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A Connection Between Hearing & Cognition: A Case Study

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A Connection Between Hearing & Cognition: A Case Study

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ABSTRACT (100-200 WORDS):
This paper is a single case study following an individual diagnosed with CADASIL (*cerebral autosomal dominant arteriopathy with subcortical infartcs and leukoencoephalopathy)* who also has a bilateral sensorineural hearing loss. Research and a critical literature review were explored to gather information to further examine the connection between hearing and cognition. Research and methods of pre- and post- testing after cognitive therapy are included and integrated into this paper. Follow-up tests were administered and the results are compared with the previous testing that had been done. Implications involving self-efficacy were further explored in this paper.

University Honors Program

Capstone Approval Page

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A Connection Between Hearing & Cognition: A Case Study

Introduction:

The purpose of this paper is to discuss the relationship between hearing and cognition and to investigate just how large of a relationship it is. Toward this end, follow up was sought into an already IRB approved study with an individual diagnosed with CADASIL (*cerebral autosomal dominant arteriopathy with subcortical infartcs and leukoencoephalopathy*: i.e., a genetic form of vascular dementia) who also has a hearing loss. Exploring this connection could have implications for many individuals who suffer from hearing loss. The research for this study is presented as a single case study with a critical literature review.

One type of hearing loss is age-related; in which aging adults have a sensorineural hearing loss, located within the cochlea, which is part of the inner ear. This is called presbycusis. Some older adults may also have hearing loss due to neural damage in the brain (Pichora-Fuller & Singh, 2006). The brain itself is also affected by a sensorineural hearing loss. It is said that sensorineural hearing loss can be linked to atrophy in the brain; meaning the density of grey matter in auditory areas of the brain is lower in people with hearing loss (Science Daily, 2011). Some believe that hearing loss is simply cognitive deficits that present themselves as auditory processing deficits. Because testing auditory processing typically involves sound as the stimulus, testing other specific modalities (e.g. vision) can determine if the deficit is a cognitive deficit or an auditory processing deficit (Humes, 2005).

As people age there are not only changes in their hearing and auditory processing but also negative changes in cognition as well (Humes & Floyd, 2005). A decline in speech understanding can be a result from both of the aforementioned changes, but which is more prevalent for the decline? Humes (2007) showed that once audibility could be restored in persons with hearing loss, differences in speech recognition scores were still seen amongst the individuals. This indicates there is another factor to look at besides the hearing loss accounting for performance on speech understanding because it cannot be credited solely to hearing thresholds. Factors could include, but are not limited to, age and cognitive abilities. These factors accounted for 30-50% of the variance in performance (Humes, 2007).

Auditory function is a complex task that involves four processes including hearing, listening, comprehending, and communicating. Necessary to three of the four previous tasks, communicating, comprehending, and listening, is cognitive processing. Recently, due to the advancement in technology, research of the connection between auditory and cognitive processing has increased greatly (Pichora-Fuller & Singh, 2006). Questions or hypotheses of my research and critical literature review included:

1) Can the known relationship between auditory processing and cognition be exploited for new or more effective ways to treat or help people with hearing loss?
2) How does this case study inform the relationship between hearing and cognition?

Case Report:

Case Description:

CADASIL is a rare genetic disorder. Individuals with CADASIL experience repeated small strokes with deterioration in cognitive function. Soon after age 60 years dementia is usually detectable. The individual in this case study, MG (initials changed) is now 60 with no marked dementia, but has mild cognitive decline. MG, who also has a hearing loss, has decided to no longer wear his hearing aids. He stated that he no longer needed them after receiving his cognitive therapy.

MG was diagnosed with CADASIL in June 2008. In May 2007 he received a full audiological assessment with results showing a bilateral sloping, moderately severe sensorineural hearing loss in the high frequencies, 3000-8000 hertz. He was given hearing aids at that point. In January 2009 he returned to the NIU clinic complaining of worsening hearing loss and that his hearing aids were no longer working properly. A full audiological assessment showed there was no change in his hearing loss or word recognition skills. He stated that he had increased difficulty with hearing when there was increased background noise. At that point he was referred for a cognitive evaluation.

Treatment Protocol:

In June 2009 MG completed tests examining language, attention, memory, and executive function skills. MG received cognitive treatment for 90 minutes twice a week for a 10-week long period. The sessions followed the Attention Process Training-II manual (Sohlberg et al. 2001) for attention training tasks in the first half of the session and the second half consisted of strategy training activities. MG was

also being taught compensatory strategies to improve performance in his activities. In addition to the sessions, MG was given homework weekly. The homework was planned to imitate the treatment sessions (Mayer & Bishop, 2012).

In this case study an audiological assessment was done as well as some cognitive tests that MG had previously done pre and post cognitive treatment with Dr. Jamie Mayer. The cognitive tests administered in October 2011 were the *Rivermead Behavioral Memory Test-Third edition,* (Wilson, et al., 2008) the *Delis Kaplan Executive Function System* (D-KEFS; Delis, Kaplan, & Kramer, 2001) and the APT-II Attention Questionnaire (Sohlberg et al. 2001). In the audiology assessment he was given a Pure Tone Audiometry test and Word Recognition tests in quiet and in noise.

