Hearing Aids and Speechreading

Should Visual Speech Cues be Considered when Fitting Hearing Aids?

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Of Course?

- Visual speech cues (speechreading) provides as much or more useful speech information than amplification
- Speechreading and hearing ***interact*** to effectively reduce background noise by roughly 8 dB
- Listeners find themselves in face-to-face communication situations often
- Multimemory hearing aids can be programmed to include a separate setting when visual cues are available

However…The Prevailing View

There is no need to consider speechreading when designing and fitting hearing aids because:

Speechreading is a constant. The benefit of adding visual cues to amplification does not depend on the details of the amplified acoustic speech signal.

The Prevailing View (continued)

If this assumption is true:

Any improvement in hearing aid design or fitting algorithm will result in improved auditory-visual performance as well. Therefore, manufacturing efforts should be focused on improving ***auditory*** speech recognition.

Counter Argument

Speechreading does not provide a constant amount of benefit to audition.

The amount of speech perception benefit due to visual cues depends on the degree of redundancy between the information available auditorily and the information available visually.

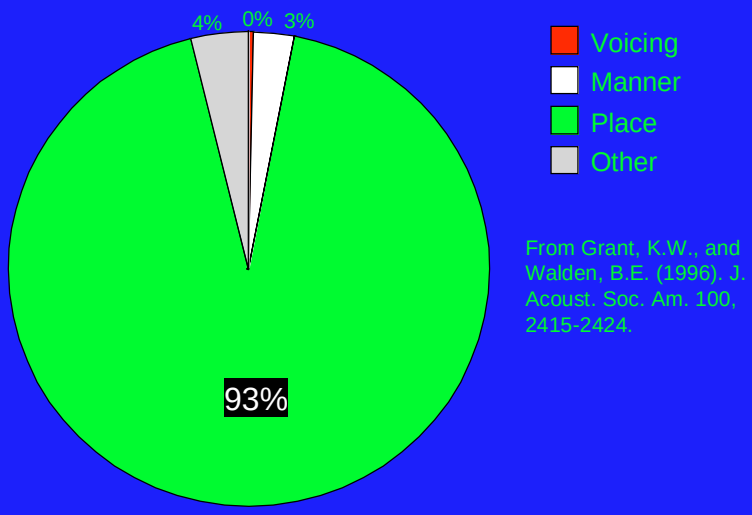
Therefore:

In order to optimize auditory-visual speech perception, visual speech information and auditory speech information needs to be considered when designing hearing aid processors.

Information Provided by Speechreading

- Lots of information about place of articulation
- Some information about manner of articulation
- Virtually no information about voicing

Visual Feature Distribution



From Grant, K.W., and Walden, B.E. (1996). J. Acoust. Soc. Am. 100, 2415-2424.

%Information Transmitted re: Total Information Received

How Successful Are Hearing Aids?

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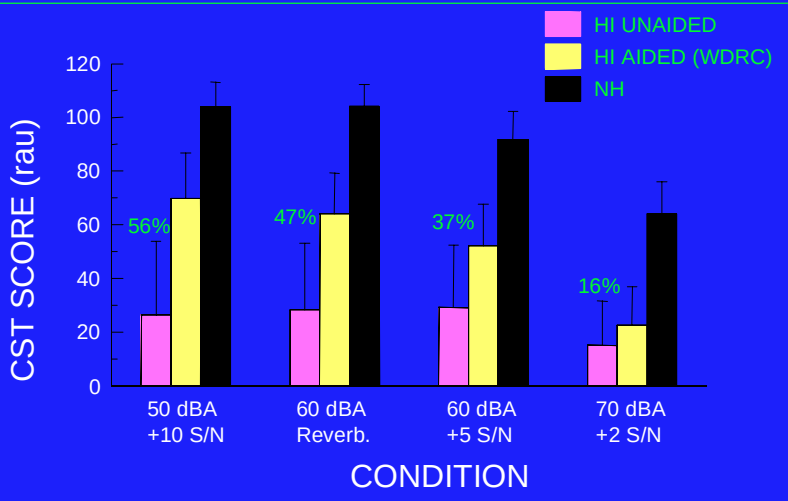
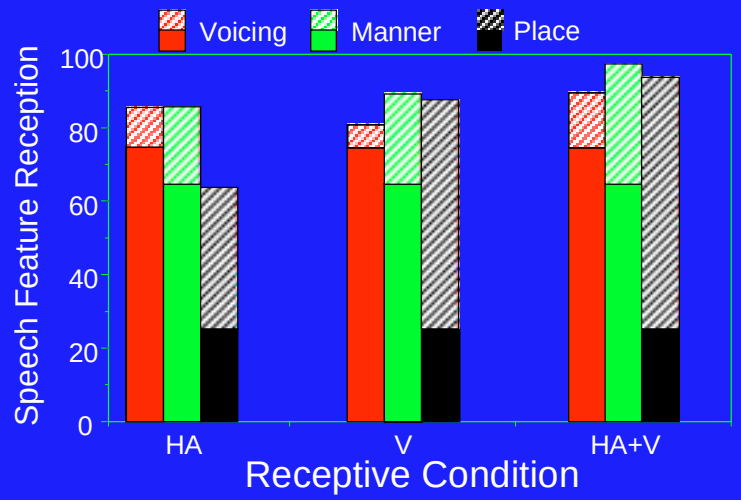


