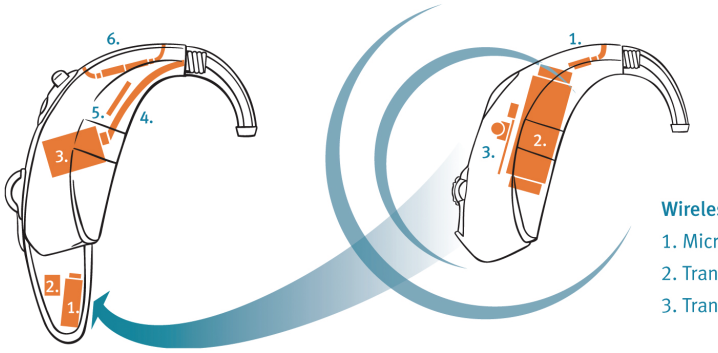
WiFi mic

Digital Wireless CROS/BiCROS

Wireless Freedom Plus Digital Performance



Executive Summary

The management of hearing loss is a challenging task that can become even more difficult if a client has an asymmetrical or unilateral hearing loss. If an ear is unaidable, due to the degree of hearing loss or for other medical reasons, questions may arise regarding the form or necessity of amplification. The desire to assist clients with an unaidable ear led to the development of CROS (Contralateral Routing Of Signals) and BiCROS (bilateral CROS) hearing instruments. By using a microphone located over the unaidable ear, the CROS/BiCROS can assist clients by transferring all sound to the ear that has the ability to process the information appropriately. They no longer need to constantly turn their heads when a signal of interest originates on the side of their poorer ear. Instead, these individuals can participate more fully in listening situations due to increased awareness of the sound around them. Unitron Hearing's WiFi Mic system has the added advantages of being both digital and wireless. WiFi Mic offers a more discreet solution without embarrassing wires or cables. Furthermore, clients can experience the benefits of high-value, feature-rich digital products to enhance their listening experiences.

unitron hearing™

The Problem

Clients with unilateral hearing loss do not experience the benefits of binaural hearing. These binaural advantages include, but are not limited to:

1. Reduction of the head shadow effect
2. The squelch effect
3. Sound localization[1]

With the head shadow effect, the head casts an acoustic shadow and reduces sound generated on one side of the head before it reaches the opposite ear. This signal reduction is frequency dependent, being greater for the higher frequencies than the lower frequencies. Acoustic measurements suggest that this decrease in signal intensity across the head can reach 6.4 dB for spondee words[2] and upwards of 15 dB to 20 dB for frequencies above 2000 Hz.[3] Given the importance of high-frequency information for speech recognition, it is easy to understand how the head shadow effect can significantly impact those with unilateral hearing loss.

The squelch effect refers to the use of binaural cues to reduce the impact of background noise on speech recognition. Researchers[4,5] have determined that individuals can obtain 'release' from the masking effects of noise and improve their ability to attend to a specific signal (i.e., speech) by comparing differences in phase, time of arrival or intensity of signals across ears. With unilateral hearing loss, the ability to compare binaural cues is degraded and speech recognition in noise suffers as a result.

Sound localization requires the comparison of interaural time of arrival and intensity differences. Once again, if an individual has unilateral hearing loss, their ability to compare signal characteristics across ears will be affected and localization skills will be impaired.

Despite these issues, clients with unilateral hearing loss may report that they function quite well in a number of listening situations. Provided the individual is located in a quiet environment and able to turn his/her better hearing ear toward the speaker, he/she may be able to participate with minimal difficulty. Unfortunately, listening rarely occurs under such ideal conditions. Often, communication must take place in noisy, reverberant environments with sound originating from various locations around a person. Such adverse listening situations can be problematic for anyone, even for those with normal hearing. When hearing loss and the inability to process binaural cues is added in to the equation, it becomes easy to understand why clients with unilateral hearing loss frequently experience frustration with:

1. Speech understanding in noise, particularly when speech is directed toward the 'unaidable' ear and noise is directed at the better ear
2. Localization of sound
3. Situations where rotation of the head to direct the better ear toward the desired signal is not possible (e.g., in an automobile, walking in tandem)
4. Hearing and understanding speech, even in quiet, when the sound source is at a distance[1]

