The ‘Cupped Hand’: Legacy of the First Hearing Aid

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Editor’s note: This is the first of a three-part series on the development of “aids for hearing,” from early manual strategies to today’s mechanical and electronic innovations.

When today’s 21st century audiologists think of “aids for hearing,” they likely conjure images of tiny behind-the-ear electronic hearing aids, bone-anchored hearing aids, and cochlear implants. These, of course, are some of the modern-day realizations of aids for hearing. Prior to the development of electrically powered devices, however, what types of aids for hearing existed?

Aids for hearing collect and amplify sound, with the ultimate goals of transmitting sound to the human ear and improving speech understanding. Historically, aids for hearing are divided into two categories: mechanical and electronic. Mechanical devices relied on no external source of power to aid in sound conduction. Humans were remarkably ingenious and resourceful, and adopted easily found items for use as aids for hearing. Per Berger, “It may have been a hollowed out animal horn or a broken sea shell at the ear to collect and concentrate more sound energy…or may have been a large fig leaf rolled like a tube, or perhaps a length of cane, which would serve to concentrate sound energy through a limiting pathway to the ear.”¹ Such mechanical devices were composed of many materials and had many forms.

Electronic hearing devices were introduced at the turn of the 20th century with the Akoulallion (from Greek: “to hear” and “to speak”) produced by the Akouphone Company in the United States. This portable, battery-powered, table-model hearing device used a carbon microphone and could be connected to as many as three pairs of earphones at one time.¹ Since then aids for hearing have used vacuum tubes, transistors, integrated circuits, microprocessors, and various digital technologies that provide significant acoustic gain and benefits for speech understanding.

THE FIRST HEARING AID

Yet, the earliest known aid for hearing is neither mechanical nor electronic; rather, it is the ever-available human hand.

Figure 1. Sir Joshua Reynolds, Self-Portrait as a Deaf Man, ca. 1775, N04505, digital image © Tate released under Creative Commons CC-BY-NC-ND (3.0 Unported).

Our ears are shaped to help capture sounds but sometimes ears need help in the form of a “cupped hand.” When cupped behind the ear, the hand acts as an extended scoop to augment sound collection. Barr-Hamilton reports that the Roman Emperor Hadrian (117-138 AD) used the cupped hand when listening.² An 18th-century English portrait painter, Sir Joshua Reynolds, even depicted the cupped hand action in his self-portrait (Fig. 1); he purportedly became partially deaf after suffering a severe cold while in Rome. Notable 19th-century personalities with impaired hearing, such as inventor Thomas A. Edison and writer and sociologist Harriet Martin-eau, also supposedly utilized the cupped hand.

ACOUSTIC GAIN

The cupped hand may serve another purpose, namely as a visual cue for speakers. This visual, non-verbal signal of the cupped hand alerts speakers to talk louder.¹ However, what are the acoustic gain and speech understanding benefits of using the cupped hand? Shown in Figure 2 is the acoustic gain from five studies that examined this benefit. Two studies used human hands,²,³ while three studies used mannequins...
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points, depending on the specific speech materials (e.g., isolated words versus easy, predictable sentences).

The cupped hand, used as a sound collector, provides acoustic gain and improved speech understanding in realistic-type environments, such as when noise and speech are spatially separated. Notably, the speech-understanding benefit does not include any potential additional benefit gained from a talker’s increased vocal effort in response to the visual cue of the cupped hand. While more limited in benefit than current technologically sophisticated aids for hearing, the cupped hand remains a universally expedient device that is readily available for most listeners and situations.

Stay tuned for brief discussions about the acoustic gains achieved by 19th-century mechanical aids for hearing and the many aids for hearing designed explicitly for concealment or disguise.

(KEMAR or the B&K HAT system) with artificial hands (surgical gloves filled with soft materials). Overall, the studies’ results agree in pattern but not necessarily in magnitude. There are two spectral regions with significant acoustic gain, 1-3 kHz and 5-8 kHz; the gain in these regions presumably reflect resonances of the hollow formed by the “pinna plus cupped-hand” structure. The acoustic gain in the 1-3 kHz frequency region, which can be very helpful for speech understanding, ranges from about 7 to 17 dB. Inconsistencies in the results may be due to many factors, including the room in which the measurements were made (some used anechoic chambers, other used a fairly non-reverberant room), and the exact size, shape, and orientation of the hand around/next to the pinna. Regardless of the details, this magnitude of acoustic gain (~7-17 dB) would be similar to that provided today to listeners with slight-to-mild hearing loss.

Figure 2. Acoustic gain as a function of frequency for a cupped hand behind the ear. Data from real people with real hands are represented with solid lines. Data from mannequins with artificial hands are represented with dashed lines.

SPEECH UNDERSTANDING

More importantly, though, what is the speech-understanding benefit of a cupped hand behind the listener’s ear? Using the QuickSIN test, signal to noise ratio (SNR) loss was assessed in 15 normal-hearing young adults with and without an artificial cupped hand behind their pinnae. Speech and noise signals were spatially separated (speech at 45 degrees, noise at 135 degrees), and for each condition, two speech lists were presented. On average, SNR loss was 4 dB in the unaided condition (i.e., without the cupped hand) and was 0.4 dB with the cupped hand. Thus, the use of the cupped hand improved (decreased) the SNR loss by 3.6 dB. The cupped hand does two things: It effectively increases the collection surface beyond that of the pinna and it attenuates sound from the rear of the listener. The amount of improvement in SNR loss is both statistically significant and clinically relevant. Based on classic data, this amount of improvement in SNR loss could lead to gains in word understanding of 18 to 40 percentage points.

References for this article can be found online at http://www.thehearingjournal.com.