From Walden, B. E., Surr, R. K., Cord, M. T., & Pavlovic, C. V. (1998). American Journal of Audiology, 7, 85-100

Information Provided by Hearing Aids

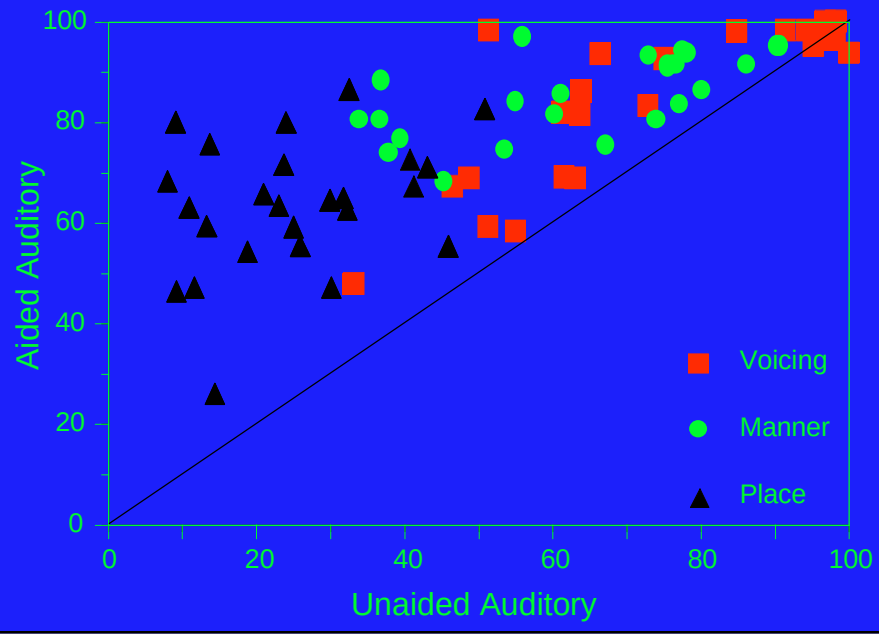
- Moderate information about place of articulation
- Moderate information about manner of articulation
- Poor to moderate information about voicing

