

WORD RECOGNITION IMPROVEMENT IN QUIET AND NOISE WITH A NEW BiCROS SYSTEM

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INTRODUCTION

People with asymmetric hearing loss with one unaidable and one aidable ear have reduced speech intelligibility for several reasons: the inability to separate background noise from the signal of interest, the lack of binaural summation effect, and difficulties hearing the signal of interest coming from the side of the unaidable ear. This type of hearing loss may have considerable consequences to individual's lifestyle. Regularly missing out on conversation, or finding communication in particular situations unusually demanding and fatiguing, heightens the risk of withdrawal, which may impact work, family, and social life.

CROS (Contralateral Routing Of Signals) and BiCROS (Bilateral CROS) hearing aid systems enable listeners with asymmetric hearing loss hear sounds from both sides of the head when the hearing ability in one ear cannot be helped by traditional hearing aids. A CROS/BiCROS hearing aid system transmits sound from the ear with no functional hearing to a receiver on the ear with normal or aidable hearing. The use of CROS/BiCROS system can help the individuals with unaidable asymmetric hearing loss to hear better in noisy environments when the desired sound is on the side of the head with no functional hearing. This could occur when having a conversation in a challenging environment such as a noisy room, driving in a car, or in a group discussion.

The current study examined the impact of asymmetric hearing loss with one unaidable ear and the use of WIDEX CROS system on speech identification in quiet and in noise when speech was presented to the unaidable ear.

WIDEX CROS

Widex CROS was developed to meet the needs of people with asymmetric hearing loss with one unaidable ear. The WIDEX CROS system includes two options of contralateral routing of signal.

The **CROS** system is targeted at people with asymmetric hearing loss with one unaidable ear and one normal-hearing ear. The transmitter is placed behind the unaidable ear. Here it picks up sound and wirelessly transmits it to the receiver hearing aid on the normal-hearing ear.

