Visual Models for Understanding Own-Voice Complaints
in First Time Hearing Aid Users

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practice management

Figure 1

Learn how to understand and address the own-voice complaints of first-time hearing aid users.

Take the quiz on page 52!

In recent years the hearing aid dispensing field has become more aware of, and sensitive to one of the chief complaints of first time hearing aid users: artifacts in the sound of their own voice in amplified state. Consequently, own voice artifacts have been a major driver for seemingly endless programming adjustments, remakes, unnecessary returns for credit, and outright rejection of amplification altogether.[1,2]

To meet the needs of hearing aid users, hearing aid professionals must be able to provide satisfactory remediation and counseling for own-voice complaints. Listed in Table 1 on page 41 are commonly-described own-voice complaints.

These constitute a range of verbal complaints that too often can make or break the initial trial for amplification irrespective of, or in addition to, the

Table 1: Commonly-Described Own-Voice Complaints

- **"My voice echoes; sounds hollow."** *(overall overamplification)*
- **"I feel plugged up when I speak."** *(acoustic and non-acoustic occlusion)*
- **"My own voice sounds funny, like in a recording."** *(overamplification)*
- **"Feels like pressure on my throat when I speak."** *(non-acoustic occlusion)*
- **"My voice is too nasally…too bright."** *(overamplification of highs)*
- **"I sound like I have a lisp."** *(speech defects/ artifacts arising from hearing impairment)*
- **"I feel like my head is down in a well."** *(too many lows, acoustic occlusion)*
- **"I tend to shout in presence of noise"** *(Lombard effect—gain with too many lows)*
- **"I talk too softly when I wear these hearing aids"** *(acoustic occlusion)*

other challenges posed by first-time attempts at amplification. Users will simply not wear hearing aids if their own voice is not acceptable to them.[3] To help discern the meaning of these verbal descriptors, dispensers can align them into five categories of artifacts as shown in figure 1 to the right.[4]

Remediation for own-voice artifact classifications #1 and #3 (acoustic occlusion, too much low frequency energy) appears well understood by most hearing aid professionals (i.e. appropriate earmold venting). However, artifact classification #2 (non-acoustic occlusion) can be immensely more complex, more difficult to discern and describe, and is far less understood by most dispensing professionals, because the user senses occlusion while the dispenser sees that it is not.

The Lombard effect or the tendency to raise one's voice in noisy environments when amplification of lows and mids are more than the audiogram calls for is an opposite adaptive response to, say, the tendency to lower one's voice when there is *occlusion* effect arising from no or too little venting in making others have to lean in closely to hear the user speak.[5] Likewise, non-acoustic occlusion or inciting of mechanoreceptors of the Arnold's branch of the vagus (Cranial X) can be sensed as pressure on a user's pharynx and larynx, bringing effortful phonation and a strained voice.[6,7]

Add to these scenarios classification #5 or the problem of new hearing aid users not liking the sound of their own voice when hearing their own hearing loss-inspired voice impediments. This latter concern, of course, can resolve by relearning the sounds of speech long forgotten while wearing the new hearing aids.[8, 9, 10]

Advent of RIC Configurations

The advent of Receiver-in-the-Canal (RIC) and other open-ear instrument configurations have helped alleviate many own voice concerns, but there remains a considerable number of issues for first time hearing aid users that run the gamut of over-amplification of low and mid frequency ambients (creating the Lombard effect) to tactile discomfort from pressure on the EAC mechanoreceptors (anything greater than a paperweight on the EAC meatal wall can incite tactile sensations), and actual occlusion as a result of underventing of the flexible receiver tip. Of course, even the improvements from RIC configuration does not help those who require and wear more traditional fitting configurations.[11, 12]

