SSW REPORTS ...

HEARING IMPAIRMENT & CENTRAL AUDITORY PROCESSING

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PRESENTATION LEVEL WITH HARD-OF-HEARING

Jack Katz

More and more, audiologists are testing patients that have hearing losses, *as well as* a concern for CAPD. A hearing loss does not make us immune to CAPD, but it does increase the challenge for the audiologists.

This month I was involved with two such cases, and in each there was the same technical error. If 2 top-notch audiologists can make this error, then the rest of us can also.

The problem here deals with word recognition scores (WRSs) that we use for understanding the person's a) clarity for speech, b) for diagnostic implications, and c) for "correcting" central test scores (e.g., SN, SSW).

A 48-year-old patient was seen for central testing. Her results are shown below.

Year	1994		2000	
Ear	Right	Left	Right	Left
SpAvg-dB[1]	40	42	75	57
SRT-dB	35	35	70	50
PL-dB[2]	65	65	85	80
WRS-%	90	96	32*	84

[1] 3 Frequency Speech Average (500, 1k, 2k Hz)
[2] Presentation Level in dB HL

The table shows that over the 6-year period, hearing loss increased by 35dB in the RE and by 15dB in the left. The corresponding decreases in WRSs were *58%* & 12%. The 32% WRS was a possible sign of retrocochlear dysfunction, but it also exerted a considerable influence on the central tests because it is used as a correction factor.

Does the drop in WRS in the RE represent a retrocochlear disorder? Probably not. When we compare the PLs to the SRTs (below) we see reasonable levels within PB-Max (25 to 40dB SL) for each WRS *except the all-important RE* on retest. Because of the additional loss and lack of tolerance for loud sounds in that ear, it was delivered at only 15dB above SRT! This is below PB-Max, suggesting that additional errors were made because of lack of *audibility* and not because of lack of *auditory clarity*.

	1994		2000	
PL-SRT	30	30	*15**	30
PL-SpAvg	25	23	10	23

In this case we cannot use the WRS to compare with the other scores in a meaningful way. Ordinarily, I would try to increase the PL as far as the patient would let me. If the PL was still below PB-Max it might have to be discounted.

On a related issue, I have argued for using the puretone speech average (SpAvg: 500, 1000 and 2000 Hz) instead of SRT for deciding PL. The reason is that SRT correlates best with threshold at 500 Hz. That is, it is primarily a low frequency measure. If the person has a hearing loss, primarily in the highs then the good SRT will underestimate the needed in the high frequencies for a maximum score.

The table below shows that a PL of 85dB HL was inaudible even in the middle frequencies.

250	500	1k	1.5k	2k	4k	8k
60	60	70	75	95	95	90

I use the SpAvg routinely for PL of speech tests, but if this is not comfortable for you, do use it when patients have a sloping loss, whether they are for peripheral or central measures. * * * *

THE MAN WITH A HEARING LOSS WHO SAID HE HAD CAPD

Jack Katz

Each of us has worked with hard-of-hearing patients and also with those who have CAPD. But not many have worked with individuals who have both hearing loss and suspected CAPD. There are lots of reasons why we haven't worked with both types of auditory impairments when found in the same individual. But hopefully this article will encourage you to give it a try.

We will discuss, a) why we don't like to work with this combination of problems, but should, b) why we should listen to our patients (who know more about themselves than we do?), and c) why you can't forget the Original and Traditional Analyses (even if you love the NOE Analysis).

Hearing Loss Plus CAPD...Gulp!!

With all of our experience and training we feel confident and competent in working with the hard-of-hearing. Readers of *SSW Reports* also work effectively with those who have CAPD. But not many people I've met are happy to see a patient with both problems.

One excellent reason for this hesitancy is that hearing losses come in all shapes and sizes and can involve many levels of the auditory system. These combined can make your head spin.

While we have good test norms for normally hearing individuals, we have none for those with hearing impairments. So how many of the errors are of a peripheral origin, and how many of the signs are central, is often unclear. This tells us that we must pay special attention to what our patients have to say.