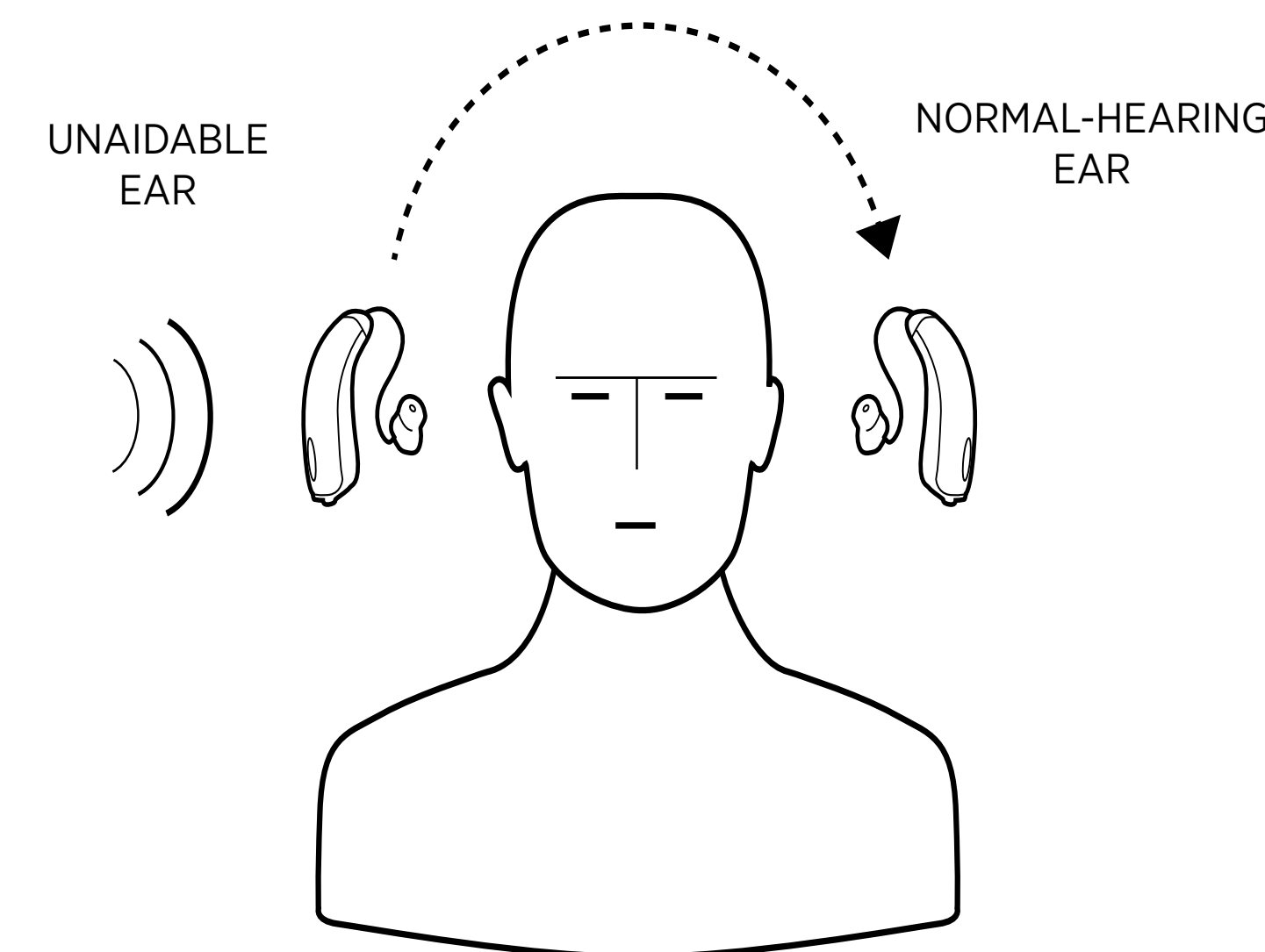


Figure 1: WIDEX CROS

The **BiCROS** system is targeted at people with asymmetric hearing loss with one unaidable ear and some degree of hearing loss in the aidable ear. The transmitter is placed behind the unaidable ear. Here it detects sound and wirelessly transmits it to the receiver hearing aid on the aidable (hearing-impaired) ear. The receiver hearing aid also amplifies sound on the aidable ear, so that it matches the degree of hearing loss in this ear.

