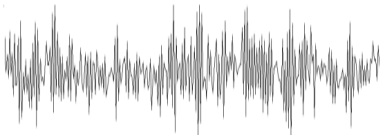



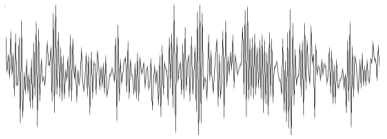
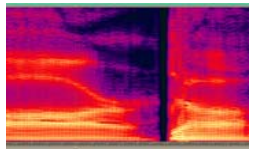



To test this hypothesis, we examined two types of context effects with NH and CI listeners.

1) **Spectral-based context effects:** Listeners identify a consonant or vowel that is preceded by phonemes that differ in their spectral pattern. NH listeners show a shift in responses that is predicted by the spectral relations of target and context (contrastive).

2) **Temporal based context effect:** Listeners identify a target consonant distinction that is temporal (e.g., /b/ vs. /w/) that is followed by a context vowel that varies in duration. NH listeners show a contrastive shift in target identification based on vowel duration.

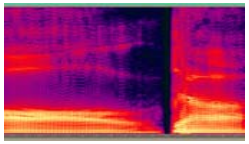
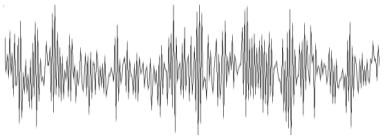



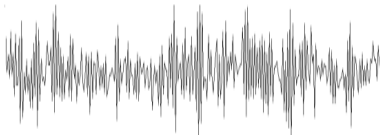
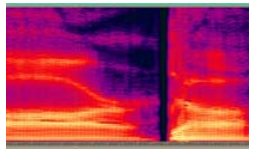
PREDICTIONS

1) NH listeners will show context effects for both spectral and temporal contexts.

2) CI listeners will NOT show context effects for spectral contexts, because of lower spectral resolution. Aravamudhan & Lotto (2004) provided preliminary data suggesting that spectral contrast effects are not present for some CI listeners.

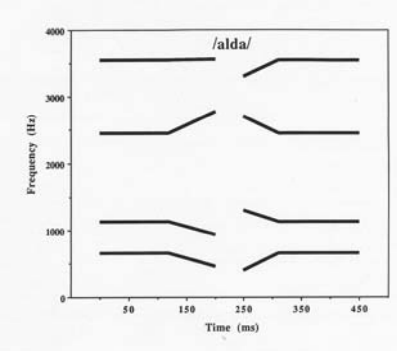
3) CI listeners will show temporal context effects because of adequate temporal resolution.

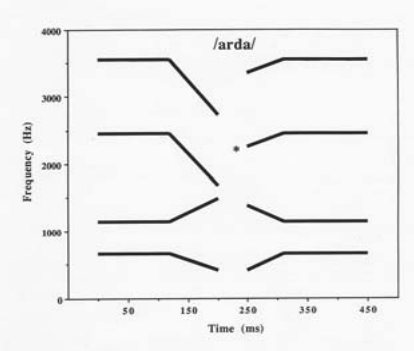



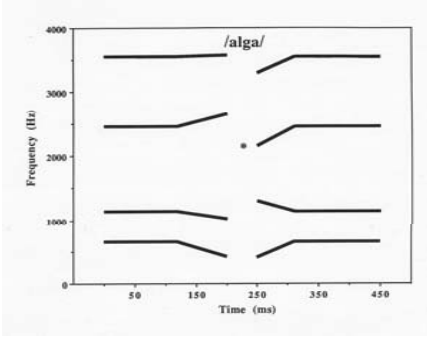



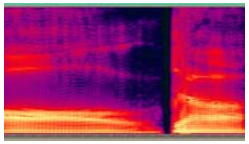
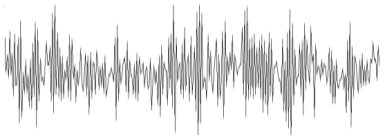
METHODOLOGY

