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REPORT

CAPD AND HEARING LOSS
CAPD CASE WITH UNILATERAL LOSS

Vol. 15 No. 1 February 1993

Dear Ackie:

Yes, I have written to you before and here I am again (you can probably tell by my poor typewriting). Here's the scoop. An Otolaryngologist asked me what I thought of two statements. It was her understanding that 1) if a person had a hearing loss that they could not have a central auditory processing problem, and 2) if a person had a unilateral hearing loss (presumably severe, profound or complete), they would automatically have a central auditory processing disorder (CAPD).

What would be your response to these questions, Ackie?

Signed: Just Curious

Dear JC:

Before getting to these important questions, please permit me to say "a word or two" about where we are in CAP.

*** It is amazing how much uncertainty and confusion there still is about CAP and CAPD. Despite the fact that our profession has been involved with these issues for 20 years or so and the field of speech-language pathology for much longer, people are just unsure of what CAP is, what constitutes CAPD, what difficulties accrue, how to measure it and what can be done about it. The confusion can be seen in the lay public, which is not surprising because the lack of understanding is rampant among speech-language pathologists (though fewer and fewer every year) and unfortunately among audiologists as well.

Ackie has said it before, she feels the education of the uninitiated is much more our responsibility than their's. That is, "we don't know - what we don't know - until we know it". For this reason we must make every effort to share our knowledge with school boards, committees on special education (CSE), fellow professional and the public.

It is for the above reasons that I was glad to get this request. You will see that the questions posed a semantic challenge, as they could be asking a number of different things. ***

The first question seems to be whether a peripheral loss indicates that there is no CAPD. Can we agree that:

1) The auditory system is made up of two sections, a) the peripheral system (from the outer ear to the central end of the VIII nerve), and b) the central system (including the brainstem, cerebellum and cerebrum).

2) If there is damage to the peripheral system, generally a hearing loss results, but if there is a central lesion or dysfunction, then we would label it a CAPD (generally not a hearing loss, but rather limitations in higher level processing such as recognizing speech in a background of noise). And, if there are both peripheral and central problems, then we should

expect both influences to affect performance.

3) If both influences are present in a person with both problems, then whatever can be heard will be distorted further by the CAPD.

4) The only exception is when there is a complete hearing loss. Obviously if nothing can be heard there is no further deterioration of performance (the central problem is academic).

I might have misinterpreted the question that the ENT doctor asked. Perhaps it was a practical and not the philosophical one addressed above. The question might be can the audiologist demonstrate CAPD if there is a peripheral hearing loss. It would be fair to say that a hearing loss complicates the evaluation and the interpretation, but doesn't automatically make it invalid. The degree of hearing loss and discrimination problem have bearing on the difficulty in getting clearcut information.

1) With a slight or mild (possibly a moderate) loss, especially if similar in each ear there is generally little difficulty in checking central function. One would try to correct for the peripheral distortion (e.g., SSW, Speech-in-Noise) and compare performance in the two ears.

2) With a complete unilateral loss we cannot demonstrate a CAPD through the deaf ear. However, one could check the good ear for CAP function by use of monaural tests (e.g., Speech-in-Noise, Phonemic Synthesis).

3) With greater losses, it is more difficult to clearly demonstrate a central problem.

Dear Ackie would summarize by saying that neither theoretically nor practically does hearing loss preclude a central auditory problem, and the presence of the hearing impairment does not necessarily prevent the evaluation of the central contribution.

Ackie would like to address the second question, does a unilateral loss represent a central auditory disorder. This appears to be a semantic question. The binaural advantage is a central phenomenon that helps us to understand speech under noisy conditions (e.g., at a cocktail party). One could say, therefore a significant (especially a complete unilateral) loss deprives the CNS of the necessary information to permit the binaural advantage. The CNS is no longer able to do its job and therefore a central breakdown. Ackie would prefer to say that a peripheral loss interfered with a central function.

Ackie would like to mention another consideration with a severe to complete unilateral loss, in particular. Could a CAPD be demonstrated in the other ear? Yes, of course. In fact it would seem that this probability would be relatively high in complete unilateral cases. Here's why.

The question is what could cause a complete unilateral loss, meningitis, mumps, etc.? Well if the loss was due to meningitis then the probablity of a central disorder increases considerably, as the meninges cover the CNS. I wonder if the mumps and other viruses can affect the central system as well as other parts of the auditory system? If so there should be a concern for CAPD as well.