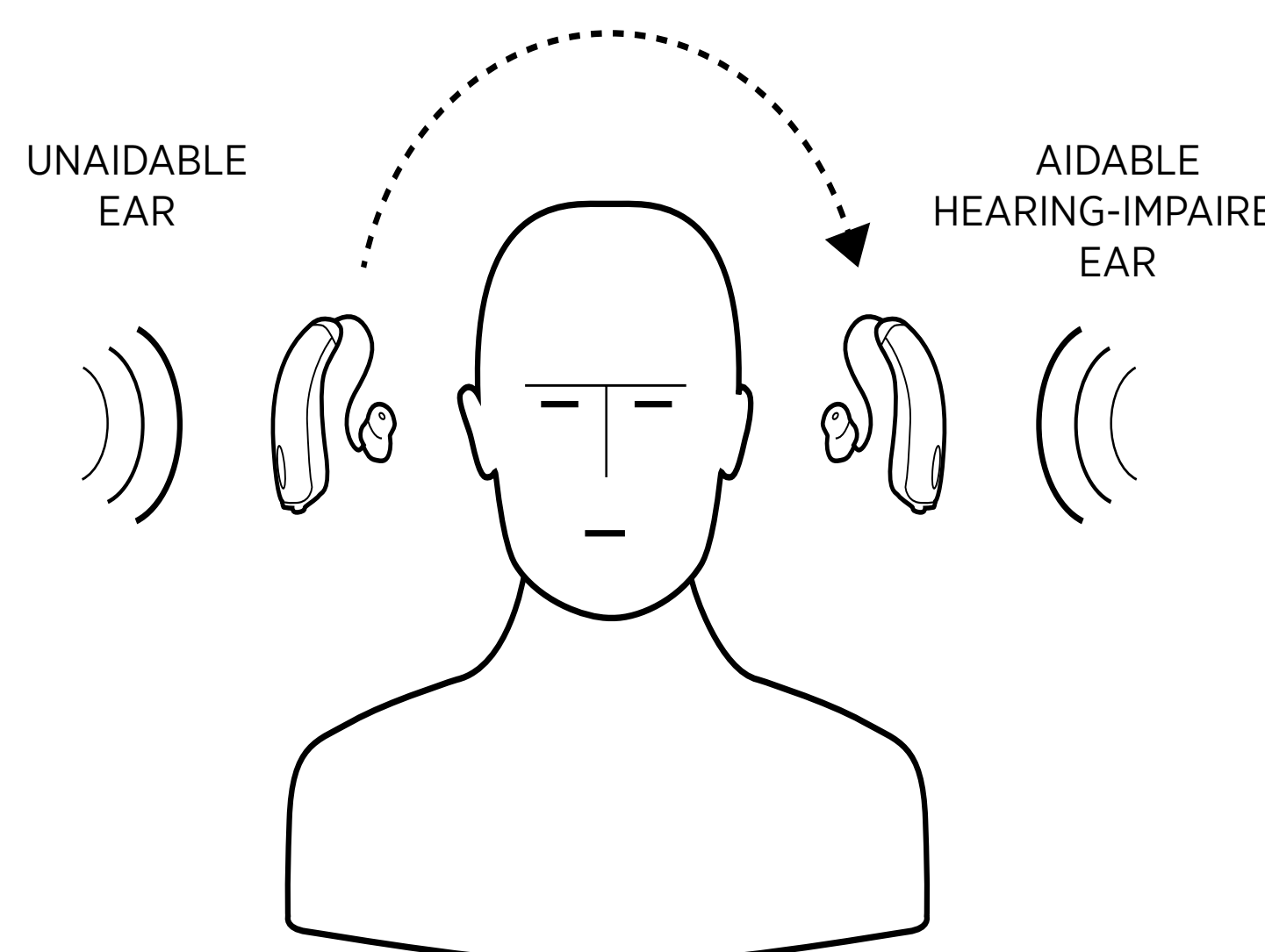


Figure 2: WIDEX BiCROS

PARTICIPANTS

Six listeners between 63 – 78 yr (mean = 69 yr, SD = 5.5) with asymmetric sensorineural hearing loss (various etiologies) participated in the study. On average, the participants had worn hearing aids for 10.3 yr (SD = 6.4 yr). Five participants had the right ear as the better ear while one had the left ear as the better ear. One participant's pure tone average was about 60 dB HL in the poorer ear, but he was included in the study because his speech discrimination in that ear was poor (20%).