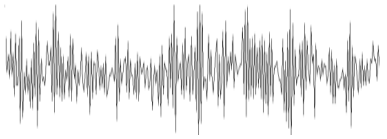
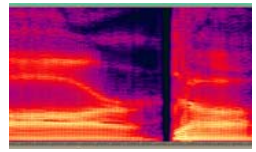
- **Subjects:**
  - 10 NH and 7 adult CI listeners participated in this study.
- **Stimuli:**
- **Spectral Based Context:**
  - A series of tokens ranging from /ga/ -/da/ preceded by the sound /al/ or /ar/
  - Another series ranging from /u/ - /e/ in the context of /b/ and /d/ - CVC tokens



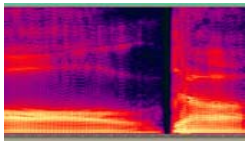
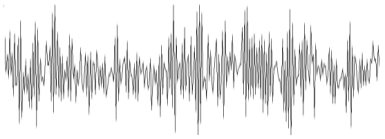


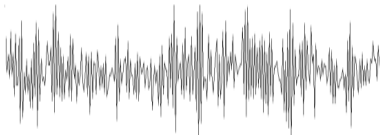
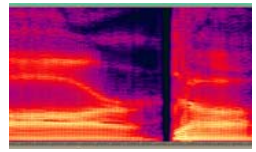


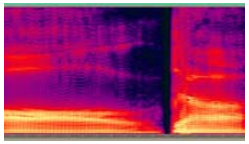
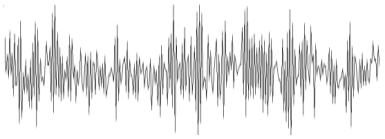
- **Temporal based Contest**
  - The third series ranged from /ba/ -/wa/ with vowel length as the context
- **Task**
  - The listener's task was to identify each sound by clicking on the appropriate label on a computer screen
- **Procedure**
  - The experiment was conducted using the experiment control software ALVIN (Hillenbrand & Gayvert, 2005)
  - Each token was presented over speakers in a sound-isolation booth at a comfortable listening level

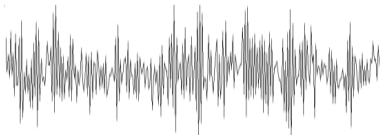
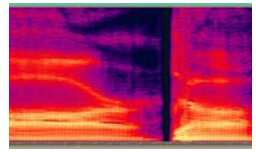



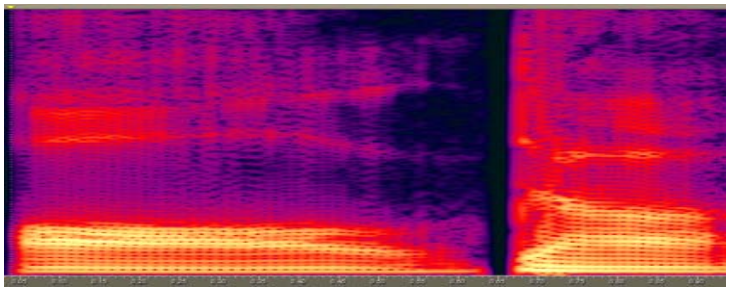



CI - Listeners - Profile

Subject No	Years with implant	Age	Type	Processor	Processing Strategy
1	9y/9m	53	Clarion CI	PSP	CIS
2	3y/6m	60	Nucleus CI24	Esprit 3G	ACE + SPEAK
3	4y/2m	45	Nucleus CI24	Esprit 3G	ACE + SPEAK
4	4y/2m	50	Clarion CI	PSP	CIS+SAS
5	4y/10m	46	Clarion CI	PSP	CIS+SAS
6	2y/2m	43	Clarion CI	PSP	Hi Res
7	3y/1m	45	Nucleus CI24	Esprit 3G	ACE



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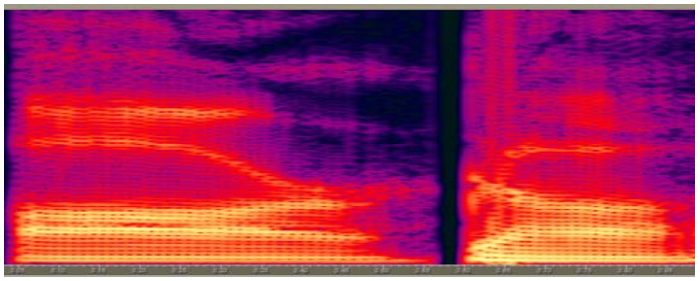

