Poster #5aPP1

WAISMAN CENTER

A "better ear" listening strategy for improving speech-in-noise understanding in bilateral cochlear implant users

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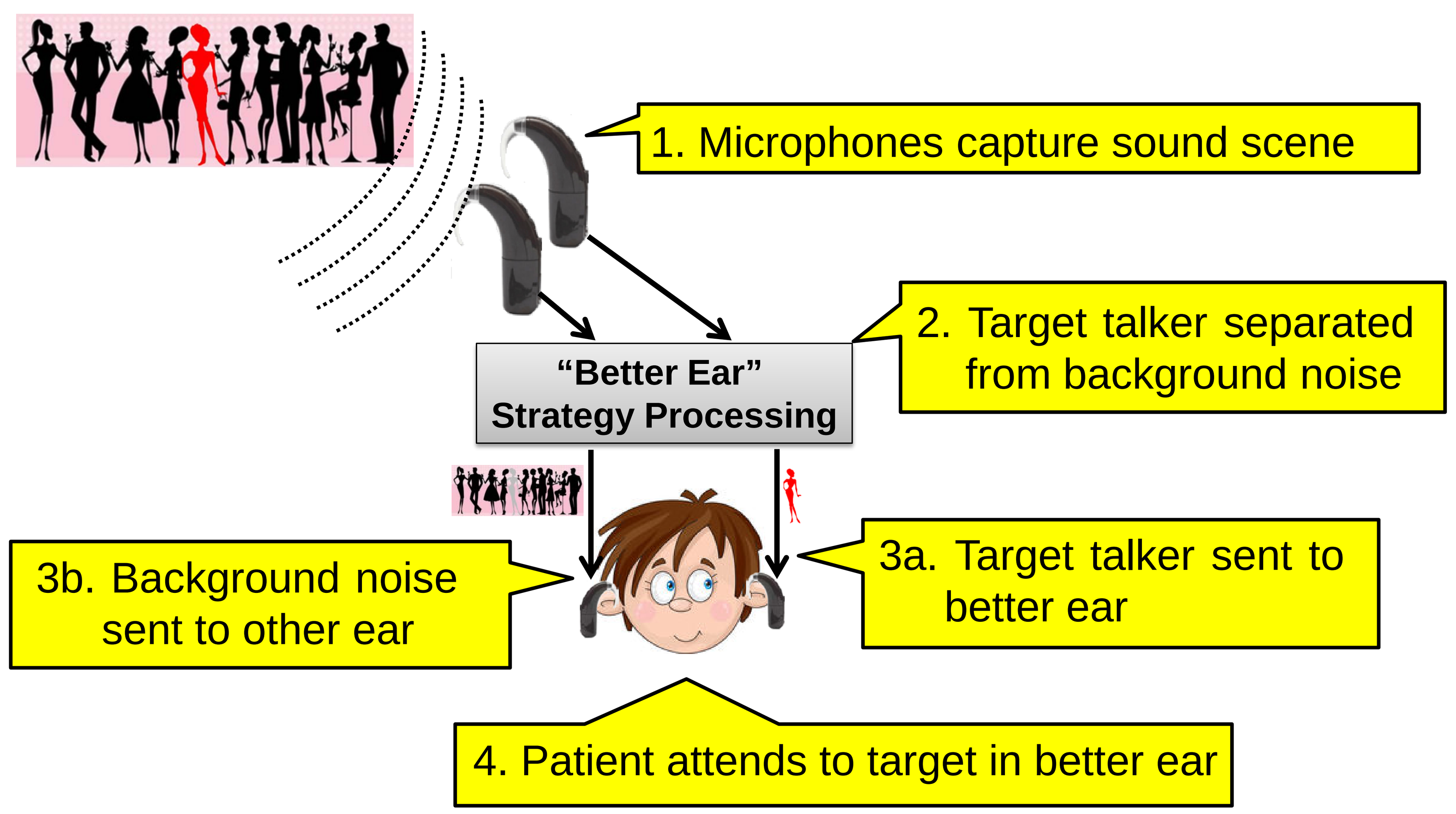
INTRODUCTION

- For bilateral cochlear implant (**BiCI**) users, understanding a target talker in noisy situations is difficult. Most efforts for improving speech-in-noise understanding have focused on improving the signal-to-noise ratio (**SNR**) using multi-microphone techniques and signal processing with only moderate improvements in performance.
- BiCI users typically report having a "better ear" for listening, and recent data (Goupell et al., 2013) have shown that they have a "better ear" for speech unmasking performance.