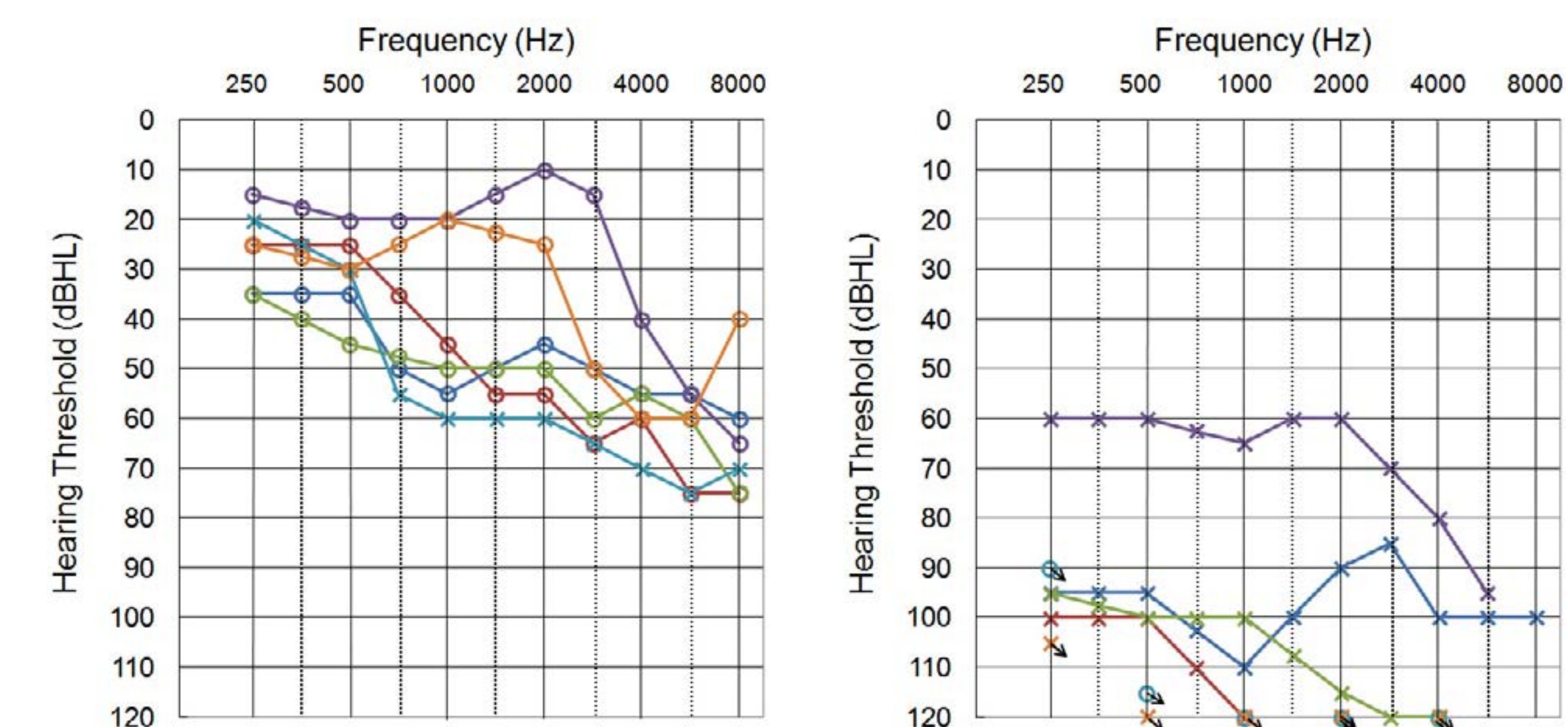


Figure 3: Audiograms for the individual participants. Better ear (left panel); Poorer ear (right panel).

HEARING INSTRUMENT

Each subject was fitted with WIDEX DREAM Fashion440 BTE hearing aids on the aidable ear and with WIDEX CROS transmitter on the unaidable ear.

WIDEX CROS features:

The WIDEX CROS mini-BTE transmitter includes a choice of Omni or Locator (fully adaptive directional) microphone. WidexLink technology uses near field magnetic induction (NFMI) to transmit the sound wirelessly with extremely low power. The current during transmission is 0.89 mA (312 battery). Widex-Link provides robust, distortion free, low delay (<10 ms) audio stream. The upper limit of the input range is 113 dB SPL.

WIDEX DREAM hearing aid:

WIDEX DREAM is a 15-channel wide dynamic range digital hearing aid. The A/D stage of this device uses a sampling rate of 32 kHz and 20-32 bit resolution. The maximum power output (MPO) is 132 dB SPL and frequency response ranges from 100 Hz to 6750 Hz (ANSI S3.22-2009). The upper limit of the input range is 113 dB SPL. This hearing aid uses slow-acting compression with an attack time of up to 2 sec in each of the 15 channels. Among the features of this device are noise reduction, adaptive feedback cancellation, and impulse noise management. These features remained in their default settings.

Hearing aid conditions:

1. Better ear Omni
2. Better ear Locator
3. Better ear Omni, CROS Omni
4. Better ear Omni, CROS Locator
5. Better ear Locator, CROS Omni
6. Better ear Locator, CROS Locator

SPEECH IN NOISE

Hearing in Noise Test (HINT) sentences were presented from the side of unaidable ear. Speech weighted continuous noise was presented from 0°, 180°, and the aidable ear side at a combined level of 68 dB SPL. Speech reception threshold (SRT) (50% correct) was measured by adjusting the level of the speech.