Consequently, the main aural rehabilitative counseling message is: 1) every individual is different in their perception of own-voice artifacts and will require specific remediation, 2) perception of "normal" will change for the better over time

if they will work closely with their dispenser during the initial trial, and 3) improved hearing acuity will aid the first time user in overcoming many speech impediments that have resulted from years of uncorrected hearing.[13, 14, 15]

continued on page 42

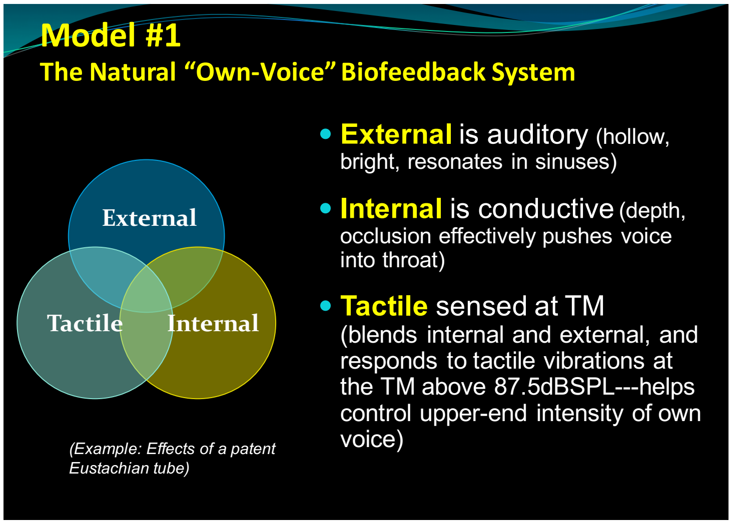

Figure 2

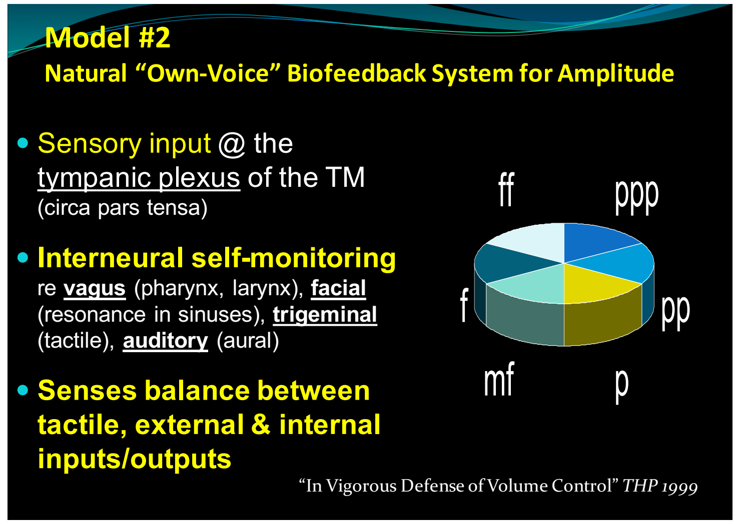

Figure 3

Presentation of the Own-Voice Biofeedback System in Unamplified State

Here are a series of visual models that depict how the human voice is monitored and modified by both normal hearing and hearing impaired speakers. Model #1 (fig. 2) presents a depiction of the natural own-voice biofeedback system. External components represent sound reception of one's voice as they present via one's EAC. These sounds are not unlike hearing one's voice in a recording—sounding brighter without the darker timbre coloration individuals hear inside their head.[16]

Internal components are the sounds of one's voice conducted internally and are comprised mostly of the lower end frequencies resonating through the temporal bone, timbre and frequency changes at the middle ear ossicles, and other resonance features of the head and neck region. The vestibular organ beside the cochlea is also involved in detecting and monitoring of one's voice. These conducted sounds give richness and depth to one's voice, but not consonantal clarity during biofeedback of auditory components. Tactile components, picked up at the tympanic membrane (TM), on the other hand, help the speaker to blend external and internal components of their voice and to control its amplitude (loudness) and resonance (timbre).

