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Questions about Auditory Memory

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This article will consider two timely questions about auditory memory:

1. **Is auditory memory part of CAPD or not?**
2. **Is short-term auditory memory really associated with speech-in-noise skills?**

Most of us would say 'of course' to both questions. It is likely that those of you who have been using the Buffalo Model for years will need no convincing. However, it looks like some people are confidently saying 'no' to both questions. They believe that auditory memory is not part of CAPD while others state that there is no special relationship between short-term auditory memory and speech-in-noise. Here is what we have to say and what the literature has to say about this.

Is Memory Part of CAP?

The ASHA task force (2005) omitted (intentionally or not) auditory memory from their list of CAP skills. Of course, a list of skills is not a definition of CAP/D so we would have to take their word that only the skills they listed comprise CAP. We prefer to start the discussion with what is CAP/D and then to provide the evidence linking the auditory memory and speech-in-noise aspects. Groenen (1997) and Jerger (1998) define CAPD as "a set of deficits in the processing of sound patterns which cannot be explained by peripheral hearing loss ". Indeed we can all agree that we are not talking about auditory memory as a direct result of hearing loss. Lasky & Katz (1983) indicate that CAP is 'what we do with what we hear.' Bellis (2002 p 27-28) concurs with this definition as we have not been able to narrow what we mean by CAP/D. Katz (2009) cautions us that we should not divest ourselves, hastily or carelessly, of critical parts of our scope of practice, because once given away it may not be easy to get it back when we realize that divestment was a serious error. At the very least there should be an open discussion of why they would cut off any part of our body. We feel that this is not a trivial loss to our profession and therefore the evidence has to be very powerful to justify it.

The second widely used definition of CAP also relates very well to auditory memory. It seems strange to us that anyone would question whether remembering is a basic part of what we do with what we hear. Rather than ruling out auditory memory both of these definitions clearly include auditory memory.

Reasons Given Against Including Auditory Memory as Part of CAP

What possible reason would anyone have to exclude something so closely associated with auditory processing? What we have heard is that auditory memory is a 'pan-sensory' function. So it seems that some don't think of auditory memory as a real auditory function. They suggest that it is actually part of a lump of sensory or related functions (e.g., along with visual memory and perhaps executive functions). If we want to exclude all things that are not purely auditory based on the suggestions of Cacace and McFarland (2005), then we would have to exclude all aspects of audition that involve other functions. We could not use speech because there is a language component and we could not include reading because that has a visual aspect. What about such a basic function as attention to certain sounds and focusing in on what we want to hear? In fact, it is hard to imagine any useful aspect of audition that does not involve some other function/s. Taking this purest position to its limit would exclude any meaningful use of hearing from the scope of auditory processing. I assume that even most of those antagonists would not condone eliminating everything useful from CAP, but why auditory memory?

Reasons for Including Auditory Memory as Part of CAP

What are some of the reasons why we should include auditory memory in CAPD?

Our first problem is that we don't have a tight definition of CAP/D? It is like asking what a learning disability is. There are so many ways to describe it, test for it and train it that we can all have our opinions, but no one can know for certain what is CAP at this time. So we must use logic and leave flexibility in the system until we actually know the answer. For example, some try to include just pure auditory system functions while others deal heavily in language and cognition.

In the recent past, certain behavioral and electrophysiological studies have been conducted to probe into the role of auditory memory in auditory processing. Heasley (1980) had mentioned auditory memory as one the auditory processes. The Buffalo Model has also stressed the importance of auditory memory as an element of CAP (Katz, 1992) and we have all seen both how functionally and theoretically it fits in. On the Buffalo Model Questionnaire for 150 children with CAPD, Katz (2009 p 8) found 79% had trouble remembering directions and 54% of the parental reports specifically indicated that their child had auditory memory problems, whereas the sibling control group had 0% for both memory questions.

In a CAP study by Muthuselvi and Yathiraj in 2009; auditory memory was noted to be one of the most predominately affected auditory processes. Wilson et al. (2011) on various comparisons

found a weak but significant (p= < 0.05) severe to moderate (>0.4 to 0.6, p= < 0.01) correlations of auditory memory subtests of TAPS – R and the diagnostic APD tests. Sharma, Purdy and Kelly (2009) studied 68 children at-risk for APD and found a significant correlation between auditory memory tasks and diagnostic CAPD tests such as frequency patterns.

