Not Your Grandmother's CADP Recommendations:
Use of Technology for More Effective Management of Central Auditory Processing Disorders (C)APDs

Kate Meade, AuD, David DeBonis, PhD, and **Kevin Ihrman, AuD**,
Sunnyview Rehabilitation Hospital

Central Auditory Processing Disorder (C)APD as a diagnostic entity remains controversial among authorities within our own profession and in related fields. Disagreement exists as to the nature of the disorder, its diagnostic utility, best methods of assessment, and best methods of management *(Bellis,2003, 2006; Cacace & McFarland, 2005; Jerger & Musiek, 2000; Katz & Tiller, 2005)*. Despite these ongoing disagreements, growing numbers of parents, teachers, and speech-language pathologists make audiological referrals for students who appear to demonstrate some fundamental deficit in their listening/processing of auditory information, even in the presence of normal hearing and language abilities. These students frequently exhibit:

- difficulty understanding speech in adverse listening environments,
- misunderstanding of spoken messages,
- a need for spoken information to be repeated,
- difficulty following complex oral directions, and
- reduced academic performance *(AAA, ASHA, 2005)*.

Because it is not reasonable to expect that those seeking to provide support to students diagnosed with (C)APD will delay doing so until professional disagreements have been resolved, clinicians working with these students need to remain updated regarding a variety of intervention methods that may be useful for this population. Unfortunately, there is currently no single validated model of (C)APD intervention and very few randomized trial studies exist that could provide efficacy data to guide intervention decisions *(Fey and colleagues, 2011)*.

A number of broad, guiding themes can, however, be gleaned from the intervention literature including the following: a) capitalize on brain plasticity by intervening early and intensively *(ASHA, 2005)*; b) use interventions that are broad in order to address the effects on overall communication and academic functioning *(ASHA, 2005)*; c) use direct auditory remediation approaches cautiously in view of the lack of efficacy data available *(DeBonis & Moncrieff, 2008)*; and d) manage the listening environment to improve access to incoming auditory information *(ASHA, 2005)*.

Technological Interventions

Consistent with these themes, those seeking to provide useful suggestions for students with (C)APD should move beyond the traditional delivery systems and should seek to incorporate technology into their package of recommendations. Table 1 that follows summarizes a series of technology-based recommendations for use by both teachers and students that capitalize on the strong motivation that students have to use technology. We believe these suggestions could: a) facilitate more intensive practice of certain skills and more regular review of academic concepts on the part of students, b) provide more effective support for students with organizational difficulties, c) give teachers some advanced tools to enhance the quality of their lectures, and d) promote greater engagement in the learning process on the part of students.

This use of technology is consistent with the literature which suggests that the availability and use of computers, either at school or at home, has become widespread *(DeBell & Chapman, 2003)* and is positively related to improved academic achievement *(Woessmann, & Fuchs, 2004)*. The increased use of technology by students to regularly work on building skills that may be crucial to academic success is also timely in view of the fact that not all students who are diagnosed with (C)APD are eligible for services, school budgets often require cuts in services, and the availability of speech and language services decreases significantly as students move into the middle and high school grades *(ASHA, 2002)*.

Table 1:
Summary of Various Technologies Applied to CAPD Management

Technology Type	Specific Examples	Goal	Application to CAPD Intervention
FM System	• Ear level receiver for children with normal hearing • Sound field (personal/desktop or classroom) system	• Improved signal to noise ratio	• auditory figure-ground deficits • attention deficits • binaural separation difficulties
Presentation Software	Powerpoint/Keynote	Provides visual supplementation to the auditory message	• Beneficial for most types of CAPDs • Use caution with integration deficits
Presentation Hardware	• Smart/Promethean Boards • Document Camera	• Provides visual supplementation to the auditory message	• Beneficial for most types of CAPDs • Use caution with integration deficits
Presentation Hardware Accessories	Wireless Interactive Tools (e.g., student response buttons)	• To provide the teacher with user feedback (monitor comprehension of classroom content)	• Beneficial for most types of CAPDs
Recording Equipment	• Digital Recorders • Smart Phones • Tablets • Some e-Readers • Some Personal Music Devices (e.g. iPod Touch)	• Enable playback of specific challenging parts of a lecture	• Beneficial for most types of CAPDs
Speech to Text Technologies	• Dragon Dictation • Typewell • Included in most Computer Software (i.e., MacDictate, Microsoft Windows 7 Speech Recognition • Smart Phones • Tablets	• To provide note-taking support • To provide writing assistance for those with motor planning difficulties	• Beneficial for most types of CAPDs • Especially beneficial for those with short-term auditory memory deficits and/or motor planning deficits
Text to Speech Technologies	• Some e-Readers • Dragon Naturally Speaking • Natural Reader 10.0 (free) • Included on most computer software (i.e. Microsoft Windows 7 Text to Speech) • Tablets • Smart Phones	• Assists with reading accuracy and comprehension • Allows the child to combine visual and auditory inputs	• Beneficial for children who have decoding and short-term auditory memory struggles that impact reading abilities
	• Electronic Planners • Some are available on Smart Phones or Tablets	• Supplements or replaces paper planners with added benefit of audible reminders	• Beneficial for children who have organizational and/or memory struggles
	• Parent Portals • Teacher Webpage	• Provides feedback to parents re: attendance & academic performance • Allows parents to be educational partners with teachers	• Beneficial to all students
	• On-line Document Storage (The Cloud) • iCloud • Google drive	• Accessible from nearly any electronic device where internet access exists • Relieves memory demands by providing easy access to important documents. • Allows student to work on one document in multiple locations creating one consistent and current document.	• Beneficial for children who have organizational and memory struggles.
	• Flash Drives	• Compact personal storage • Accessible from nearly any electronic device • Allows student to work on one document in multiple locations creating one consistent and current document.	• Easy access to personal files for all children.
	• Organizational Software/Applications (e.g., Evernote, ClassOrganizer, Idea Sketch).	• Provide opportunity to store important information, content, ideas, and brainstorming in an easily accessible electronic format	• Beneficial for children who have organizational and memory struggles.
Computer programs	• Earobics • LindaMoodBell.com	• Provide specific therapy that can be completed at home.	• Each Program is targeted at strengthening specific skills