In cases of a patent (usually open) Eustachian tube the blending phenomena is bypassed, making it difficult for the speaker to monitor voice amplitude and quality. For the sound of one's voice reaches the inner ear before the acoustic version can through the EAC. In prolonged closure of the Eustachian tube state, as during a cold or sinus infection, air pressure is not equalized between external and middle ear regions, creating the occlusion effect or an unpleasant amplitude increase in the low frequencies of up to about 20%.

Model #2 (fig. 3) depicts a representation of natural own-voice biofeedback for amplitude (loudness). It is often said that humans do not have a "volume control", but in a very real sense they do. Normal ears utilize squelching (decreasing the intensity of that which they do not hear) and attending (increasing sensitivity to that to which they do), but impaired ears lose this ability to varying degrees. This, in turn, makes listening in noise-competitive environments difficult and frustrating for those with hearing impairment.

Typically, everyone is shorter by .25" to as much as .65" by the end of a given day from where they started in the morning after eight hours of sleep.[17] The height analogy is an excellent analogy for dispensers to use in describing the phenomenon of auditory fatigue, where an average loss of 1-2 jnds (just noticeable differences) occurs in hearing sensitivity. While both normal and abnormal ears experience auditory fatigue, impaired ears suffer far greater changes, because of the addition of suprathreshold abnormal loudness growth that overlays missing range of audibility.[18] These seemingly small artifacts in hearing perception can also negatively impact the success of a hearing aid fitting if not taken into consideration in the fitting process.

Likewise, when one hears their voice from a recording they are often surprised by how different their voice sounds from inside their head, because the internal energy and resonance characteristics they utilize to monitor and adjust their voice are missing from the recorded version. That also presents a challenge when the voice is heard more loudly and clearly through the hearing aid than by that being heard through venting, eustachian tube, and temporal bone conduction.

Adjusting MCL to Own-Voice Perceptions in First Time Users

Transferring the voice biofeedback constructs described above to that of the first time hearing aid user: Model #3 (figure 4) presents a visual model that can aid the dispenser in understanding how changes in amplified energy might be perceived by users as hearing aids are being programmed, and Model #4 presents an approach that can be used to train the first time user to adjust the volume control of their hearing aid(s) to accommodate the quality of their own voice.

In the left column of Model #4 (figure 5) titled "Patient Perception" are verbal descriptions where varying degrees of decibels above MCL produce complaints such as "echo", "hollow", "bright", to finally arriving at "just right" which theoretically will be found at the individual's true MCL if balance between lows and highs are correct. At the other end of the intensity spectrum where one is starting below acceptable audibility, the perceptions are verbalized as "down in the chest", "dark", to finally "just right". Having the user point with their hand at which part of the face they are sensing the sound (as it is being adjusted up and down by the dispenser) will almost invariably lead them to just above the lips as the best location for comfort and clarity of their own voice with the new hearing aids.

Once their own voice is acceptable it is much easier to clarify others' voices (usually by adding more highs). If the dispenser starts with others' voice and then attempts to find the best position in gain for the user's voice, the effort becomes never ending.

Reducing Non-acoustic Occlusion

Figure 6 (see p. 44) helps the dispenser understand the neuroanatomical relationships of EAC neuroflexes and remediation of user complaints. Of course, RIC configuration of hearing aids reduces most of these complaints. But some still remain in many sensitive patients, because of the loss of EAC keratin (outer layer of the ear canal) and maceration of EAC tissue seen more and more today. In this sense, some ears are simply too sensitive to wear hearing aids of any configuration without aggressively accommodating these neuroreflex issues.[19]