Finally, Katz (2009) indicates a practical reason for including auditory memory as part of CAPD: a) memory can be evaluated auditorily; b) then auditory training can be used to treat the problem and c) this results in improvement in academic and other concerns. Furthermore, it is not clear if pan-sensory training, that excludes auditory training, can produce as good results as we get when we do auditory memory training as part of the CAPD approach.

Are Short-Term Auditory Memory and Speech-in-Noise Closely Related?

In 1988 Brunt, Bessing and Monoson reported their study of 36 right-handed children with no signs or history of CAPD. They used the 0.01 level of confidence as significant (or r= >.418). They found a correlation of 0.77 between WISC-R digit memory span and the Total SSW score and for the CV span r= 0.61. In the Buffalo Model research, short-term auditory memory was found to be related to speech-in-noise. Katz and his colleagues Paula Smith, Barb Kurpita and Susan Brandner ran a factor analysis on the data from their various clinics for more than 200 children with CAPD, finding a strong, but unlikely, relationship between speech-in-noise and short-term auditory memory. They puzzled over this finding because they could not make any functional connection between these two auditory skills. Nevertheless, there appears to be an anatomical connection. Efron et al. (1983) found a powerful speech-in-noise effect when an anterior temporal lobe was amputated. In addition, the well-known organ of the memory system, the hippocampus, is also in the anterior temporal lobe, suggesting a regional connection. However, over the next 25 years we have come to rely on this connection. There is also much recent evidence that this connection is real and strong.

Recently, there have been a number of studies which have also pointed towards the relationship between these two auditory functions. Yathiraj and Maggu (2012) using data from 267 children in the age range of 8 to 13 years, found after a principal component analysis (PCA) that speech-in-noise and auditory memory shared the same component. Their findings were reinforced by a sequel of their study (Yathiraj & Maggu, in press) where they had utilized scores of 400 children. In this study, in addition to the PCA, they also conducted a confirmatory factor analysis to double check their findings. Again they found the strong relationship of auditory memory and speech-in-noise. Brannstrom et al. (2012), while studying auditory evoked potentials in 21 normal hearing adults also found a significant correlation between auditory working memory and speech-in-noise. They conducted the PCA and found the same connection

between speech-in-noise and auditory working memory. Each of these studies was conducted with different aims and populations. However, they all obtained the same finding!

The relationship of auditory working memory and speech-in-noise perception has also been revealed by the studies on musicians. Parbery-Clark et al. (2011) found that musical training improves speech perception in noise and auditory working memory. In fact, they obtained a strong correlation between these two auditory skills. Similar findings have been reported by Coleman (2012). In addition, Kraus et al. (2012) report findings which support the important role of auditory working memory and its relation to speech-in-noise.

Summary

We were most pleased to find strong support in the literature. We found no evidence, and surely not any powerful evidence, that would make us even consider a drastic change in our practices and scope of practice a) to ignore memory as part of auditory processing and b) no reason to believe that auditory memory is not closely related to speech-in-noise.

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A Case in Point and What I Learned From It

Jack Katz

Speaking of memory; I don't do memory testing at the initial visit when I evaluate someone for CAPD. Most kids are tired, or exhausted, just taking the three Buffalo-Model Tests (despite ample breaks). Instead I give a digit memory test at the first therapy session, word memory at the second session and working memory at the third.

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Many years ago I tested a child and found plenty of Decoding and Tolerance-Fading Memory indicators. Speech-in-Noise was, not surprisingly, quite poor. But when I looked over the case history form it said that he did not have any memory problems. There was even a comment that the child had a wonderful memory. What? Does having a wonderful memory sound like many of the kids that you have seen?

At the parent conference, after the testing, I asked the mother if her son did indeed have an excellent memory. She said, "Oh yes, he is amazing." I then asked for an example of what he could remember so well and she said, "He remembers things from when he was a young child and even today can sing the songs we taught him when he was maybe 3 years old." Yes, actually I can believe that, because I can do those things too.

Ah, that makes sense. He does have what appears to be a good memory, but not necessarily a good Short-Term Auditory Memory (STAM). So I asked if he is good at remembering when given oral directions and does he remember people's names whom he just met? She replied, "Oh no, he can't do those things well at all." That's all I needed to know for that child. But it was an important teachable moment for me.

The child's mother was likely correct. And I was the one who made the mistake. I was not really interested in 'memory' but specifically 'STAM'. From that moment on I have been careful in my speech, on my forms and reports, as well, to specify, 'Short-Term Auditory Memory'. However, after it is well established that we are talking about STAM I will sometimes remove one or both of the qualifiers as it will not be confused with visual or with long-term auditory memory.

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