The benefit of binaural hearing to spatial perception in normal and hearing impaired listeners

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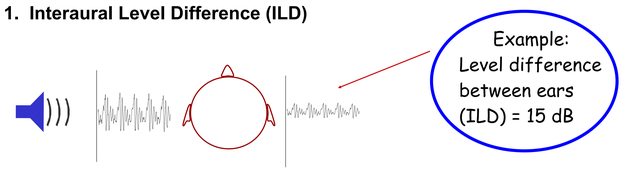
Introduction

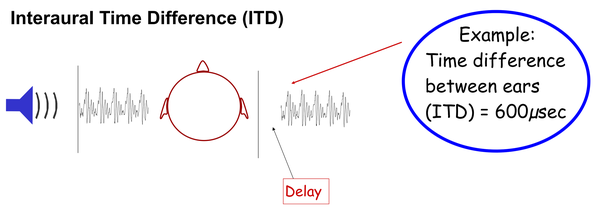
Hearing-impaired listeners complain of difficulty understanding speech in noisy environments. This difficulty is partly due to a diminished ability to use spatial location for segregating target speech from interfering speech (Noble and Gatehouse, 2006). Benefit in speech perception achieved from spatial separation is known as spatial release from masking (SRM). Certain auditory deficits and/or hearing aid processing could alter acoustic cues for spatial separation, and thus, potentially reduce SRM. Previous research has shown that normal hearing listeners get SRM even when given limited spatial cues. This study investigates SRM in hearing-impaired listeners when spatial cues are fully available and when they are altered.

Main acoustic cues for spatial perception

1. Interaural Level Difference (ILD)

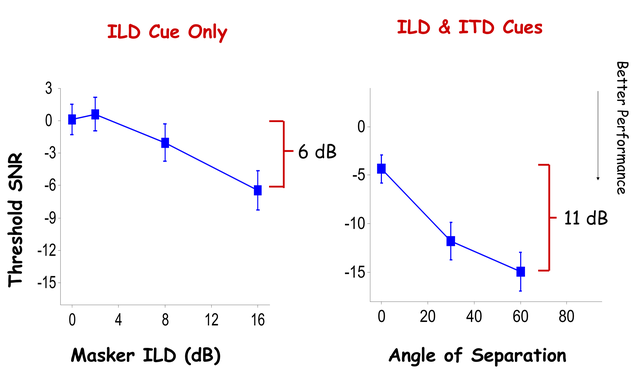


2. Interaural Time Difference (ITD)

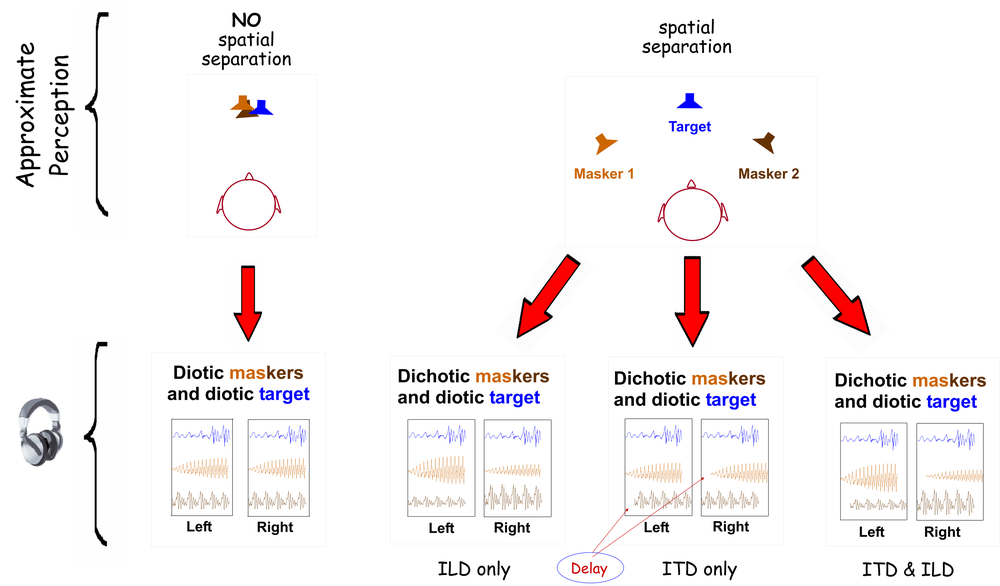


Previous research with normal hearing listeners

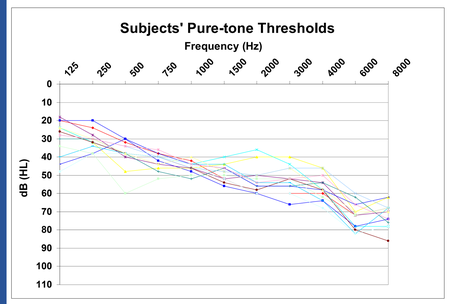
Previous research has shown that normal hearing listeners obtain a significant spatial release from masking (SRM) even when limited spatial cues are provided (Kalluri, 2007).