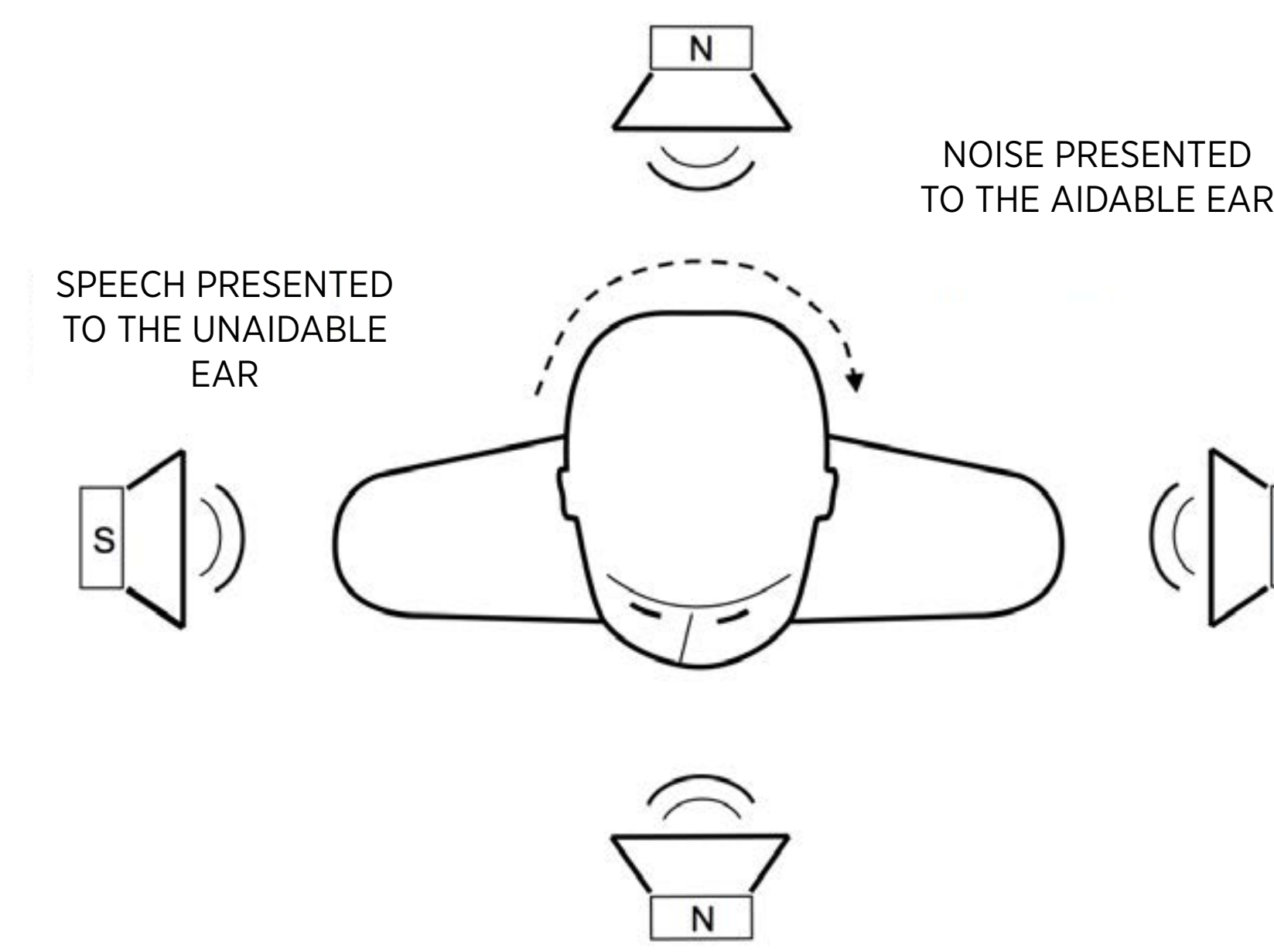


Figure 4: Hearing in the noise test

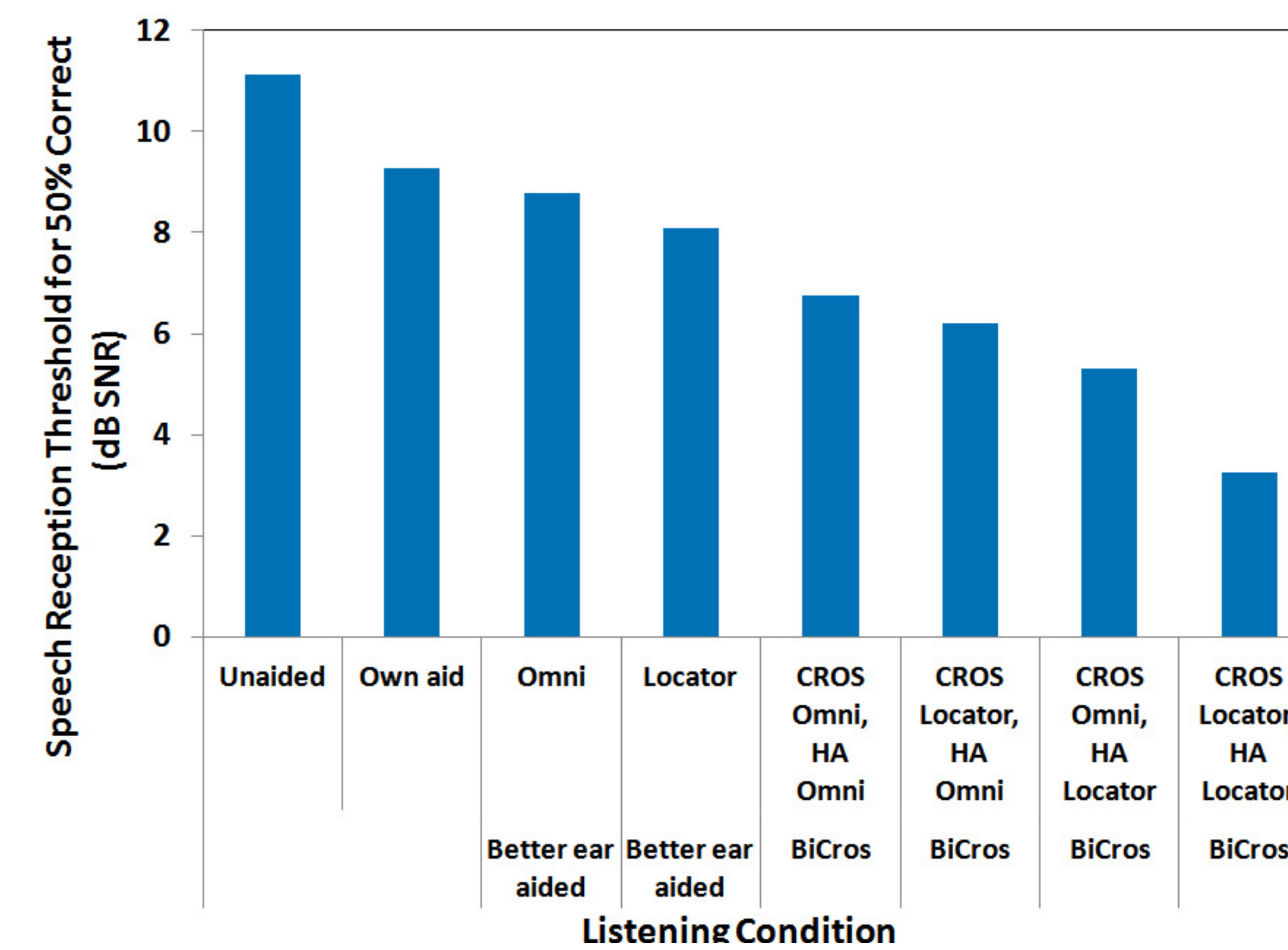


Figure 5: Average speech reception threshold (50% correct) in dB SNR in the HINT test for different listening conditions. Speech was presented from the unaidable ear side.

Figure 5 summarized the SNR required for 50% correct identification on the HINT across various hearing aid conditions. A lower SRT suggests better performance.

- The SRTs at the different listening conditions were: 11.1 dB (Unaided), 9.3 dB (Own aid), 8.8 dB (Omni), 8.1 dB (Locator), 6.7 dB (CROS Omni, HA Omni), 6.2 dB (CROS Loc, HA Omni), 5.3 dB (CROS Omni, HA Loc), 3.3 dB (CROS Loc, HA Loc).
- The use of WIDEX CROS improved the performance up to 7.9 dB compared to no amplification ($p < 0.05$). The improvement was up to 5.5 dB compared to when only using amplification on the better (hearing impaired) ear ($p < 0.05$).
- The CROS users demonstrated the best performance when using the Locator (fully adaptive directional) microphone both in the WIDEX CROS transmitter and in the DREAM hearing aid. The use of the Locator microphone in the WIDEX CROS improved the performance by 2.0 dB compared to when using omnidirectional microphone in the CROS transmitter.
- The use of WIDEX CROS improved the SNR over the unilateral fitting by 4.8 dB when both microphones on the BiCROS system were directional even when the hearing aid in unilateral fitting had a directional microphone.