CROS: Candidacy and Implementation

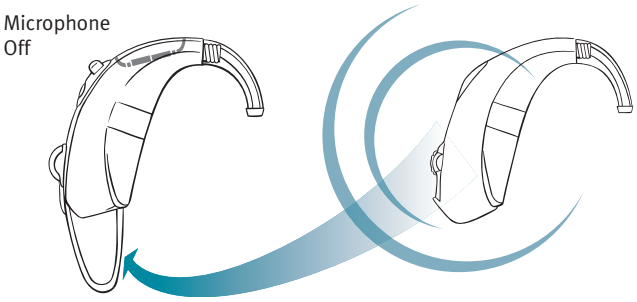
CROS hearing instruments are typically provided to clients with unaidable hearing loss in one ear and normal hearing to a mild high-frequency hearing loss in their better ear. Some researchers suggest that the degree of success with a CROS fitting is related to the degree of hearing loss in the better ear.[1,6,7] The best CROS candidates typically have at least a mild high-frequency hearing loss in the better ear. However, it has been shown that a high success rate with CROS fittings can be obtained even with clients having normal hearing in their better ear.[8]

With a CROS hearing instrument, a microphone (transmitter) is placed on the unaidable ear that sends

CROS Client Candidacy	
Audiometric Criteria	
Better Ear	Normal to mild high-frequency hearing loss
Unaidable Ear	No useable hearing Medical contraindications Very poor word recognition scores Distinct intolerance to amplified sound
Other Criteria	
High degree of motivation towards amplification Demands on hearing are high due to occupation or lifestyle	

signals by wire or radio frequency to a hearing aid (receiver) fitted on the normal or near-normal ear (see Figure 2). As the better ear does not require amplification, the hearing aid microphone is disabled and the instrument simply becomes a receiver that processes sound sent from the unaidable side and delivers it to the better ear. In a CROS fitting, signals from the receiver are usually delivered through a non-occluding earmold so naturally occurring sound from the better side and sound from the transmitter on the unaidable side are both received by the better hearing ear.

Figure 2
CROS System Receiver/Transmitter Arrangement



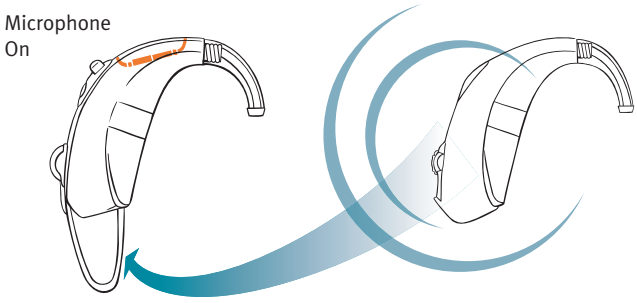
BiCROS: Candidacy and Implementation

BiCROS hearing instruments are usually given to clients with unaidable hearing loss in one ear and a significant degree of hearing loss in the better ear. For these clients, even the better ear requires some degree of

BiCROS Client Candidacy	
Audiometric Criteria	
Better Ear	Mild to severe hearing loss
Dead Ear	No useable hearing Medical contraindications Very poor word recognition scores Distinct intolerance to amplified sound
Other Criteria	
High degree of motivation towards amplification Demands on hearing are high due to occupation or lifestyle	

amplification. As a result, a microphone is required on both ears; however, all signals are again delivered only to the better hearing impaired ear. With a BiCROS system, a microphone (transmitter) is placed on the unaidable ear, sending signals through wire or radio frequency to a hearing aid (receiver) placed on the better aidable ear. In contrast to the CROS candidate, the BiCROS individual also requires amplification for their better ear; thus, the hearing aid microphone on the better ear is also turned on. Sound from both microphones is processed by the hearing aid on the better ear and delivered to that ear through tubing and a closed earmold.

Figure 3
BiCROS System Receiver/Transmitter Arrangement



CROS/BiCROS: Client Benefits

Clients can experience a number of benefits by using a CROS/BiCROS hearing instrument. They can benefit from increased awareness of sound arising from their

unaidable side due to the reduction of the head shadow effect, and the potential for improved speech intelligibility in environments where speech is directed towards the unaidable ear. Further, some CROS/BiCROS wearers report improved localization abilities by comparing differences in signal characteristics for sound arriving from the transmitter/receiver (i.e., unaidable side) and through the unoccluded ear canal (i.e., better side).[1] The CROS hearing instrument may also be suitable for clients with severe to profound hearing loss as a feedback solution since these clients would have unaidable hearing in one ear and high gain requirements in their better ear. Since the microphone and receiver are separated by a greater distance in a CROS fitting than in a typical unilateral hearing aid fitting, the potential for feedback is reduced. Using this Power CROS arrangement with a tightly fitted earmold may allow a fitter to provide additional gain and output in situations where other feedback prevention strategies have failed.