In addition, it is unlikely that we will even see a hearing impaired person for CAP testing. This is because most people (including the enlightened) will assume that the difficulties are due to the hearing loss alone. This is not a snide comment about the people *out there*, indeed, with all our experience, knowledge, and commitment, we too would have a tough time figuring out if it is one, the other, or both.

Case Study

In 1997, I was contacted by an audiologist in another city to find out if I would be willing to test a hearing-impaired adult who claimed to have a CAPD. She was not very experienced in CAPD, and felt it was over her head to evaluate someone who had a moderate sensory-neural hearing loss for CAPD. I thought it was a worthwhile challenge because, a) even a person with a hearing loss is entitled to CAP services, b) patients generally have good insights about themselves, making CAPD more probable, and c) because in previous cases with whom we worked, we were able to gather valuable information despite their hearing losses.

Patient History

RL was a 56 year old man who felt that he had recently developed CAPD, in addition to his longstanding hearing loss. RL has Alport's Disease, a genetic kidney disorder that is associated with progressive, bilateral, sensory-neural hearing loss.

Despite signs of hearing loss in early adulthood RL graduated from college Phi Beta Kappa, only assisted by preferential seating. Eventually, his doctors realized his need for hearing aids. He has worn them successfully for many years thereafter.

Despite his fine word recognition scores (WRSs) he felt that he had inordinate difficulty understanding speech under noisy conditions. In addition, he was less able to keep up with the pace of speech. He concluded, he had CAPD.

In addition to RL's hearing problem, he also had a life-threatening kidney condition. In 1991 he had a successful kidney transplant and for 8 years after that was taking powerful steroids to ward off kidney rejection.

Evaluation at UB - 1997

RL was a most cooperative and communicative patient. We were able to obtain a great deal of information that served as a baseline later on. Although our main purpose was evaluating CAPD, it was not possible to test central functions without establishing the extent and type of difficulty at the peripheral level. In fact, in this case, because of the hearing loss, central problems could have been associated with the

brainstem as well as the cerebrum, so the diagnostic testing was thorough.

Puretone thresholds
Because both ears had very similar puretone thresholds, average scores for the 2 ears are shown in Table 1. The results demonstrated a rather flat, sensory-neural (S-N) loss for each ear.

250	500	1000	2000	4000	8000
35	50	60	55	50	65

Table 1. Average puretone thresholds for both ears for a patient with Alports disease in 1997.

Word recognition scores (WRSs)
RL's WRSs were quite good considering his moderate S-N losses. Using recorded materials, for this and all other speech tasks (Central Test Battery – CD), he obtained a score of 88% in each ear (not a sign of retrocochlear pathology).

Immittance measures
Tympanograms were normal Type A, bilaterally. Similarly, all acoustic reflex thresholds (ARTs) were normal, both ipsilaterally and contralaterally. All AR thresholds were 85-90dB HL, except for one at 95dB HL. Reflex decay results were negative in the RE but were not tested in the left because of insufficient seal.

With elevated puretone thresholds and such normal ARTs, the Metz test (≤ 60dB difference) indicated a cochlear loss.

Staggered Spondaic Word (SSW) test
This case is a good example why you should keep your Traditional SSW Analysis skills sharp (or purchase the SSW-Plus program). With hearing loss it is necessary to use the Traditional (CSSW) one. RL did so well on the SSW that it was difficult to see any obvious signs of CAPD.

The results (see Fig.1) are consistent with his cochlear loss and not CAPD, as each Condition was within normal limits (overcorrection is not a factor in CAP testing). Response Bias is often a by-product of a hearing loss and therefore the significant Type-A (barely significant) may be discounted. The Type-A ordinarily nullifies any Ear or Order Effects and these signs may be the result of hearing loss alone. So they were discounted as well.