Experimental Set-up



Subjects



- Average age = 69 years (range: 55-79 yrs)
- 5 subjects in each condition

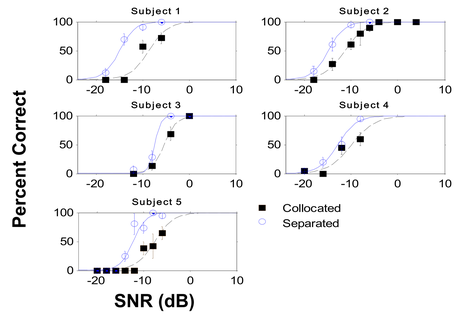
Methods

- Target speech = string of 5 digits spoken by a male talker.
- Maskers = two different samples of continuous speech spoken by the same female talker.
- Subjects were asked to repeat the target speech
- Feedback was provided

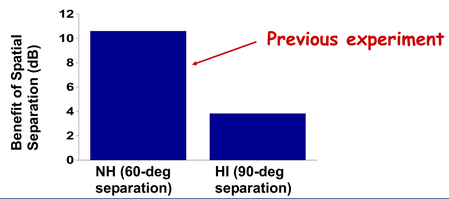
Results: Hearing-impaired listeners get limited SRM when full spatial cues are available

Spatial separation with ITD and ILD cues using HRTFs.

All five subjects obtained some spatial release from masking when full spatial cues were provided.

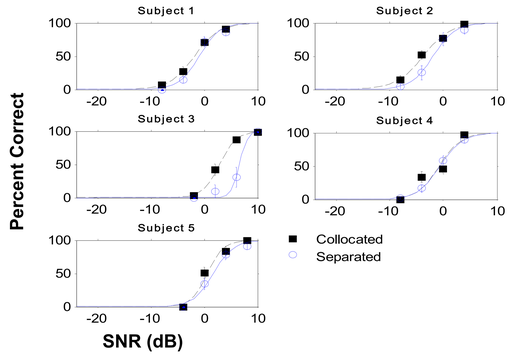


Hearing-impaired listeners obtained significantly less benefit of spatial separation than normal hearing listeners

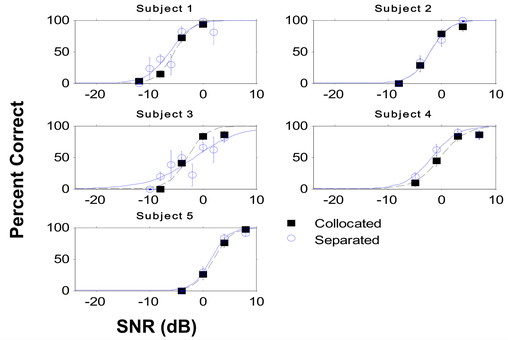


Results: Hearing-impaired listeners get no SRM when only limited spatial cues are available

Subjects were not able to obtain any spatial release from masking when spatial cues were limited to ILD only.



Subjects were not able to obtain spatial release from masking when spatial cues were limited to ITD only.



Conclusions

- Hearing-impaired listeners are less able than NH listeners to use spatial cues to improve intelligibility.
- HI listeners completely fail to benefit from spatial separation if spatial cues are limited.
- Hearing aid signal processing should preserve all spatial cues in order to preserve spatial release from masking in hearing-impaired listeners.

References

- Kalluri, S. and Edwards, B. (2007) "Impact of hearing impairment and hearing aids on benefits due to binaural hearing", 19th International Congress on Acoustics in Madrid, Spain.
- Kalluri, S., Shinn-Cunningham, B., Eiler, C, and Edwards, B. (2006). "Interaction of hearing-aid compression with spatial unmasking", International Hearing Aid Research Conference in Lake Tahoe, CA.
- Noble and Gatehouse (2006) "Effects of bilateral versus unilateral hearing aid fitting on abilities measured by the Speech, Spatial, and Qualities of Hearing Scale (SSQ)", *Int. J. Audiol.* **45** (3):172-81.