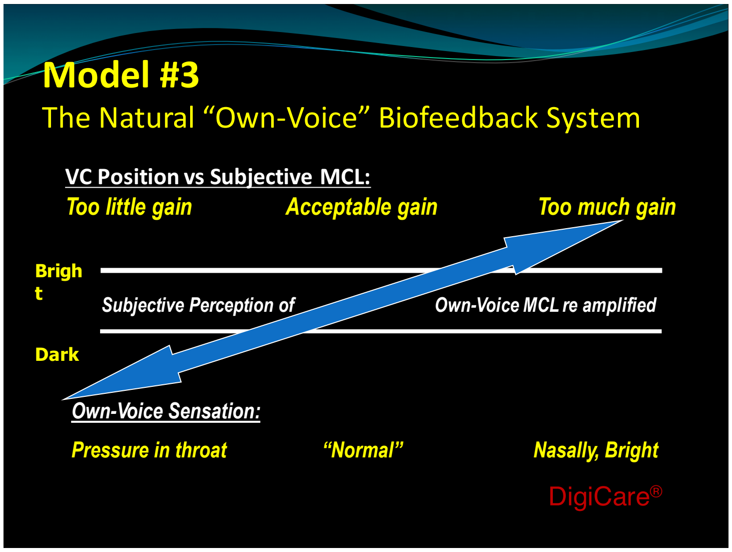

Figure 4

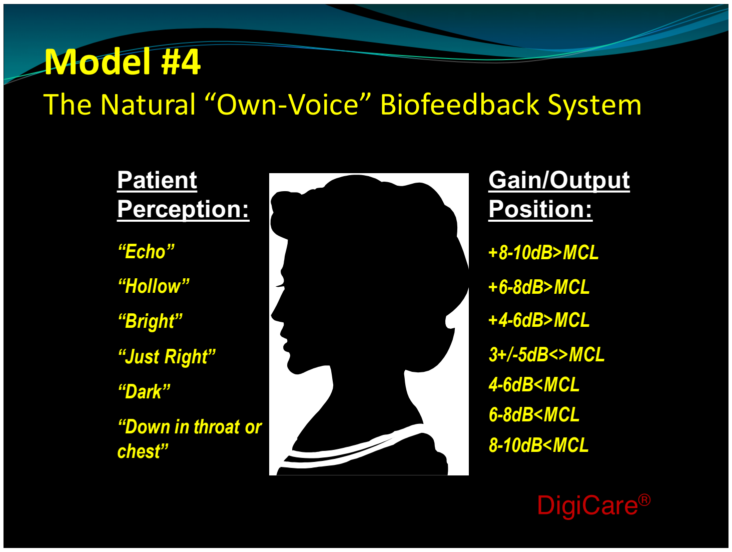

Figure 5

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Evidence & Remediation of EAC Neuroreflex Hyper-Reactivity while Wearing Hearing Aids

Reflex Label	Observation	Fitting Artifact	Remedy
Trigeminal (Red Reflex)	Hyper-vascularization re Otoscope Speculum Placement	Requires increased gain/output after 15-30 minutes of wearing hearing aids	Reduce/eliminate pressure in cartilaginous area of EAC or fit RIC/Provide wearing schedule
Vagus/Arnold's Branch Reflex (Cough Reflex)	Cough, gag reflex upon otoblock insertion	Complains of Non-acoustic occlusion, plugged sensation	Find most sensitive area & remove earmold material, or fit RIC
Lymphatic Reflex (Tissue Swelling)	Painful sensitivity upon insertion of earmold in EAC—note missing keratin	HA becomes uncomfortable in short durations of wear, cannot acclimate	Improve keratin status before delivery, reduce pressure on canal of EAC, or fit RIC

Figure 6

As a form of an "advance warning system" alerting that something is entering the EAC, the *Trigeminal Reflex* (or "red reflex") involves a cascade of mechanoreceptor reflexes that cause the lymph and vascular systems to dramatically dilate the vasculature of the tympanic membrane and become thicker and more taut in preparation for an attack of a foreign object. In other words, human neuroanatomy can treat the insertion of an otoscope speculum, an otoblock, injected impression material, and a hearing aid as invading foreign objects.