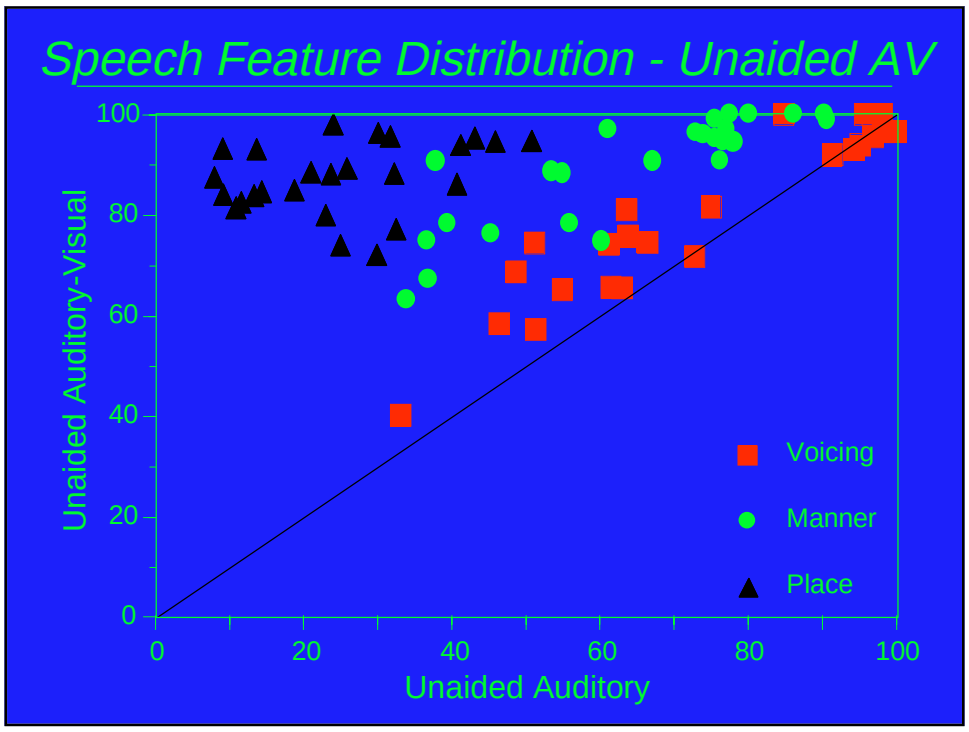
Information Provided by Hearing Aids and Visual Cues

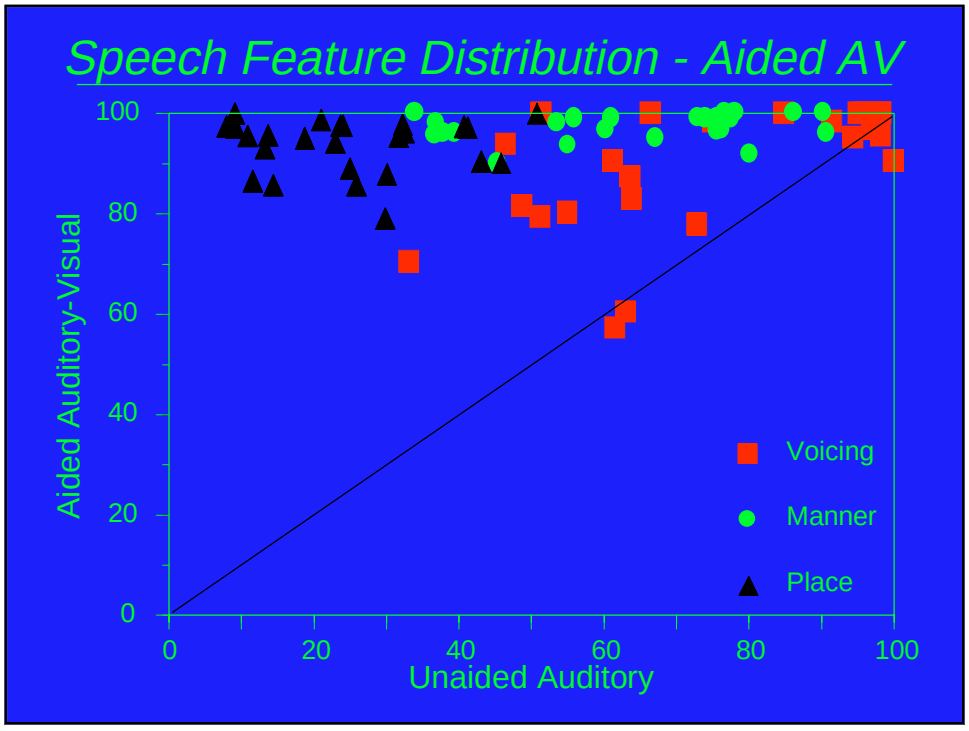


From Walden, B.E., Grant, K.W., and Cord, M.T. (2001). Ear and Hearing 22, 333-341.