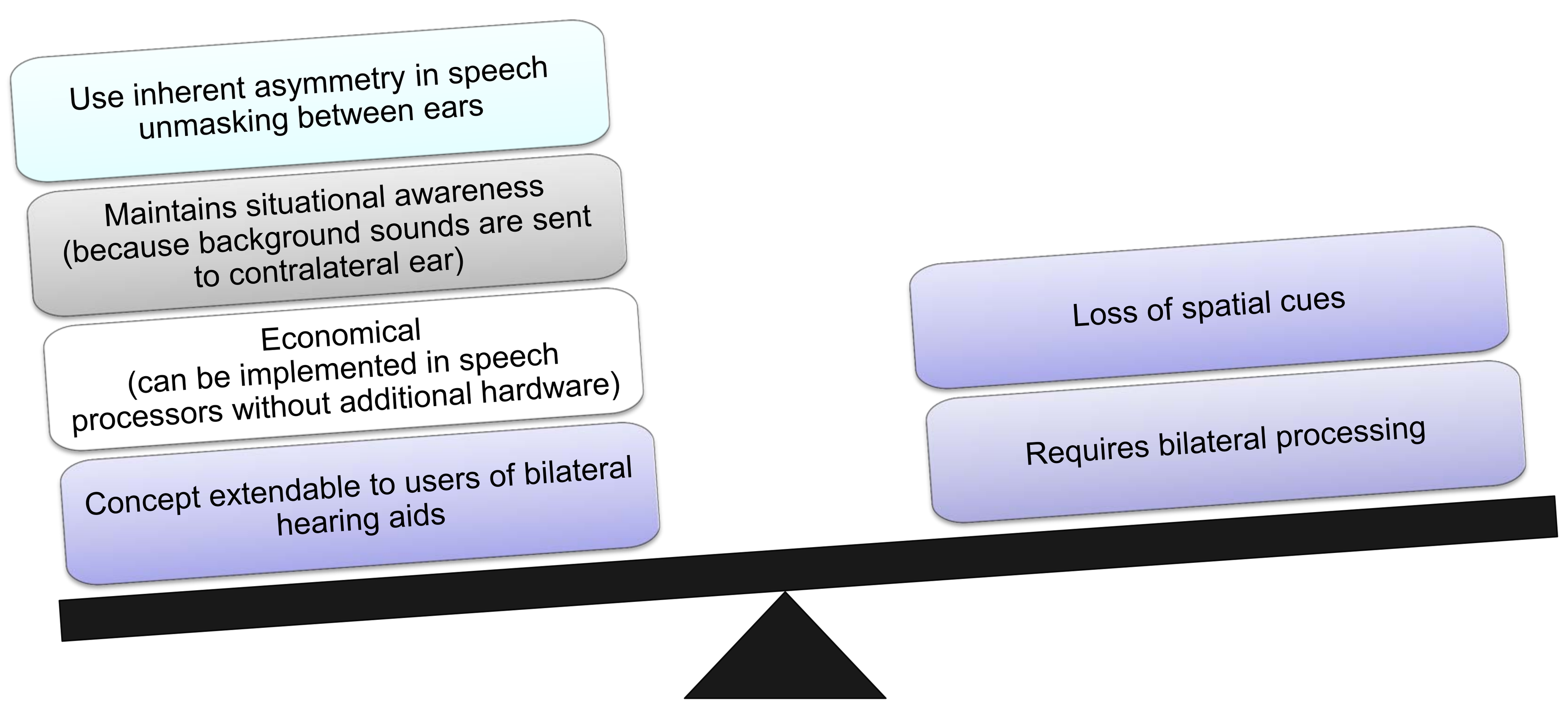
This work proposes to take advantage of the "better ear" for speech unmasking, as a way of improving speech-in-noise understanding in bilateral cochlear implant users.

THE "BETTER EAR" STRATEGY CONCEPT



Advantages

Limitations



IMPLEMENTATION

Target-background separation can be achieved using algorithm from Kan et al. (2008)

- Model microphone signals, M1 and M2 as:

$$M1 = G_1 \times T + B_1 \times N \qquad M2 = G_2 \times T + B_2 \times N$$

where G_1 and G_2 are the directional gains applied to the target signal, T, and B_1 and B_2 are the directional gains applied to the background noise, N.