Inciting this reflex, in turn, can create a (temporary) need for more gain and/or elevated conduction of one's own voice when first inserting a hearing aid or earmold. The time required for this phenomena to calm will vary greatly from user to user, which is why all new users need a wearing schedule and thoughtful counseling about what to expect.

Of course, the system calms as it acclimates and accepts the invasion of the foreign object much like the mechanoreceptors of the wrist eventually accepts wearing a wristwatch without further inciting of reflexes. So, most first time users can simply be counseled to observe the wearing schedule and those artifacts will go away. Others, though, may need slight reduction in the amount of pressure the earmold places in the EAC.

The *Vagus/Arnold's Reflex* is incited in about 37% of first time users and forms the phenomena called non-acoustic occlusion. It involves primarily several interconnections and excitations between Arnold's Branch of Cranial Nerves X (vagus), V (trigeminal), VII (facial), IX (glossopharyngeal), VIII (vestibulocochlear) and mechanoreceptors Pacinian, Meissner, and Meckel Discs. In essence, when an object, be it hardened earwax, keratosis obturans, or a hearing aid earmold apply pressure at a spot on the human ear canal it causes the hearing aid user to sense own-voice occlusion no matter how large the "venting" around it. In other words, simply enlarging the vent does not relieve the feeling of occlusion. The chart above suggests the dispenser find the area of greatest sensitivity and remove some material from the earmold over that area.[20]

Finally, the *Lymphathic Reflex*, which creates tissue swelling in the EAC as a result of pressure of the earmold can also hamper both own-voice and fitting comfort. If the user also has macerated tissue (often caused from cotton swab trauma or ongoing ear irritation like that found in using substances like hydrogen peroxide, boric acid, or petroleum based solutions) those practices must be stopped if the user wishes to be able to wear their hearing aids successfully. Instead, a gentle botanical solution is a much better way to relieve this type of complaint.[1]

Conclusion

Own-voice artifacts brought on by wearing amplification for the first time can be disturbing to the uninformed first time user. Encountering these artifacts without dispenser remediation and counseling can cause user rejection. That is why it is crucial for dispensing professionals to have visual and explanatory tools to aid in auditory rehabilitative counseling and in making intelligent adjustments and modifications that make wearing the hearing aid a more pleasant experience.

Non-acoustic occlusion was introduced in this article because it is a serious, but less well understood artifact that occurs in some fittings during the adjustment period. By having explanations that can be shared as part of the counseling process, as well as specific modifications that can be made to alleviate or reduce such effects, new hearing aid users will be more compliant and patient while adapting to wearing hearing aids.

Acquiring the skills to translate hearing aid user verbal expressions into the most likely artifact classifications become the starting point to making appropriate adjustments and modifications to alleviate unwanted own voice artifacts. Even so, some artifacts will resolve on their own over time, but only if the hearing aid user is sufficiently counseled and convinced to abide by a thoughtfully designed wearing schedule.[21]

Ideally, pre-empting own-voice issues before they happen will help reduce the disappointment many new users feel upon first wearing hearing aids. But even those items that primarily present during the adaptation period and virtually resolve on their own over time need explanations that make sense to the user. Having a systematic procedure with a visual model like the one presented in Model #4 can help users and dispensers understand the relationships between adjusting gain, output, and frequency slope as they relate to user comfort and success. The goal, every time, is to help assure every hearing aid fitting case is an optimal one and the start of a professional/consumer relationship that will last for years to come. ■