Just as technology has impacted so many of us both personally and professionally, the information in Table 1 supports the potentially positive role of technology for individuals who have (C)APD. At the same time, it seems appropriate to close this article with a word of caution about the over-reliance on technology as a number of researchers have suggested that this can be problematic.

Technology And Multi-Tasking

Susan Greenfield *(2008, 2004)*, neuroscientist and professor of pharmacology at Oxford University, believes that use of technology is changing our brains at the micro-cellular level, which in turn affects our personalities. Further, she notes that the two-dimensional world created by video games and computer screens is negatively affecting attention spans, inter-personal communication skills, and abstract thinking. Greenfield also suggests that students' increased visual literacy resulting from use of technology has enhanced their real-time analysis abilities at the expense of other forms of analysis that involve reflection and imagination; these latter skills are critical to academic success. Greenfield also found that students who were allowed to use the internet during class lectures did not process the information as well as those students who did not use the internet, suggesting that one possible drawback of technology use relates to its role in multi-tasking.

Research has established that the younger generations spend more time multi-tasking than older generations *(Carrier and colleagues, 2008)*. The problem with multi-tasking, according to Daniel Siegel, Associate Clinical Professor of Psychiatry at UCLA Medical School, is that when we do several things at once we tend to be less engaged in all of the activities and therefore do not engage certain brain regions that create strong neural connections. A 2010 New York Times article by Matt Richtel summarizing studies on multi-tasking suggests that those students whose multi-tasking involves technology had greater difficulties filtering out irrelevant information. Further, Foerde and colleagues *(2006)* describe brain scans that show that when students interrupt their studying with use of technology (e.g., texting, tweeting) information goes into the striatum (rather than the hippocampus) which makes retrieval of facts and ideas more difficult. Gary Small, a neuroscientist and author of the book iBrain *(2009)*, adds that very young children who spend a lot of time multi-tasking may miss important subtle non-verbal messages that contribute to their ability to establish social connectedness. He adds that if the brain circuitry related to human interactions becomes weakened, social interactions can become quite impaired.

As is common in our work as professionals, a careful balance with ongoing data collection is necessary. Clinicians should attempt to blend new, innovative, and motivating approaches to intervention (like those addressed in Table 1) along with traditional, established approaches in our ongoing effort to meet the individual needs of our clients and to promote development of a wide range of important abilities. ◆

Kate Meade, Au.D. is the Senior Audiologist and Pediatric Specialist at Sunnyview Rehabilitation Hospital in upstate New York. She has 21 years experience with hearing rehabilitation and has been with Sunnyview for 14 years. Dave DeBonis, Ph.D., CCC-A is an Associate Professor and previous Chair of the Department of Communication Sciences and Disorders at The College of Saint Rose and Clinical Audiologist at Sunnyview Rehabilitation Hospital. Kevin Ihrman, Au.D., FAAA serves as Chief of Audiology at Sunnyview Rehabilitation Hospital and is board certified in Audiology by the American Board of Audiology. Both Dr. Irhman and Dr. Meade also serve as adjunct instructors at The College of Saint Rose in the Department of Communication Sciences and Disorders. Sunnyview Rehabilitation Hospital has been providing comprehensive evaluations for Central Auditory Processing Disorder for over 25 years and is highly regarded as one of the leading providers of those services in the greater Capital Region in New York State. Contact Dr. Meade at meadek@nehealth.com.

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