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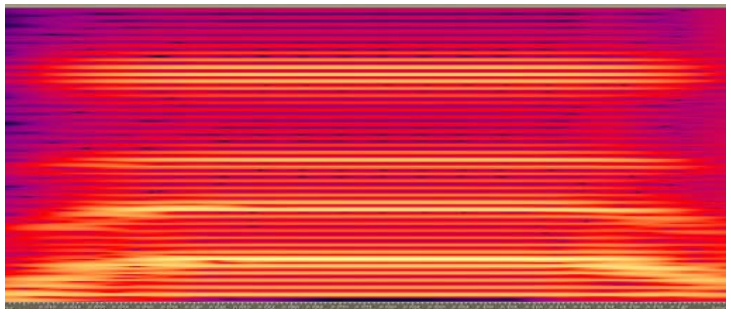

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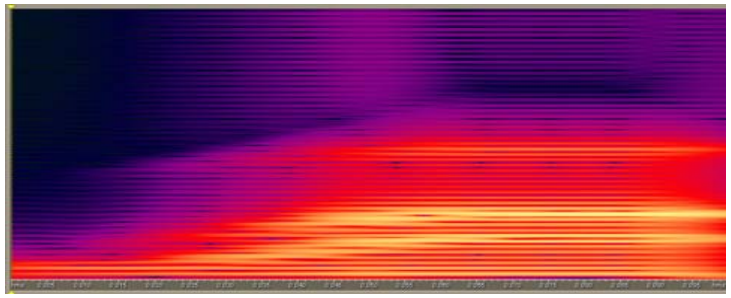
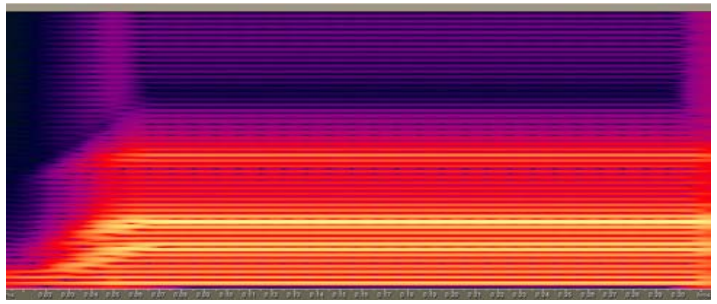
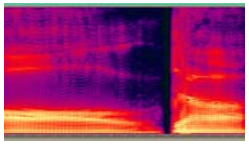
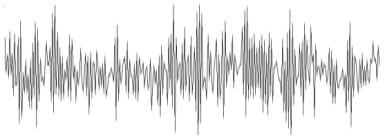
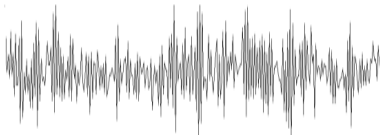
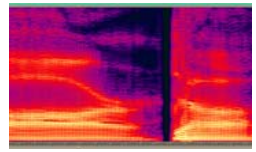