SPEECH IN QUIET

ORCA-NST nonsense syllable test was presented in quiet at 50 dB SPL from the side of unaidable ear. This test consists of 32 nonsense syllable words (CVCVC) including 25 consonants found in American English. Both the WIDEX DREAM HA and the WIDEX CROS used Locator microphone.

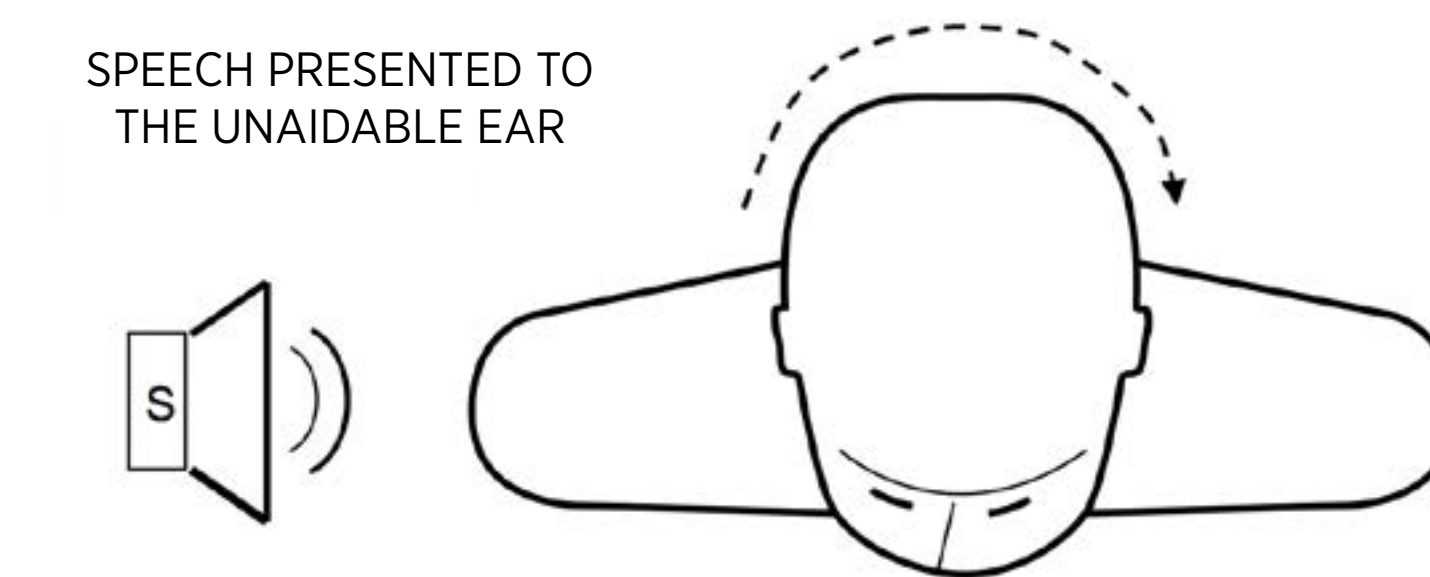


Figure 6: Speech identification in the quiet test

The vowel and consonant identification accuracy for different listening conditions were displayed in Figure 7.

- The participants own aid provided no significant benefit for consonants. The use of WIDEX DREAM improved the consonant identification performance by 30% compared to subjects' own aid. This improvement was achieved with the default WIDEX gain. The fitting software allows the clinician to select increased gain for soft sounds, but this option was not used in the current study.
- The use of WIDEX CROS improved the consonant identification performance by 46.7% compared to no amplification. The improvement was 10.5% compared to when they only used amplification (WIDEX DREAM) on the better (hearing impaired) ear.