- Estimate T and N at each time-frequency bin by:

$$T' = W_1 \times M1 + W_2 \times M2 \qquad N' = W_3 \times M1 + W_4 \times M2$$

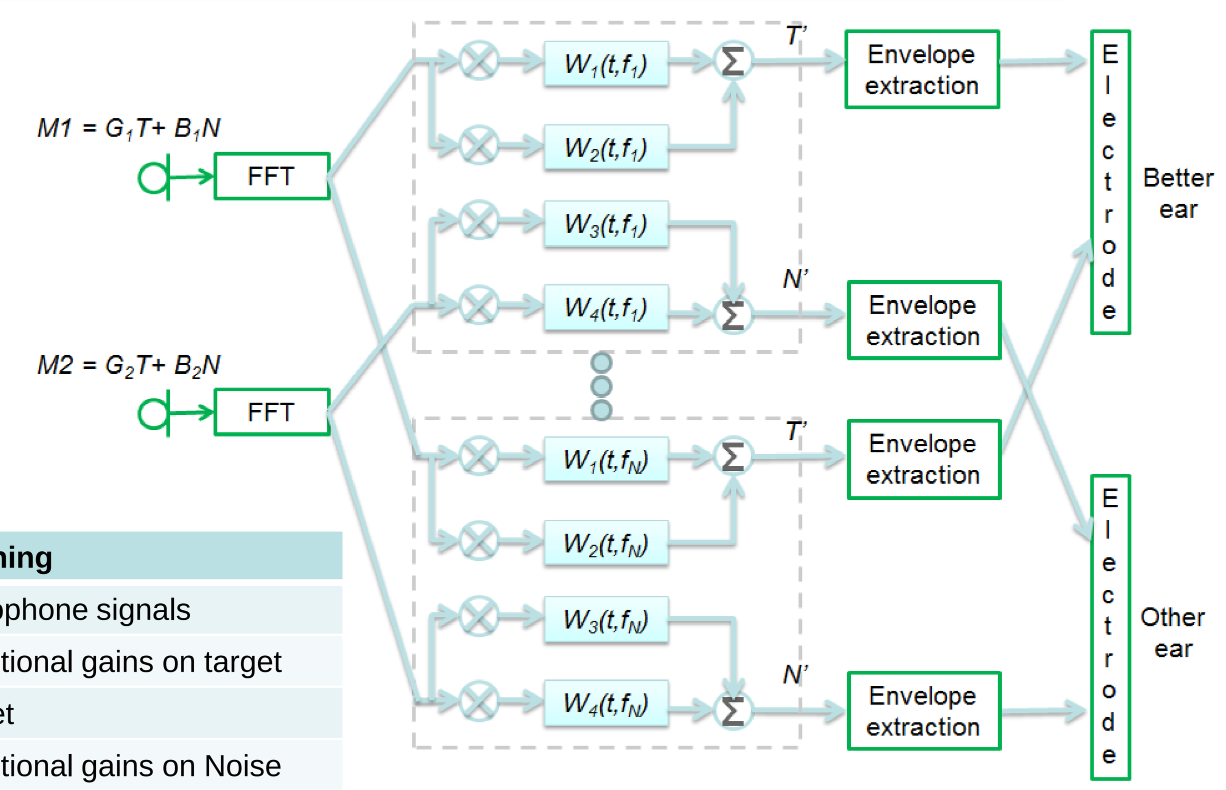
where W_1, W_2, W_3 and W_4 are optimal weights in the least-mean-squared error sense.

- By assuming location of target is known and that the target and background noise are uncorrelated:

$$W_1 = 1 / (G_1 - \beta \times G_2) \qquad W_2 = -\beta / (G_1 - \beta \times G_2)$$
$$W_3 = G_2 / (G_2 - \beta \times G_1) \qquad W_4 = -G_1 / (G_2 - \beta\, G_1)$$

where $\beta = (G_2 \times \rho_{M1M1} - G_1 \times \rho_{M1M2})/(G_2 \times \rho_{M1M2} - G_1 \times \rho_{M1M2})$. ρ_{xx} and ρ_{xy} denotes the auto- and cross-correlations, respectively.