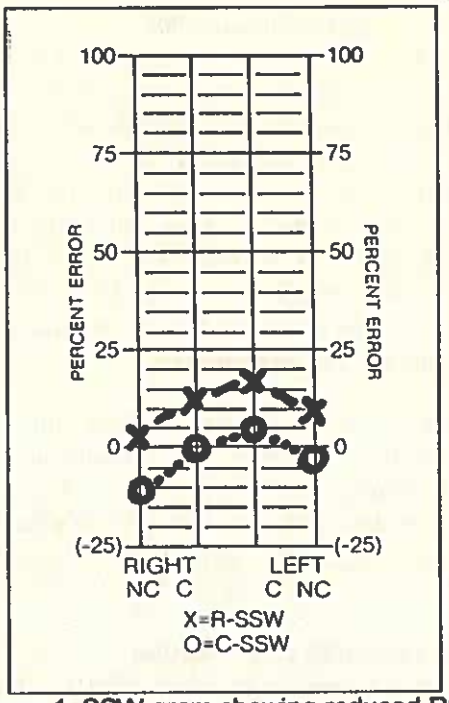

Figure 1. SSW-gram showing reduced RSSW scores but essentially normal CSSW scores (when WRS was taken into account).

Phonemic Synthesis (PS) test
The PS Quantitative score was 9. This is very poor and the first indication of a possible CAPD (considering his 88% WRSs). Unfortunately, there are no PS norms for the hard-of-hearing. According to the CTB-CD data, for normal hearing adults a score of 23 is passing.

Speech-in-Noise (SN) test
The final central test given in 1997 was SN. He had noise WRS scores of 44% correct in the RE and 40% in the LE. These yielded difference scores (Q-N) of 44% and 48% error (compared to the quiet condition). For normal hearing adults 17% is the limit of normal for each ear. RL's scores were 4 SDs poorer than the mean in the RE and 5 SDs poorer in the LE. While these are awful scores for a normally hearing person it is hard to say how poor it is for someone with a 55dB hearing loss. However, considering his good WRSs in quiet, this is likely a significant finding.

Summary
Although we could not say for sure that there was a CAPD on top of the hearing loss, RL did appear to have a central component as well as a peripheral one involving DEC and TFM.

Reevaluation 2000

Over the next 3 years RL continued to experience difficulty in noise and more than usual difficulty in keeping up with the rate of average speakers. He felt increasingly as if his CAPD was getting worse. For this reason he came for a week of therapy at the UB clinic and while here, I had an opportunity to reassess his CAP functions. RL also mentioned that he had an MRI that showed some spots, but that the significance of them was not yet determined.

RL is now 59 years old. His difficulty in communication has hampered him socially and in obtaining appropriate employment. He was most cooperative and extremely reliable in his responses. All speech testing used the same CTB-CD.

Puretone threshold re-evaluation

RL had equal hearing in each ear (±5dB). Thus the thresholds were combined in the table 2.

250	500	1000	2000	4000	8000
45	55	65	65	70	65

Table 2. Average puretone thresholds for both ears for a patient with Alports disease in 2000.

Over the 3-year period, RL's combined SpAvg shows a drop of 7dB for the two ears. However, looking at his threshold variations for the past 9 years across, all the audiometric frequencies, the change averaged about 1-2 dB per year. This would represent a gradual reduction.

Word recognition - in Quiet re-evaluation

I was a bit alarmed when I saw in RL's recent report that his WRS was greatly reduced (from 88% to 44%). The test was presented at comfort level. After much testing, I realized that the 44% was with a PL below PB-Max. Therefore, our current testing appears to be a better estimate of his clarity because the PLs were all within PB-Max (although not at the usual 40dB SL that I use). He indicated that the PLs were higher than he would like but that they were surely tolerable. The scores were 88% and 76% in the right and left ears, respectively. Thus, the WDSs are essentially unchanged from 1997.

Immittance re-evaluation

Tympanograms were normal Type-A for each ear. This is consistent with our previous testing. Acoustic reflexes (ipsi and contra) were normal and consistent with our previous testing.

Staggered Spondaic Word re-evaluation

Previously we had used the Traditional Analysis, however, this time the Original Analysis was used because of the site-of-lesion capability of this measure. Compared to '97 there were more raw errors for the left ear, but when the correction factor was used, again it completely compensated for the errors. Thus the TEC was normal, indicating no auditory reception problem and was consistent with cochlear pathology. However, a non-auditory reception (NAR) problem could not be ruled out.