/wa/



/ba/

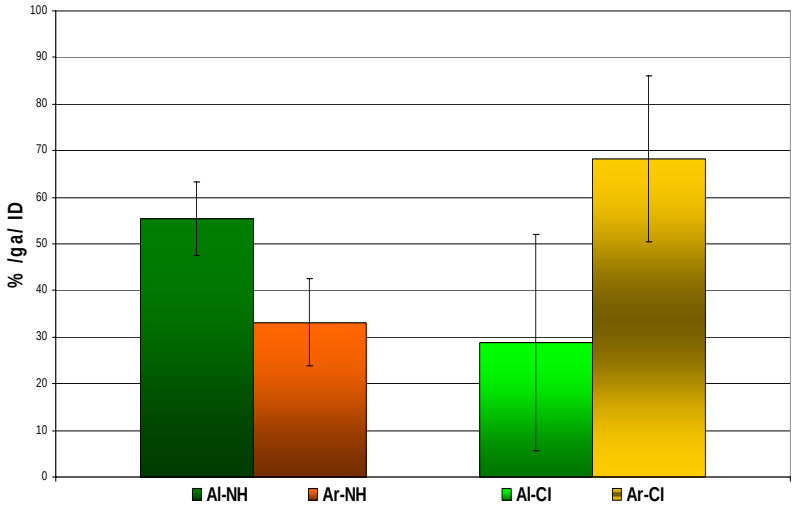



RESULTS

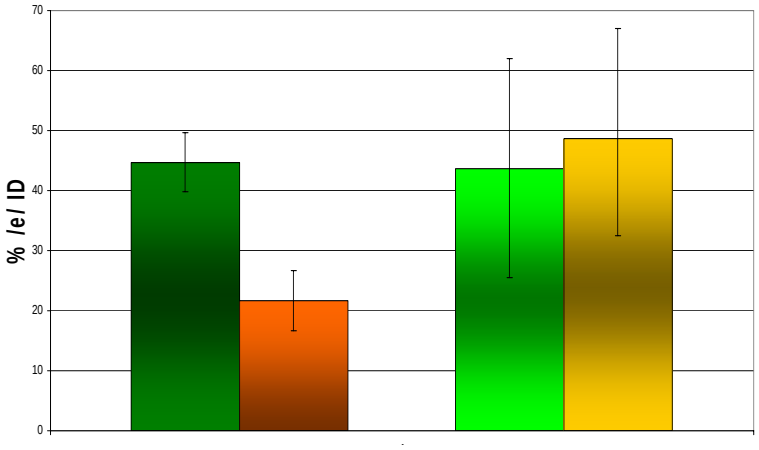
- NH subjects showed a significant shift in ID for all 3 conditions demonstrating effects of context. CI listeners did not show normal context effect for the spectral-based effects.

Average /ga/ ID shift in the context of /al/ and /ar/ in NH and CI listeners

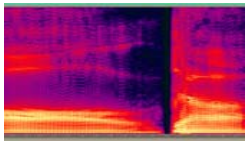
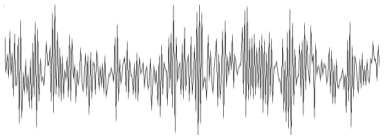


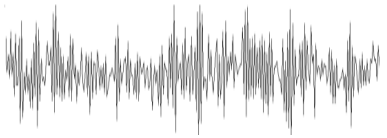
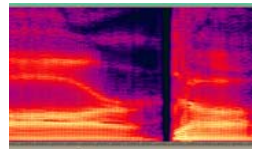
NH: Al Ar **CI:** Al Ar