Signal Block Diagram



Variable	Meaning
M1, M2	Microphone signals
G_1, G_2	Directional gains on target
T	Target
B_1, B_2	Directional gains on Noise
N	Noise
W_1, W_2, W_3, W_4	Estimated weights applied to M1 & M2

ACKNOWLEDGEMENTS

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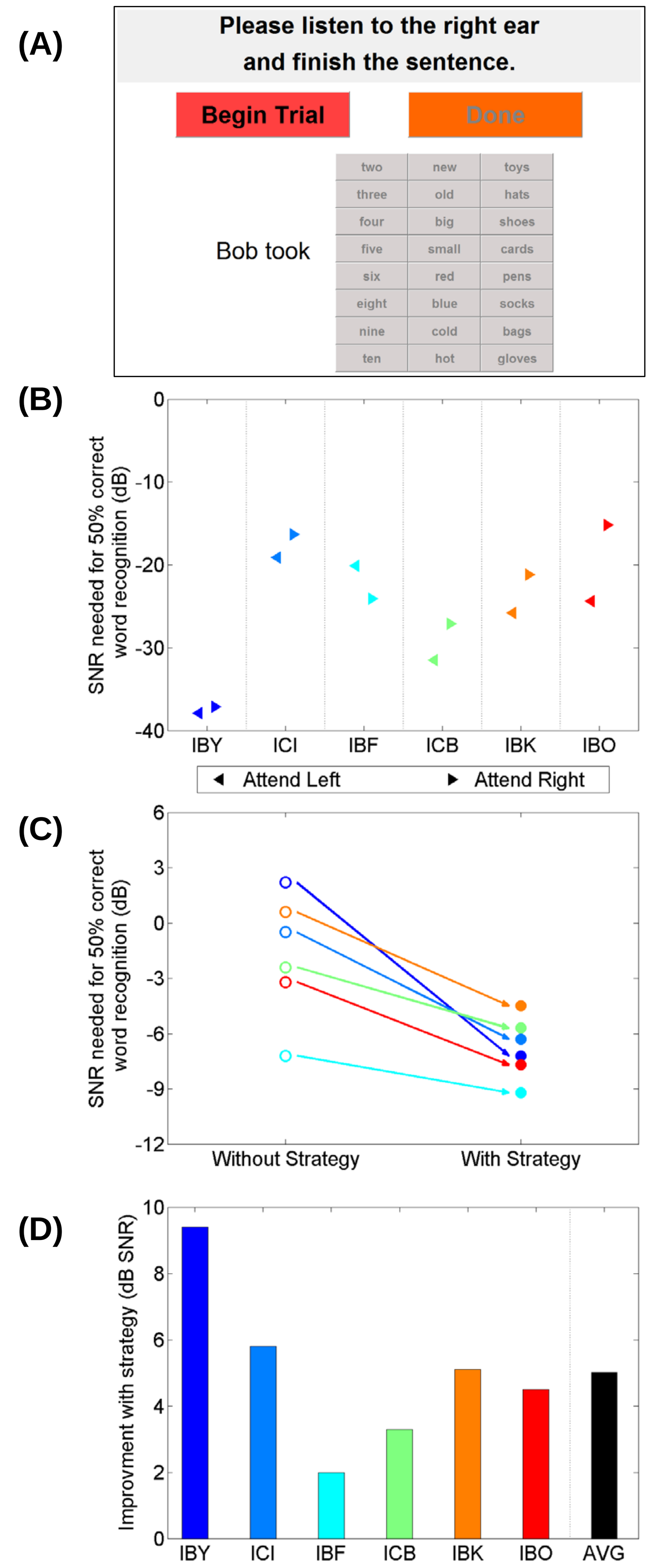
EXPERIMENT

Methods

- Six post-lingually deafened BiCI subjects.
- Stimuli was pre-processed and delivered to clinical processors via direct connect cables.
- Male target and two male maskers from Kidd et al., (2008) corpus. Target talker always began sentence with "Bob took". Response interface shown in Fig. A.
- 18 sentences per SNR (54 words scored).
- SNR = 6, 3, 0, -3, -6, -9, -12 dB.
- To determine "better ear", target talker was played to either left or right ear, while maskers were played to contralateral ear. Subject was instructed to attend to the ear with target talker.
- To test "better ear" strategy, individualized head-related transfer functions were used to create a virtual sound scene with target talker in front and a masking talker on either side (without strategy condition). Kan et al., (2008) algorithm applied to virtual sound scene to separate target from maskers. Subject attended to target played in better ear and ignored maskers in contralateral ear (with strategy condition).

Results

- Subjects show a range of asymmetry in performance when attending to target on left and right, ranging from 1 to 9 dB (Fig. B).
- <u>All subjects show an improvement</u> when listening with the "better ear" strategy (Fig. C & D)



CONCLUSION

Bilateral implant users typically have a "better ear" for speech unmasking. We can take advantage of the "better ear" to improve word recognition in noise by combining: (1) *a priori* knowledge of the "better ear" and having the implant user attend to a target talker in that ear, with (2) signal processing that sends the target talker to the "better ear" and the background noise to the other ear.

REFERENCES

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