We are fortunate to have more and more techniques that can seek out central dysfunction in unilateal cases. For example, electrocochleography, ABR, middle latency and long latency responses offer further insights.

Ackie will summarize in her usual eloquent style by stating that a hearing loss does not preclude a central auditory problem any more than an ingrown toenail precludes a broken leg. However, it is worth noting that a hearing loss complicates the evaluation and reduces ones confidence by some vaiable degree. A complete unilateral loss does not insure that a CAPD is not affecting the listener in an important way. The following article reports on such a case.

CAP EVALUATION OF A CHILD WITH PROFOUND UNILATERAL HEARING LOSS

Jack Katz and M. Gay Masters

Recently, Evan a 6.3 year old first grader was seen at our clinic for a central auditory processing (CAP) evaluation. Although his school has insisted that he is doing fine (the implication is that the parents are worrying about nothing) his parents see a different picture. They feel that their son is very bright and yet must do all that he can just to keep up with his class. He comes home exhausted and frustrated. If this is the case in first grade, what is his fate as the curriculum becomes more demanding in the higher grades?

MEDICAL HISTORY

Evan was delivered by emergency caesarean section when he was found to be in fetal distress. At 3 weeks of age he was hospitalized for failure to thrive. To make matters worse, the family indicates that he had approximately 30 bouts of otitis media in the first 3 years of life. On one occasion his TM (left) ruptured and drained for 2 days. PE tubes were inserted on each side at 3 years of age and have long since been extruded. Occasionally he still complains of fullness in his ears. Evan was reported to have a complete unilateral hearing loss in his left ear, which was thought to be congenital (although this was not picked up until about 3 years of age). He is right handed.

COMMUNICATION HISTORY

Occasionally this patient does not respond when spoken to, confuses the location of sounds, has difficulty understanding speech in a noisy place and is annoyed by loud sounds. His parents note that he pays particular attention to the speaker's face when spoken to. All of this seems consistent with a unilateral hearing loss but equally so with CAP problems.

Evan's speech-language skills were evaluated at age 3 because of parental concerns and was found to have speech and expressive language delays of about 6 months. His family was referred to an intensive speech and language intervention program for preschool children. It was this agency that first diagnosed the unilateral hearing loss.

Evan remained in the preschool program until age 5. At that time he was reported to have essentially normal receptive language scores, but his expressive language was significantly disordered, in particular due to his inability to find the proper words he needed to communicate.

Toward the end of his kindergarten year, his parents became increasingly concerned about his academic potential. They, and especially his mother, a second grade teacher, felt that Evan was not grasping classroom concepts quickly. He struggled especially with pre-literate tasks, such as early phonic skills. His word-finding difficulties seemed even more obvious. At that time his parents requested an independent speech and language evaluation at our clinic.

Our speech and language evaluation revealed word-finding difficulties, which is often a sign of poor phonological awareness. "Deep" testing revealed that this was indeed the case; Evan's phonological awareness was equivalent to that of a 3 year old child.

This past summer Evan obtained intensive auditory training and language therapy at our clinic. He made good progress which was confirmed by our tests as well as reading measures carried out by his mother. However, because he continued to have difficulties in pre-literate and literate academic areas, his word-finding difficulties, and parental concerns because of his inability to play in a room full of children, he was referred for a central auditory processing evaluation.

AUDIOLOGIC EVALUATION

Perhaps you were wondering how we administered the SSW test to a 6-year-old

child who has no hearing in one ear. Sorry to say we did not do an SSW. That is not to say that we couldn't. The SSW can be administered in 2 ways to those who have no hearing in one ear. Goldman and Katz (1965) used the test in four modes in normal adult right-handed subjects in 1) dichotic (standard method), 2) diotic (both channels to both ears), 3) monaural competing (each ear was tested separately with both channels directed to it). [FYI- You will not be surprised to learn that right handers had better scores in the right ear than left, and it is of interest to note that performance in the right ear alone was the same as in the diotic condition, as if they relied on the right ear and ignored the left.] Unfortunately, the data that we obtained in that study do not provide even a hint of what we could expect of Evan's right ear as we have never tried this technique with a child (no less a 6-year-old).