Average /e/ ID shift in the context of /b/ and /d/ in NH and CI listeners



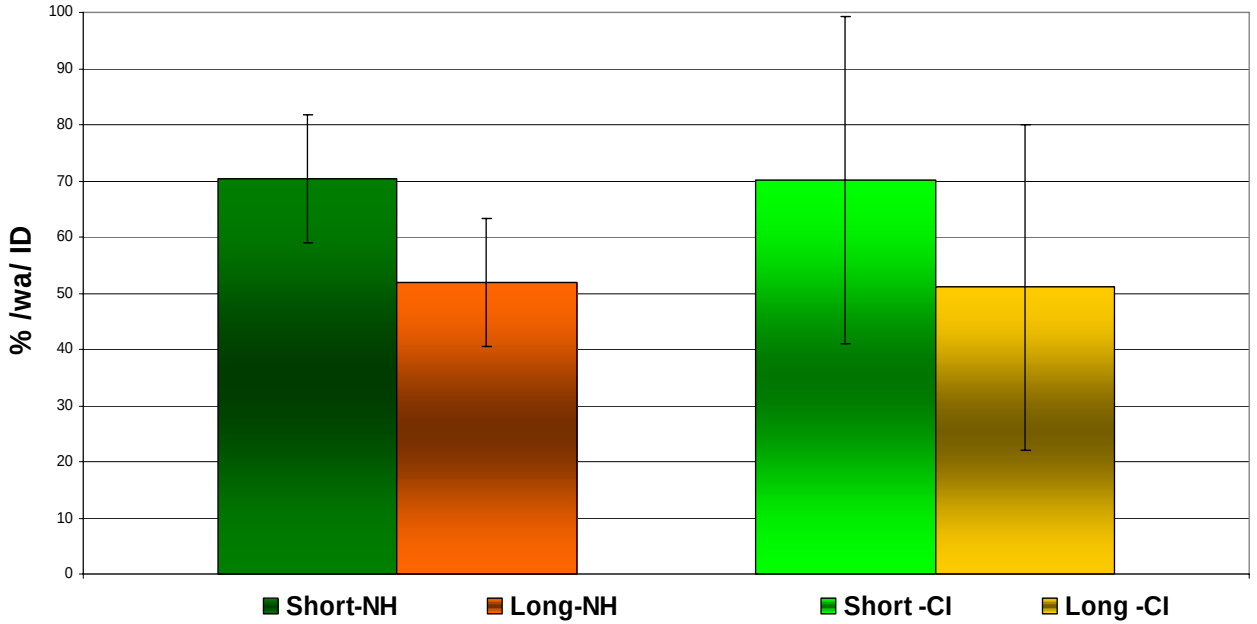
NH : /b/ /d/ **CI:** /b/ /d/

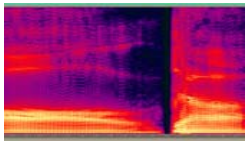
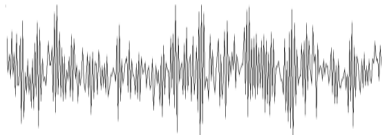



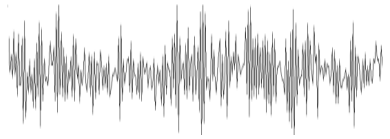
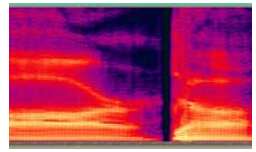



- CI listeners showed significant context effect (similar to NH) for temporal-based effects based on vowel length.

Average shift in /wa/ ID in the context of vowel length in NH and CI listeners



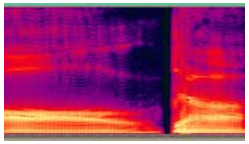
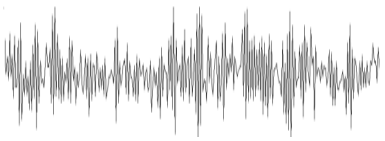



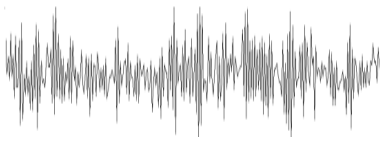
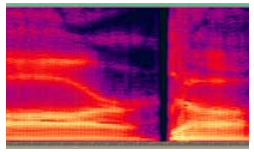



- CI-Simulation with NH listener:
  - CI-simulation was conducted by processing the natural /ga/ -/da/ continuum preceded by the sound /al/ or /ar/ through the CI-simulation program that processed the stimuli using a CIS strategy.