While it is may be dangerous to consider response bias in light of so much hearing loss, it is of special interest because of the questionable MRI finding. The Ear Effect hi/lo is a posterior sign. But in light of the normal TEC AR is not a likely prospect. Nevertheless, a DEC problem seems entirely reasonable and consistent with RL complaints. This is supported by 5 delayed responses, in which his answer was completely correct after the significant delays. This supports his contention that he needs more time to process.

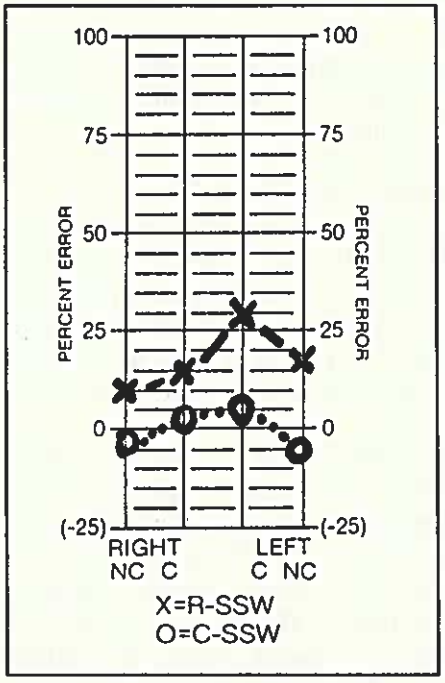

Figure 2. SSW-gram for retest showing reduced RSSW scores & essentially normal CSSW scores (when WRS was taken into account).

Phonemic Synthesis re-evaluation
RL obtained a score of 13 out of 25 words on the PS test. Normal limits for normally hearing adults is 23. So the score is quite poor, but without appropriate norms it is hard to say how abnormal it is, except that it helps to explain his complaint and is consistent with the SSW response bias and delays.

His score last time was only 9. We generally expect a 2-point improvement on re-test, so getting +4 is a bit more than expected. This is certainly not evidence of deterioration in this skill. However, he had one therapy session (dealing with DEC) prior to this test.

Speech-in-Noise re-evaluation
The Speech-in-Noise test was of particular importance because of the difficulties experienced by RL. The CTB-CD's noise task is not a noxious one. Nevertheless, RL had considerable difficulty with it. His scores in noise were 36% and 56% correct in the right and left ears. The difference scores were 52% and 20%. Normal limits for normally hearing adults is 17%. The right ear was so poor that it was re-tested and almost identical results were obtained.

The LE score was so close to normal for individuals without hearing loss, so clearly it represented normal performance for one who has a moderate sensory-neural loss. However, the RE score was extremely poor, somewhat lower than in '97 while the LE (also retested and found to be reliable) got better.

Another factor in his SN difficulty is that his two ears behave so differently at this time that they likely add further to his misunderstanding in noise. The 'binaural advantage' functions best when both ears are normal or at least equal. He had a difference of +32% between ears with a norm of +7 (and mean of -.3). This puts his interaural difference score 4 SDs poorer than the mean. With such good, consistent performance for the two ears on peripheral tests, it is not difficult to support a central factor contributing to RL's difficulty in noise.

Based on this finding one might wonder about the central location that could account for this impairment. Although the frontal ½ of the brain is associated with SN difficulty, the anterior temporal region is the most potent one in interfering with the "cocktail party effect", so I guessed that it was an anterior temporal problem on the left side.

The preliminary information from the neurologist is that it is in the frontal region. Hopefully he will send information when he has a chance to see the actual MRI.

Discussion

There is no argument that it is easier to test a person who is normally hearing for CAPD than one who has a hearing loss. But, it is possible to identify CAPD especially if the hearing loss and WRSs are similar for the two ears, but the central test signs are different. In the past I have had patients with greater losses on one side and found the central problems when testing the *normal ear*.