The second way that one can test a unilateral case is to present the signal at a maximum level to the bad ear (@ 100 dB or more) and at the usual level to the good ear. When we have done this with unilateral cases (e.g., college students) we generally find good performance in the good ear (as though they were hearing spondees without competition and no response or almost nothing at all from the "bad side". It is surprising that even the noncompeting words that should crossover by bone conduction are generally omitted and the competing words to the poor ear were rarely responded to even though they should have been about equal in SPL to the speech from the good ear when crossover is calculated. Thus, we could have administered the SSW in this way to Evan, but again we would not have known how to interpret the results.

TEST BATTERY

The following tests were administered:
1. puretone air-conduction thresholds
2. puretone bone-conduction thresholds
3. word discrimination (Hirsh recording of the W-22s, 25 items, 40dB SL)
4. tympanograms
5. acoustic reflexes (ipsilateral and contralateral)
6. Phonemic Synthesis (PS) (at 50dB SL, now distributed by Precision Acoustics)
7. Auditory Figure-Ground subtest of SCAN (50dB SL)

TEST RESULTS

The puretone results (Figure 1) show Evan to have a slight conductive loss in his right ear and a profound sensory-neural loss in the left. The discrimination in the right ear was 72%. Because of this reduced score despite his relative good hearing, we immediately retested the right ear using the same recorded list. This time he obtained a score of 80% generally making the same errors as before.

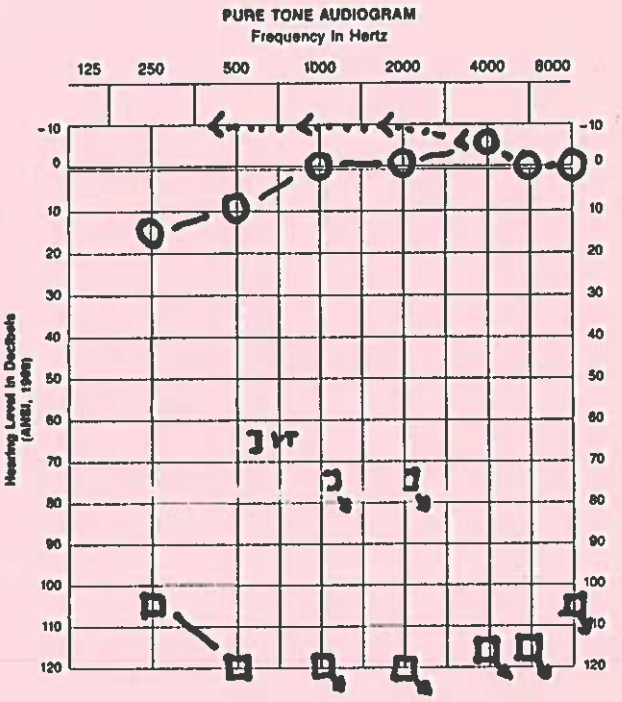

Figure 1. Puretone audiogram for child with a profound sensory-neural loss in LE.

Normal tympanograms were obtained for each ear. As expected, no acoustic reflexes were elicited (ipsilaterally or contralaterally) when stimulating the left ear. The responses when stimulating the right ear were much more interesting. Reflex

thresholds ipsilaterally when stimulating the right ear were quite normal (80-90dB HL), but in each case there was an indication of a biphasic response. That is, prior to the expected positive response, there was a slight negative one (see Figure 2). When stimulating the right ear and measuring the reflex in the "bad ear", the thresholds were elevated by about 15dB above the ipsilateral right (to 95-105dB), however, they were entirely in the negative direction (greater admittance instead of greater impedance). Negative or biphasic acoustic reflexes are often associated with otosclerosis (doubtful at this age), eighth nerve tumors, negative reflexes (the remotest possibility), and in just plain normals (like first author).

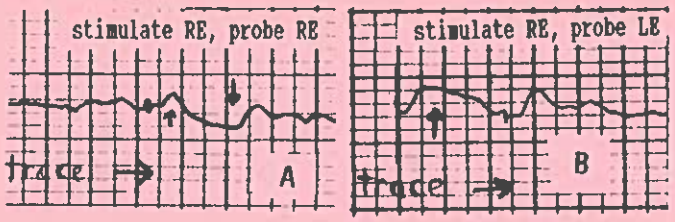

Figure 2. Evan's acoustic reflex patterns when stimulating the right ear at 1k Hz (A) measuring the reflex in the right ear (biphasic response), and (B) measuring the reflex in the left, poorer ear (a negative response showing greater admittance rather than reduced admittance).