References

1. Chartrand, MS (2007). An Exploration of Psychological & Physiological Causes for Failure to Fit. AudiologyOnline.com. Found at http://www.audiologyonline.com/articles/exploration-psychological-physiological-causes-for-940.
2. Groth, J. (2014, August 25). How do I make adjustments to the hearing instrument for own voice complaints? AudiologyOnline.com.
3. Laugesen S, Jensen NS, Maas P, Neilsen C. (2011) Own Voice Qualities (OVQ) in hearing Aid Users: These is More Than Just Occlusion. International Journal of Audiology. 50:226-236
4. Chartrand, MS (2005), Effectiveness of Hearing Aid Manipulation for Elderly Hearing Aid Users. AudiologyOnline, found at http://www.audiologyonline.com/articles/effectiveness-hearing-aid-manipulation-training-1024.
5. Laugesen, S, Nielsen, C, Mass, P, Jensen, NS (2009). Observations on Hearing Aid Users' Strategies for Controlling the Level of Their Own Voice. Journal of the American Academy of Audiology, 20:503-513. http://www.audiology.org/sites/default/files/journal/JAAA_20_08_04.pdf.
6. McSpaden, J. B., and McSpaden-Hickock, D. K., and Hickock, R. L. (1993, January-February). More than everything you wanted to know about non-acoustic occlusion and venting. Audecibel.
7. Johnson, A., and Hawke, M. (1988). "The nonauditory physiology of the external ear." From Physiology of the Ear, J. Santos-Sacchi, ed, New York: Raven Press, pp. 41-58.
8. Lind, A, Hall, L, Breidegard, B, Balkenius, C, and Johansson, P (2014). Auditory feedback of one's own voice is used for high-level semantic monitoring: the "self-comprehension" hypothesis. Frontiers in Human Neuroscience, 28 March 2014, doi: 10.3389/fnhum.2014.00166.
9. Nasir, S. M., and Ostry, D. J. (2006). Somatosensory precision in speech production. Curr. Biol. 16, 1918–1923. doi: 10.1016/j.cub.2006.07.069
10. Waldstein, R. S. (1990). Effects of postlingual deafness on speech production: implications for the role of auditory feedback.J. Acoust. Soc. Am. 88, 2099–2114. doi: 10.1121/1.400107
11. Ravichandran, A (2014). Performance of RIC Hearing aids in sloping SN hearing loss: A comparative study. Publisher: Lambert Academic Publication, Editor: Steven Frazier, ISBN: 978-3-659-12850-9
12. Ross, M (2006). Feedback Cancellation Systems and Open-Ear Hearing Aid Fitting. Rehabilitation Engineering Research Center on Hearing Ehancement, http://www.hearingresearch.org/ross/hearing_aid_use/feedback_cancellation_systems_and_open-ear_hearing_aid_fitting.php
13. Hannan, G. (2011) 11 Good Reasons to Wear Hearing Aids. Hearing Health Matters, found at http://hearinghealthmatters.org/betterhearingconsumer/2011/11-good-reasons-to-wear-hearing-aids/.
14. Tomblin, JB, Oleson, JJ, Ambrose, SE, Walker E, Moeller, MP (2014). The influence of hearing aids on the speech and language development of children with hearing loss. JAMA Otolaryngol Head and Neck Surg, 2014 May;140(5):403-9. doi: 10.1001/jamaoto.2014.267. Found at http://www.ncbi.nlm.nih.gov/pubmed/24700303.
15. Laukkanen, AM, Mickelson, NP, Laitala, M, Syrja, T, Salo, A, Sihvo, M (2004). Effects of HearFones on Speaking and Singing Voice Quality. Journal of Voice, 18, 4:475-487.
16. Hullar, T. (2009). Why does my voice sound so different when it is recorded and played back? Scientific American. http://www.scientificamerican.com/article/why-does-my-voice-sound-different/.
17. Anonymous (2015). Why are we taller in the morning than in the evening? Human Anatomy and Physiology, found at http://www.answers.com/Q/Why_we_are_taller_in_the_morning_than_in_the_evening.
18. NIH (2015). NIH Supplement Series [Internet]. Found at http://www.ncbi.nlm.nih.gov/books/NBK20366/
19. Chartrand, M.S. (2011). Resolving Problem Hearing Aid Fitting Cases: In-depth counseling instruction for solving the most difficult fitting problem cases. Found at http://www.digicarehearing.com/im-here-to-learn-more/our-library/for-hearing-health-professionals/item/27-resolving-problem-hearing-aid-fittingcases.
20. Chartrand, M.S. (2010). Video Otoscopy: A Quantitative View of the Relationship between External Ear Keratin Status and Success in Adaptation to Hearing Aids. DigiCare Behavioral Research, ISBN13 978-0-9827756-0-8.
22. Chartrand, M.S. (1999). Hearing Instrument Counseling: Practical Applications in Counseling the Hearing Impaired, 2nd edition. Livonia, MI: International Institute for Hearing Instruments Studies.