When the loss is not so great and WRS is pretty good then scores falling $\geq$4 SDs below normal generally give me more confidence of CAPD or a central lesion. While this may cause us to miss some central problems, it seems necessary to set a high mark to be reasonably sure the problem is not solely a peripheral one.

That being said, my general concern is for the patient who shows significant deviations on central tests, whether we can specify CAPD or not. Appropriate recommendations for assistance are called for. The therapy that we do with CAP cases is to improve the patient's central functioning. Although the person with a pure peripheral hearing loss has a different site-of-lesion and needs "ear training", they too need to improve their central function because the *ear can't be trained*. Only the CNS can learn.

Thus, appropriate training is the best recommendation for either problem or a combination of the two.

Training Program for RL

A speech-language pathologist and two of her students worked with RL on his CAPD symptoms, for a week. He received two hours of therapy each day and was free to use a computer program (Earobics) when he had free time. Proper training and monitoring are required.

Emphasis was placed on the two major difficulties that he experienced, decoding and speech-in-noise. In addition, time was spent on localization of sound. Localization is important for both safety and communication purposes. It also may aid in speech-in-noise as the individual is better able to auditorily focus attention on the target and select it from the noise. My guess is that it is more effective than locating it visually.

Localization is best carried out in a room with normal acoustics and one that is large enough to permit the therapist to move about rather freely. Training should begin at a radius of about 3 feet from the patient. First establish the ability to identify front, back, right and left. When these are well established, then work on the diagonals. When this is accomplished, it is time to increase the circle. A noise is needed to conceal the movements of the clinician. But this is stopped when the person speaks.

Occasionally, the patient may need to see where the clinician spoke from to correct a misconception. As for all types of learning, an increase in speed of identification is a good indicator, in addition to accuracy, of successful training.

Decoding therapy was carried out using the recorded Phonemic Synthesis program (Precision Acoustics) as well as speech sound discrimination for a number of problematic phonemes. In the beginning RL encountered difficulty, but quickly improved his decoding skills.

Just as we do with straight CAP speech-in-noise cases, tape recorders are used to deliver both the speech at a comfortable level, and the noise. Live voice is difficult because of the Lombard Effect in which the person's voice increases reflexively when noise is present.

RL indicated that he came to Buffalo to see what could be done for him, but without hope that he would get much out of it. He indicates that he was wrong. He got a great deal out of the week spent at UB Speech-Language-Hearing Clinic. He feels that his hearing is much sharper, both in quiet and in noise. Clearly his localization of sound is improved as well.

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- The purpose of this issue is to raise the awareness of the needs of the hearing impaired in the area of CAPD. It isn't just for normal hearing any more!
- Listen to your patient.
- After the evaluation, make recommendations to suit the complaints, even if CAPD cannot be confirmed.
- CAP-type training seems to work very well with symptoms such as, poor decoding, speech-in-noise, and sound localization in the hearing impaired population.
- If you do not do therapy yourself, join forces with others who do. If they are not well versed in this work, give them some guidance.

NOW HEAR DEAR ACKY
by Dear Acky

Dear Acky:
I recently tested a 6-year-old child who had normal SSW scores on the 4 Conditions and Total score using the NOE Analysis, but he had significant response biases. He had an Ear Effect L/H and 16 reversals. His 8CNs were: 1 4 3 0 0 7 5 3. Do you report on the response bias even if the Condition and Total NOE scores are within normal limits?
Debbie

Dear Debbie:
The SSW, PS and SN battery have about 40 indicators of CAPD and generally give information about the type of CAPD, if there is a problem. We like to see the signs pile up in one or two CAP Categories so we can get confirmation. Although, the Conditions and Total NOE scores are more likely to be significant, sometimes we have to depend on the other signs instead. No one seems to know why this happens. Look at the other tests and Qualifiers to support or refute what you have found.

I also like to see that the problems suggested by the findings are in agreement with what the parents have to say. Of course we often see more or different signs than they do because of our experience and sensitive tests, but general correspondence is expected.

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