On the Phonemic Synthesis (PS) test, Evan obtained a score of 6 correct out of 25 (14 correct represents normal limits for a first grader). The test was normed on naive children therefore, if Evan had normal phonemic skills we would have anticipated better than normal scores (especially in light of his intelligence). Thus, we concluded that he had significant difficulty in quickly and accurately processing speech at the phonemic level.

On the Auditory Figure-Ground subtest of the SCAN, Evan had only 2 right out of the 20 items. A score of 15 was needed to fall within normal limits. These results showed a severe speech-in-noise deficit. It should be noted that other children whom we see have the potential for doing better binaurally than they do in either ear (the binaural advantage), although this is often not the case. However, Evan has hearing in only one ear, so we know that his performance is likely to be no better under real life (noisy) conditions as there is no binaural advantage.

INITIAL DISCUSSION

The results showed that Evan was greatly overachieving at school if he was indeed keeping up with his class. Bess and colleagues (1987) have clearly demonstrated that a unilateral hearing loss is a major challenge to overcome at school. In this case we have a child who must deal with both a profound unilateral hearing loss and a severe CAP problem. He is severely impaired in phonemic processing (Decoding disorder) and severely impaired in speech-in-noise perception (TFM or Tolerance-Fading Memory dysfunction). Each of these three problems would be significant by themselves, but together they represent a most formidable barrier to normal communication and academic achievement. Fortunately, in this case we have a child who is very bright and who has parents who are eager to do whatever is necessary. Before, we discuss our recommendations, we would like to mention the results of further testing that we carried out a number of weeks after the CAP evaluation.

Evan was seen again for further testing because 1) his discrimination ability was too poor for his puretone hearing, 2) acoustic reflexes on the left side were abnormal, perhaps implicating the VII CN system (which would include the brainstem level) though ruling out gross damage to the V CN (tensor tympani was ok), 3) there has been no explanation for the complete unilateral hearing loss, and 4) the severity of the CAP disorder made us suspicious that this was not a typical developmental disorder, but rather there was some underlying neurological dysfunction.

FURTHER TESTING

Three tests were carried out with Evan on the second visit. We rechecked tympanometry and acoustic reflexes to insure that he had essentially normal middle ear status (in light of his middle ear history this was a major consideration). There were slightly negative tympanograms with good amplitude (equal to his earlier results) and the acoustic reflexes were unchanged. Therefore, we assumed that Evan was having one of his not so infrequent eustachian tube flair ups. Neither middle ear fluid nor additional conductive involvement were likely.

Auditory Brainstem Response (ABR) audiometry was carried out. There was no response when stimulating the poorer (left) ear with clicks (11.1/s) at 70 or 80 dB nHL. However, when stimulating the right ear at 70dB we obtained a marginally delayed response for wave I (1.82ms vs +2sd value of 1.77ms), a normal response for wave III (3.60ms vs 4.03ms limits) and a delayed response for wave V (6.16ms vs 5.97ms the outside limit of normal).

Of further interest was the interwave latencies. Wave III - I was 1.76ms falling well within normal limits (2.37ms). The V - III latency of 2.56ms however was considerably delayed when compared to the 2.12ms limit representing +2sd above the mean for normal listeners. The interwave latency for V - I was also delayed somewhat. Evan had a latency of 4.32ms whereas the normal limits were set at 4.23ms.

We had reason to suspect a dysfunction at the level of the brainstem or the cranial nerves and the ABR helped to confirm our suspicion. We believed that this would help us to convince Evan's school that they had to provide special services to him. This proved unnecessary.

FURTHER DISCUSSION

The SSW test formed the basis of our CAP category system that we have used for the past several years to classify CAP problems in our clinic. Over time we have found similar signs on other central tests such as speech-in-noise and PS. In this case because of the child's profound loss in one ear we had to rely on these two tests without benefit of the SSW. Because of the severity of the problem, we had no difficulty in demonstrating Decoding and Tolerance-Fading Memory dysfunction.

We made numerous recommendations including preferential seating, auditory training for both Decoding and TFM dysfunctions and the use of an FM auditory trainer (of course, properly modified for a "normal" hearing child). Perhaps because of the volume of evidence, or the fact that one of us worked closely with the speech-language pathologist in Evan's school, or that a number of the CSE members had heard one of us present on CAP, or .... they decided to carry out every one of our recommendation. We have high hopes for Evan. We believe that the school will not know the importance their efforts on behalf of this child (but we feel they will surely see the improvement). One can only hope that we will be as successful in getting services the next time we come before such a group (but we doubt it).

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