Letter to the Editor

CONFOUNDING BINAURAL INTERACTIONS

To the Editor:

In their article “Case Studies in Binaural Interference: Converging Evidence from Behavioral and Electrophysiologic Measures” (Jerger et al, 1993), Jerger and his colleagues illuminate an important, and presumably rare, auditory phenomenon — confounding binaural interactions. The literature even includes curious cases of cross-sensory interference (McGrew and Craig, 1973) between vision and audition.

I have no doubt about the accuracy of the electrophysiologic measures, and the carefulness of the behavioral procedures. Since, however, this work raises the specter of rationalizing the use of monaural amplification, I think it is important to express a concern regarding the hearing aid findings.

Hearing aid measures notoriously omit time-related aspects of signal processing (Schweitzer and Kepler, 1989), and it is therefore not surprising that good clinical research routinely neglects to include analysis of phase or transient distortion. Since “release from masking” and/or “masking level differences” are such well-researched aspects of human hearing systems, it is, indeed regrettable how little attention has been given to the phase relations of the rehabilitative appliances.

Factually, hearing aids may be delivered with 180-degree phase reversals and an assortment of temporal alterations unanticipated by engineers or clinicians (Schweitzer, 1986; Schweitzer and Smith, 1991).

Anecdotally, one case of a “matched” set of hearing aids from a prominent manufacturer was found to have phase relations, as measured with a probe microphone, that were 180 degrees opposite. The patient complained that it “just seemed easier to hear in noise with only one” aid applied. A simple reversal of the receiver wires yielded both a measured phase concordance for the two aids and a measurable reduction in noise interference for connected discourse. Subjectively, the client immediately reported that the adjustment made her much more comfortable with two aids in noise — the reverse impression from the unmodified units.

Several other examples of phase problems in hearing aids have been seen in our practice with similar resolution.

I re-emphasize that I have no doubt that there are clearly patients with physiologically complicated hearing as in the carefully detailed examples of Jerger et al. However, I am concerned that the suggestion that “some hearing-impaired individuals may, indeed, function better with one than with two hearing aids” might be overly applied without, at least, first determining that electroacoustic equipment is not a confounding factor.

In one of the cited cases (No. 4 in the Jerger et al report) an interesting measure of directional cues previously used by Jerger and Jordan (1992) was utilized. I would like to applaud the use of such a test with hearing aids, but also point out that time differences of less than a millisecond can greatly alter the perception of directionality. In an unpublished study, we used a phase shift circuit connected to a canal hearing aid and monitored the shift with a probe microphone. Not surprisingly, time adjustments of a fraction of a millisecond on the seven normal-hearing subjects produced pronounced perceptual shift of the click image in space. This, of course, is consistent with experimental lateralization phenomena (Yost and Hafter, 1987), but not previously reported with hearing aids.

It may be that for some people neither perfectly “in phase” or entirely reversed phase (180-degree) hearing aids yield the best auditory performance. One could postulate that a history of middle ear disease could conceivably alter the interaural time relationships in such a way that a subtle adjustment, of say 30 or 75 degrees, might restore a measure of lost binaural advantage, and conceivably improve release from masking capacity.

The point of this letter is simply to encourage caution in overly quick conclusions about a client’s binaural hearing aid candidacy without first ascertaining that critical (time) features of the hearing aids are not contributing to the conclusions.

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Response to Schweitzer

Schweitzer (1993) makes a very good point. His letter also raises a series of interesting questions. First, what is the likelihood of polarity reversal in matched commercial aids? We put this question to a number of colleagues in the industry. They told us that manufacturers go to great lengths to assure uniformity of connection to the transducer. Wires are color coded, placement/orientation of the transducer is checked and rechecked, and we are told by one of the largest manufacturers that polarity is acoustically verified in 100 percent of aids. Furthermore in class A amplifiers, where one wire carries a bias voltage, erroneous wiring would result in improper operation of the instrument. Still, human error can always occur. One industry spokesman estimated such likelihood at no more than 1 in 500 aids, although all admitted that no firm data are available.

A second question raised by Schweitzer's letter is whether or not we may assume that a zero-degree phase angle between transducer outputs is always the best condition for users of binaural aids. Certainly our experience with normally hearing persons would lead us to this position. But several years ago Zenith marketed a binaural system devised by Bob Briskey in which the phase angle was purposely set at 180 degrees, based on his observation that many binaural users reported better sound “separation” at this phase angle. So it is not altogether clear that the zero-degree, in-phase condition is necessarily the best for all binaural users. Indeed, as Schweitzer suggests in his second to last paragraph:

“It may be that for some people neither perfectly ‘in phase’ or entirely reversed phase (180-degree) hearing aids yield the best auditory performance.” To which I would add “amen” and append the observation that phase asymmetries introduced by faulty auditory systems may explain at least some of the binaural interference phenomenon.

Still a third question is raised by Schweitzer’s very appropriate caveat that one should be cautious about reaching a conclusion concerning a client's candidacy for binaural aids “...without first ascertaining that critical (time) features of the hearing aids are not contributing to the conclusion.” The question is, having made the determination that the two aids (ITEs for example) are out of phase, perhaps by means of suitable probe-microphone measurement, what can the dispenser do about it? One could open up the case of one aid, unsolder the wires to the transducer, reverse the connections, and resolder the wires. This is, however, a practice uniformly frowned upon by manufacturers. Another possibility would be to send one of the aids back to the manufacturer and demand that it be wired properly. The problem here is to know which one of the two is in error. If you send back the one that is, in fact, properly wired, you open up the possibility of a lively interchange between yourself and the manufacturer's engineering staff. A better solution would be to send them both back.

But suppose your discovery of out-of-phase polarities is not matched by subjective complaint? For example, the transducers are 180 degrees out of phase, but the client does well with the binaural arrangement. Should you then let sleeping dogs lie? Or is it possible that the client would do even better with in-phase aids? And, for that matter, what about those clients who do well with in-phase aids? Might at least some of them do even better with out-of-phase aids?

Perhaps the best answer to all of these questions might be to equip one or both aids with a variable phase adjustment and to seek the inter-aid phase setting that produces optimal binaural performance.