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IHS Continuing Education Test

1. The natural own-voice biofeedback system that allows individuals to control speech production features three main components:
a. Phonation, Elocution, and Breath Control
b. External, Internal, and Tactile
c. Inner, Outer, and Vision
d. All of the above

2. The Receiver-in-the-canal (RIC) hearing aid configuration alleviates most own-voice complaints, because:
a. It relieves pressure from the EAC canal wall
b. With a vented tip it can relieve occlusion
c. It provides minimal obstruction (ie, open ear) of incoming sound into the ear
d. All of the above

3. Which type of own voice artifact is less well understood by many dispensers and continues to cause distress to some first time hearing aid users, if not addressed?
a. Acoustic occlusion
b. Too many low frequencies
c. Resonant distortion
d. Non-acoustic occlusion

4. The one own-voice artifact for first time hearing aid users, which only counseling and time can resolve, is:
a. To compare their performance against industry standards
b. As the basis for assessing their business
c. To set fact-based improvement goals
d. All of the above

5. When someone coughs during insertion of the otoblock, otoscopic speculum, or a tight fitting earmold, they are inciting which neuroreflex of the external auditory canal?
a. The trigeminal reflex
b. The vagus (Arnold's) reflex
c. The lymphatic reflex
d. None of the above

6. When a hearing aid user speaks louder in the presence of noise, they are inciting the Lombard effect because:
a. High frequency gain is too high
b. Low frequency gain is too high
c. Too much occlusion
d. The hearing aid is too tight

7. When MCL is reached upon adjustment of the user's volume control, the physiological perception is that the sound of their own voice is:
a. Deep in the chest
b. Up into the sinuses
c. Between the lip and nose
d. None of the above

8. Normal hearing listeners have a "volume control" of sorts that they "adjust" through which mechanisms?
a. Attending to raise auditory sensitivity toward that which they wish to hear
b. Squelching to suppress that which they do not wish to hear
c. Both A & B
d. None of the above

9. Hearing one's voice over a recorded media sounds strange to us because:
a. Only the external components are heard
b. Only the internal components are heard
c. The Eustachian tube is normally closed
d. All of the above

10. Auditory fatigue:
a. Is not unlike temporarily losing height as the day wears on
b. Can help explain why users need slightly more gain at night than in the morning
c. Is greater in impaired ears than normal ears
d. All of the above

For continuing education credit, complete this test and send the answer section on the next page to:

International Hearing Society • 16880 Middlebelt Rd., Ste. 4 • Livonia, MI 48154
- After your test has been graded, you will receive a certificate of completion.
- All questions regarding the examination must be in writing and directed to IHS.
- Credit: IHS designates this professional development activity for one (1) continuing education credit.
- Fees: $29.00 IHS member, $59.00 non-member. (Payment in U.S. funds only.)

VISUAL MODELS FOR UNDERSTANDING OWN-VOICE COMPLAINTS

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Answer Section

(Circle the correct response from the test questions above.)

1.	a	b	c	d	6.	a	b	c	d
2.	a	b	c	d	7.	a	b	c	d
3.	a	b	c	d	8.	a	b	c	d
4.	a	b	c	d	9.	a	b	c	d
5.	a	b	c	d	10.	a	b	c	d