The Digital Wireless Solution

The principles behind CROS or BiCROS systems have remained the same over time. Each arrangement attempts to provide greater awareness and discrimination of sound arising from the unaidable ear by transferring all environmental signals to the better ear. However, the physical implementation and manner in which this goal is achieved can vary.

Conventional CROS or BiCROS systems essentially consist of a hearing aid, a remote microphone unit, and a cord, which runs behind the head to connect the two devices. Unfortunately, cables can be a nuisance and they are not cosmetically attractive.[9] Many individuals who could benefit from CROS/BiCROS devices simply avoid them entirely because of the cables.

Progression in hearing instrument technology has led to the development of wireless CROS/BiCROS systems as an alternative to the hard-wired approach. Wireless CROS/BiCROS systems use radio frequency technology to transmit audio signals from the microphone unit to the hearing aid. With the wireless approach, the inconvenience of a corded CROS/BiCROS system is eliminated. However, some wireless systems are limited because they are incorporated in non-programmable, analog hearing instruments. With Unitron Hearing's WiFi Mic, CROS/BiCROS clients can experience the freedom of a wireless device and have access to the practical features and advanced technologies of Liaison™ and Unison™ digital hearing instruments.

CROS or BiCROS: One System Fits All

One system is all you need to fit your CROS and BiCROS clients. WiFi Mic is composed of three parts: a wireless microphone, an audio boot receiver and a digital hearing aid.

1. Wireless microphone

The WiFi Mic wireless microphone is housed within a mini BTE shell. A standard hearing aid microphone picks up the incoming signal and passes it to the transmitter amplifier. The amplified signal is passed to the transmitter coil, which is an antenna that transmits a radio signal to the radio receiver attached to the hearing aid (see figure 4). The transmitter coil generates a 374 kHz carrier tone to allow transmission of signals from one side of the client's head to the other side without affecting the quality of the signal. The intensity of the transmission can be adjusted by the volume control on the wireless microphone. The wireless microphone is fitted to the unaidable ear and can be attached by a retainer earhook or regular earmold.

2. Audio boot receiver

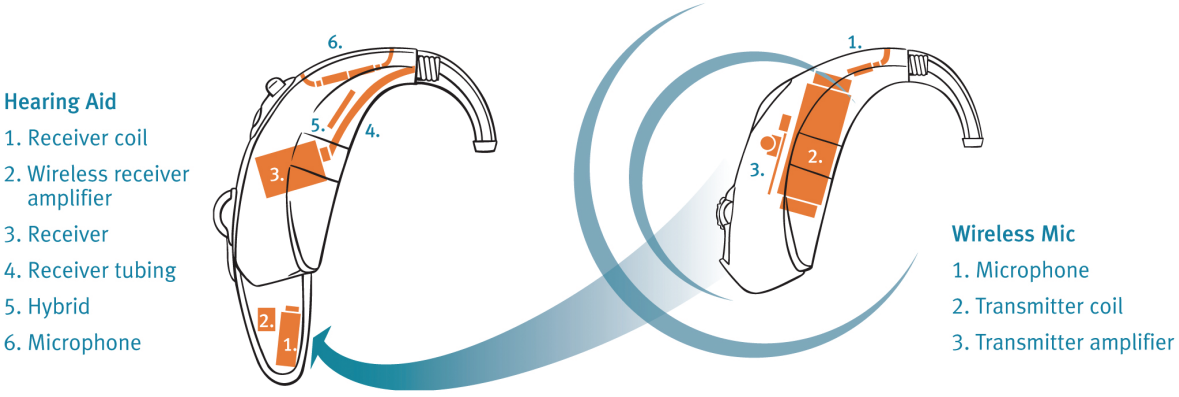
The transmission from the WiFi Mic microphone unit feeds into the audio input of the Liaison™ or Unison™ hearing aid by means of the audio boot receiver. The audio boot receiver contains a receiver coil (see Figure 4) which picks up the 374 kHz carrier signal from the wireless transmitter coil. The receiver coil transduces the radio signal back into an electrical signal similar to what originally passed through the wireless microphone. The output of the receiver coil passes through the wireless receiver amplifier (see figure 4) within the audio boot and is routed through the hearing aid's audio input. The audio boot receiver is integrated into the hearing aid battery door. To attach the audio boot receiver, the battery door must first be removed from the hearing instrument. The audio boot receiver can then be mounted onto the battery door holder on the hearing instrument.