Speech Feature Distribution - Aided A




Speech Feature Distribution - Unaided AV
Unaided Auditory-Visual
Unaided Auditory
0
20
40
60
80
100
Voicing
Manner
Place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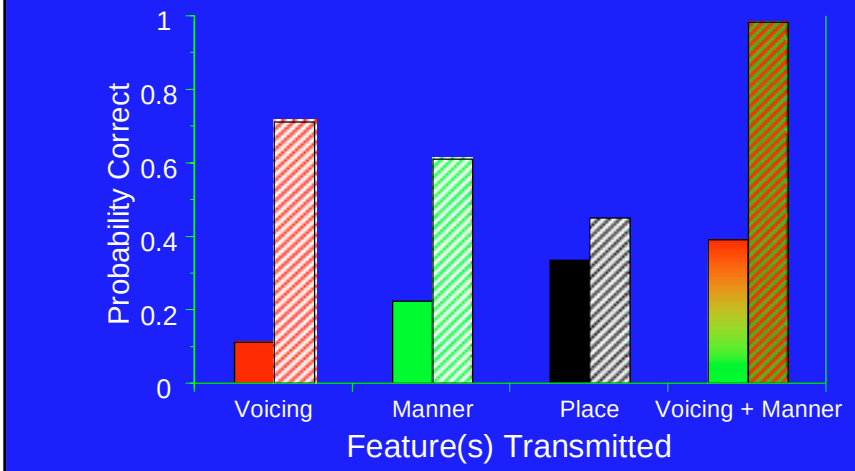
Optimizing AV Speech Recognition

- To optimize AV speech recognition, voicing and manner-of-articulation information needs to be transmitted better

- Models of auditory-visual integration suggest that optimizing auditory speech recognition alone will not necessarily result in optimal AV speech recognition

Hypothetical Consonant Recognition - Perfect Feature Transmission



A — Auditory consonant recognition based on perfect transmission of indicated feature. Responses within each feature category were uniformly distributed.

PRE — Predicted AV consonant recognition based on PRE model of integration (Braida, 1991).

The Set Up and The Big Question

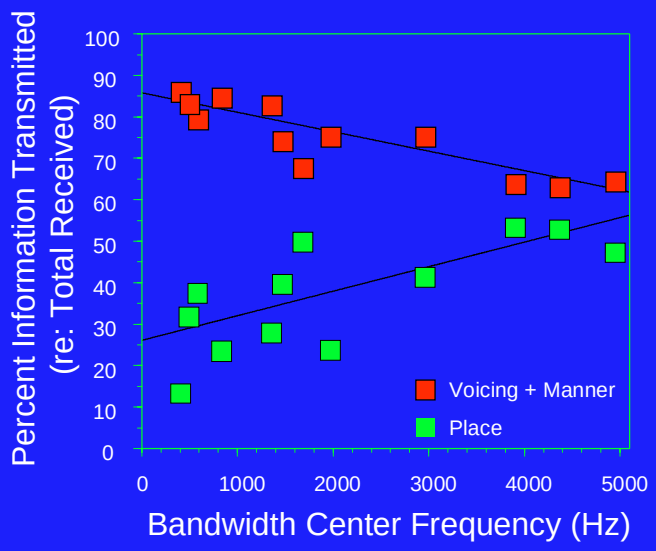
Hearing aid manufacturer's are actively trying to reduce environmental noise in order to improve the speech-to-noise ratio.

This has to be a good thing.

Do current processing algorithms designed to improve the speech-to-noise ratio (e.g., directional microphones, noise reduction) interact in a negative way with speechreading?

Only if they unwittingly reduce the transmission of voicing and manner information.

Feature Distribution re: Center Frequency



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The Set Up and The Big Question (Continued)

Typical (auditory only) strategies for hearing aid fitting may reduce low-frequency speech cues.

Roll off low frequency energy:

- avoid upward spread of masking
- direction microphones result in reduced gain in low frequencies
- attenuate low frequencies in noise to enhance comfort

Distortion of temporal cues:

- compression

Final Thoughts

Given that visual cues offer so much potential to improve speech recognition, how can we not try to optimize auditory-visual performance?

Auditory and visual cues ***DO*** interact to determine speech recognition benefit (redundant vs. complementary cues)

Multimemory hearing aids used when visual cues are available would try to optimize voicing and manner cues.

The challenge is to improve voicing and manner cues without exacerbating speech communication problems in noise.