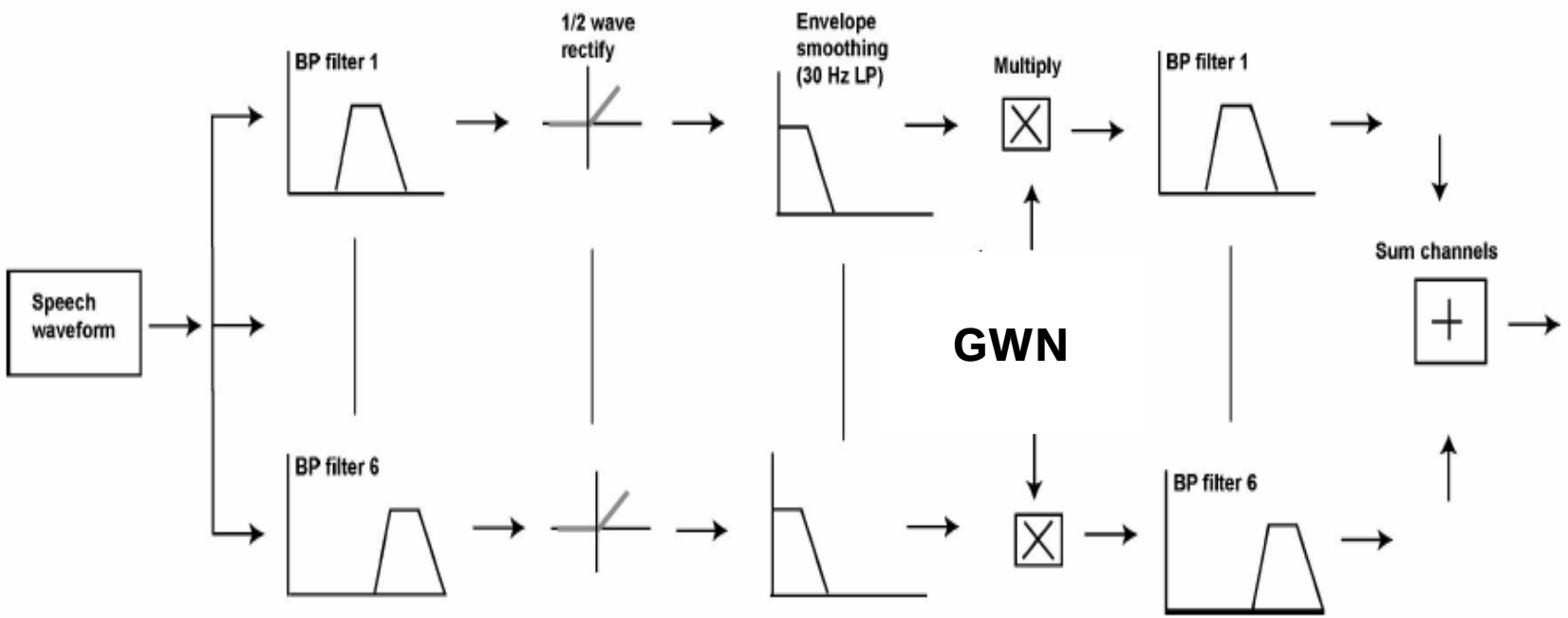
    (CIS simulation from University of Granada, Spain)
  - The same continuum was modified using technique described by Shannon et al. 1995, to study CI-simulated conditions.
  - Filters used were the default filters from a PSP processor.

Number of Channels	PSP Table							
	Filter 1	Filter 2	Filter 3	Filter 4	Filter 5	Filter 6	Filter 7	Filter 8
8	(250) 350-494	494-697	697-983	983-1387	1387-1958	1958-2762	2762-3898	3898-6800

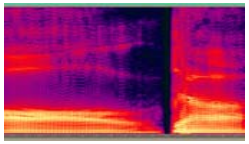
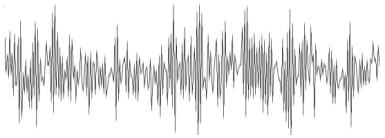



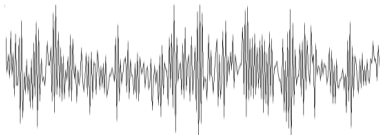
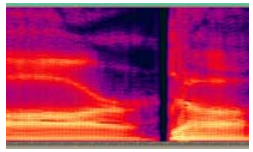
Simulation Algorithm