3. Digital multi-memory hearing aid

The transmitted signal is processed by the digital hearing aid, which provides the wearer with the benefits of digital sound processing. Besides optimal sound quality, features such as multi-channel compression, low-level expansion and intelligent noise reduction are also available. For the BiCROS wearer, the hearing aid is capable of processing inputs from both the wireless microphone and the hearing aid/receiver microphone.

By using the CROS/BiCROS system in conjunction with digital hearing instruments, the client can selectively access the CROS/BiCROS feature. Fitters can create programs that either include or exclude the wireless microphone input. This is particularly beneficial for BiCROS wearers who may not want or need to use the wireless microphone in all situations. For instance, when noise is primarily directed toward the unaidable ear (i.e., wireless microphone) and speech is directed toward the better ear (i.e., hearing aid/receiver), the client would function better if the wireless mic was deactivated. In this example, the wireless mic would introduce noise that would interfere with the audibility of speech originating from the better side. By deactivating the wireless mic, the signal to noise ratio would essentially be improved. If the location of speech and noise is reversed (e.g., speech directed at poor ear, noise directed at better ear), input from the wireless mic would provide benefit by increasing audibility of the speech signal (i.e., improving the signal to noise ratio).

Figure 4
WiFi Mic System Components



Summary

Individuals with unaidable unilateral hearing loss experience many difficulties due to their inability to access binaural cues. The desire to assist these individuals led to the development of CROS/BiCROS hearing instruments. Each system attempts to provide awareness of sound from all directions around an individual, particularly if it originates from the side of an unaidable ear. The use of a wireless microphone that sends all sound to the better ear can assist those with unaidable unilateral hearing loss by overcoming many of the difficulties associated with the head shadow effect. Conventional CROS systems which provide a corded attachment between the receiver and transmitter on each ear can be a nuisance and cosmetically unappealing. In addition, many are incorporated in analog, non-programmable hearing instruments. The desire to overcome these limitations led to the development of Unitron Hearing's WiFi Mic system. With Unitron Hearing's WiFi Mic, clients can benefit from a more discreet solution without embarrassing wires or cables and from high-value, feature-rich digital products such as Liaison™ and Unison™.

Bibliography

1. Valente, M., Valente, M. Meister, M., Macauley, K. Vass, W. (1994). Selecting and Verifying Hearing Aid Fittings for Unilateral Hearing Loss. In Strategies for Selecting and Verifying Hearing Aid Fittings (Valente, M., ed.) Thieme.
2. Tillman, T.W., Kasten, R.N. Horner, I.S. (1963). Effect of Head Shadow on Reception of Speech. ASHA 5, 778-779.
3. Hodgson, W.R. (1986). Special Cases of Hearing Aid Assessment. Hearing Aid Assessment and Use in Audiologic Habilitation, 191-216.
4. Markides, A. (1977). Advantages of Binaural Over Monaural Hearing. In Binaural Hearing Aids (Markides, A., ed.), Academic Press.
5. Gulick, W.L., Gescheider, G.A., Frisina, R.D. (1989). Hearing, Oxford University Press.
6. Harford, E., Dodds, E. (1966). The Clinical Application of CROS. Archives of Otolaryngology 83, 73-82.
7. Punch, J. (1988). CROS Revisited. ASHA 30 (2), 35-37.
8. Ericson, H., Svard, I., Hogset, O., Devert, G., Ekstrom, L. (1988). Contralateral Routing of Signals in Unilateral Hearing Impairment. A Better Method of Fittings. Scandinavian Audiology 17 (2), 111-116.
9. Dillon, H. (2001). CROS, Bone Conduction and Implanted Hearing Aids. In Hearing Aids (Dillon, H., ed.) Thieme.

Contributors

John Pumford, M.Cl. Sc., Aud (C), Corporate Audiologist

Brad Stephenson, Au.D., Product Manager

Donald Hayes, Ph.D., Manager of Audiology, Research and Training