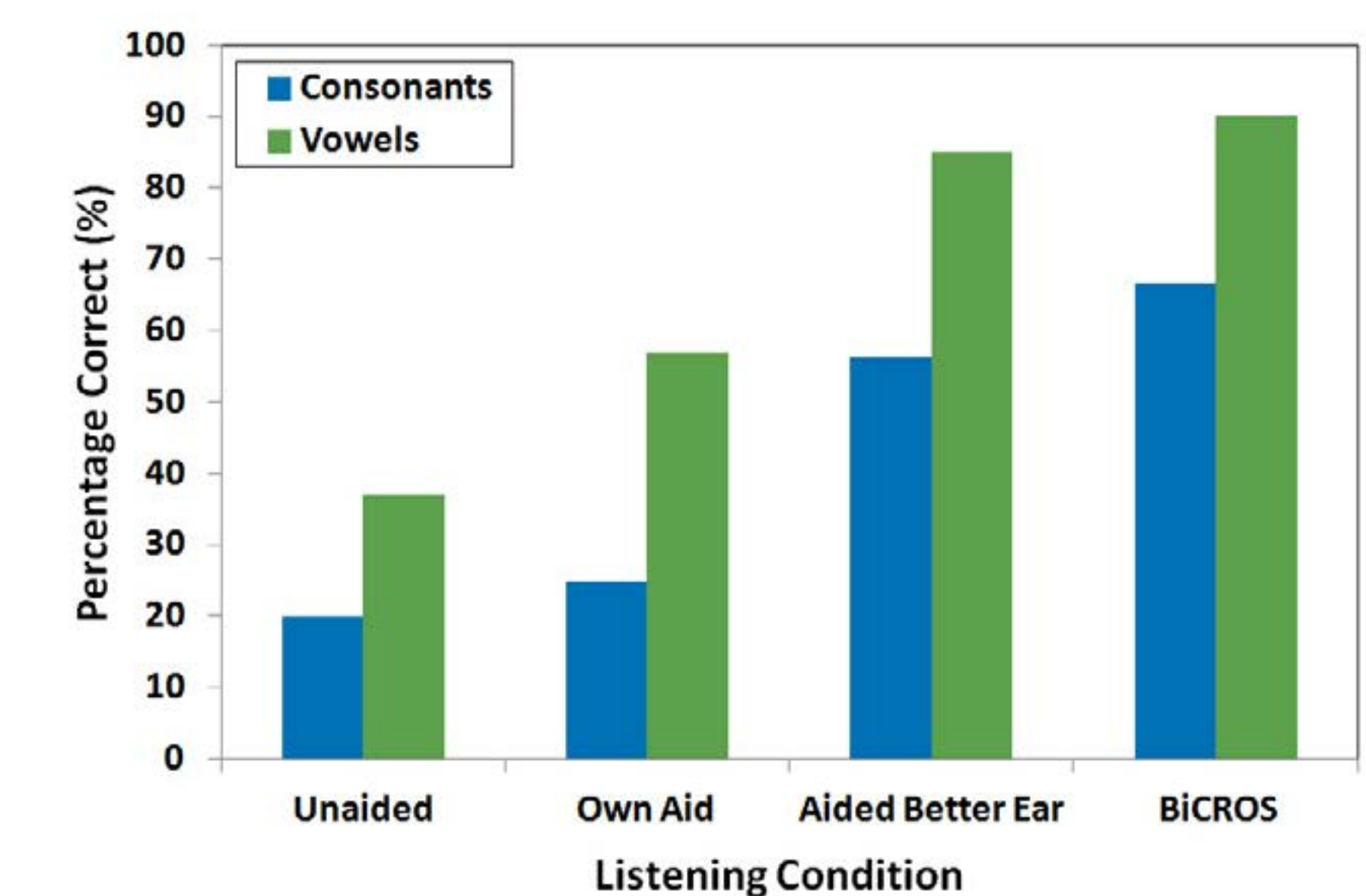


Figure 7: Average consonant and vowel identification performance in the ORCA-NST test for different listening conditions. Speech was presented at 50 dB SPL from the unaidable ear side.

CONCLUSIONS

The new WIDEX CROS offers superior technology to help minimize the detrimental effects of asymmetric hearing loss with one unaidable ear by wirelessly transmitting sound from the side of the unaidable ear to the user's aidable or normal-hearing ear. The objective of the current study was to determine the improvement of speech intelligibility when using this device. The results from the objective testing showed that the WIDEX CROS improved the participants' speech intelligibility significantly in quiet and in noise when speech was presented to the unaidable ear. WIDEX CROS includes a choice of fully adaptive directional microphone (Locator) in the transmitter. This feature was demonstrated to provide an additional improvement in speech-in-noise performance compared to when using omnidirectional microphone in the CROS transmitter.

REFERENCES

Kuk F, Lau C, Korhonen P, Crose B, Peeters H, Keenan D. (2010) Development of the ORCA Nonsense Syllable Test. Ear Hear 31(6):779-795.