Analysis Filters

Synthesis Filters

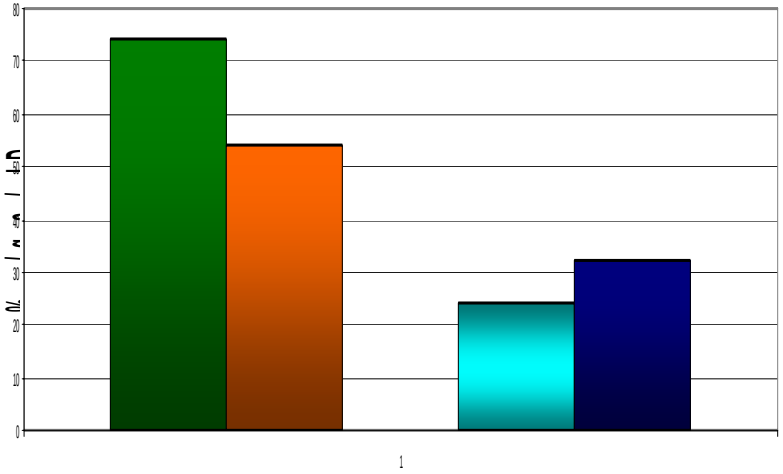



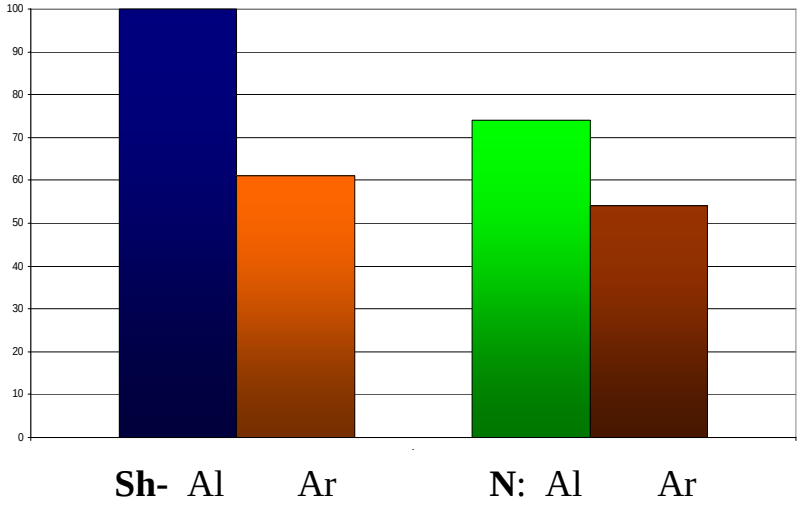
CI-Simulation Results

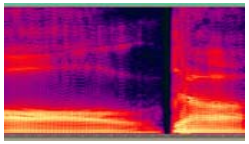
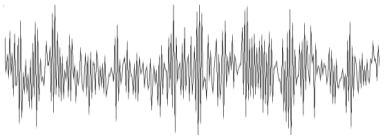
- CIS simulation in NH listener resulted in no effect (or slightly backwards) similar to CI-listeners
- Simulation using Shannon speech technique resulted in normal (or larger) context effects.

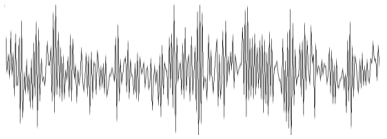
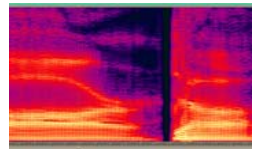
CI-Simulation - % /ga/ ID in the context of /al/ or /ar/ using CIS program



CI-Simulation - % /ga/ ID in the context of /al/ or /ar/ using Shannon Speech

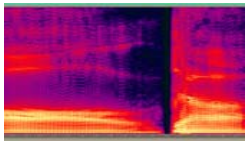
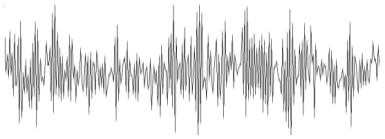


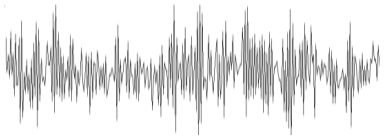
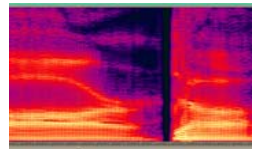



SUMMARY

- As predicted CI listeners showed normal temporal context effects but not spectral context effects. This is probably because of the substantial deviation of spectral patterns but preserved duration patterns in CI input.
- The lack of normal spectral context effects may have practical implications for situations in which there is substantial coarticulation (e.g., non-laboratory speech) or talker variability (e.g., switching between multiple speakers).
- The simulations using the CIS program, showed similar results to that of CI-listeners, but the Shannon speech technique showed larger shifts and more like NH listeners. The lower spectral resolution modeled in the Shannon speech is not enough to account for the effects. Some other component of the speech processing must play a role.

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Acknowledgments

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