Test Results:

On the *Rivermead Behavioral Memory Test-Third edition,* MG scored within normal limits pre treatment and his most recent scores yielded similar results as before with minimal changes. Table 1 shows MG's progress. As you can see MG scored significantly better in the visual and spatial memory tests. There were a few tasks MG took a while longer to respond which resulted in a lower score. He did not show an overall improvement on all of the tasks nor an overall decline on the tasks. However, if you look at Table 1 in the final two rows you will see MG's scores for a summary of scaled score and a general memory index score for pre-treatment and follow-up. The slight drop in his pre-treatment scores to his follow-up scores is within one standard deviation and is not clinically significant.

Table 1. Pre and Past treatment and follow up on the Rivermead Behavioral Memory Test 3rd Edition

Measure		Pre-treatment (6/09)	Post-treatment (10/09)	Follow-up (10/11)
RBMT-3				
Verbal Memory	Name	9	NA	1
	Story-Immediate	10	NA	15
	Story- Delayed	8	NA	15
Visual Memory	Picture Recognition	11	NA	11
	Face Recognition-Delayed	6	NA	15
Spatial Memory	Route-Immediate	9	NA	12
	Route- Delayed	9	NA	12
Prospective Memory	Belongings-Delayed	12	NA	6
	Appointments-Delayed	12	NA	8
	Messages-Immediate	11	NA	11
	Messages-Delayed	11	NA	11
Orientation/Date		10	NA	6
New Learning	Novel Task-Immediate	14	NA	9
	Novel Task-Delayed	10	NA	12
Sum of Scaled Scores		141*	NA	136*
General Memory Index		102*	NA	97*

Note, Mean=10, Standard Deviation=3, *Mean=100, Standard Deviation=10

He was also administered the D-KEFS. On the pre-treatment test he was within normal limits on the non-executive functioning parts of the test and scored

much lower on parts where processing speed demands were placed on him. As shown in Table 2 MG scored higher on the parts of the D-KEFS that had caused trouble for him previously, with the exception of Category Fluency; his performance on this subtest remained within normal limits (i.e. less than one standard deviation below the mean) and was not considered a clinically significant decline.

Table 2. Pre and post treatment and follow up on Delis-Kaplan Executive Function Systems.

Measure		Pre-Treatment (6/09)	Post-Treatment (10/09)	Follow-up (10/11)
D-KEFS				
Trails	Combined Scaled Score (Conditions 2 & 3)	14	14	15
	Condition 4	5	12	12
	Contrast scaled score: combined	2	9	7
Fluency: Verbal	Letter Fluency	8	8	12
	Category Fluency	12	7	8
	Category Switching: Total Correct	6	8	10
	Category Switching: Accuracy	7	9	11
	Switching vs. Fluency	4	11	12
Color-Word Interference	Color Naming	10	10	11
	Word Reading	10	9	11
	Inhibition	13	13	12
	Inhibition/switching	8	12	12
	Completion Times	10	10	11
	Inhibition/Switching vs. Inhibition	4	9	10

Note: Mean=10, Standard Deviation=3

MG was also given the APT-II Attention Questionnaire where he reported functional deficits in distracting environments and on multi-component questions. The APT-II questionnaire has been given to MG a total of four times now. Table 3 illustrates the questions asked and MG's responses for three of his tests. At the pre-treatment (July, 2009) MG answered over half the questions as 'frequently' and 'all the time' resulting in a score of 33. At post treatment just three months later (October 2009) he received a score of 11. MG answered almost all of his questions as 'on occasion.' Almost a year later in June 2010, MG scored a 9. His answers to the questions were 'on occasion' or 'not a problem' for all responses. MG's most recent (October 2011) APT-II questionnaire score was a 13. The category with the biggest problem for him was 'easily distracted by surrounding noise' and 'easily getting off track if other people milling about nearby.' See table 3 for all of the questions used in the report and MG's responses.

Table 3. Pre and post treatment and follow up on APT-II Attention Questionnaire

Question	Pre-Treatment (7/09)	Post-Treatment (10/09)	Follow-up (10/11)
Seem to lack mental energy to do activities	Sometimes	On occasion	On occasion
Am slow to respond when asked a question or participating in conversations	Sometimes	On occasion	Not a problem
Can't keep mind on activity or thought because mind keeps wandering	Sometimes	On occasion	On occasion
Can only concentrate for very short periods of time	Sometimes	On occasion	On occasion
Miss details or make mistakes because level of concentration decreased	Frequently	On occasion	On occasion

Easily get off track if other people milling around	Frequently	Not a problem	Sometimes
Easily distracted by surrounding noise	All of the time	Sometimes	Frequently
Trouble paying attention to conversation if more than one other person	All of the time	On occasion	Not a problem
Easily lose place if task or thinking is interrupted	Frequently	On occasion	On occasion
Easily overwhelmed if task has several components	Frequently	On occasion	On occasion
Difficulty to pay attention to more than one thing at a time	Frequently	Not a problem	On occasion
Total Score	**33**	**11**	**13**

Note: "On occasion"=<once/week; "Sometimes"=1-3 times/week; "Frequently"=most days.

The audiological assessment just recently done yielded the same results as the assessment done in January 2009. MG still presents with a sloping moderately severe sensorineural hearing loss bilaterally. At present time MG still does not wear his hearing aids. After further questioning as to why MG no longer wears the devices we found that he had lost one two years ago and never got it replaced because it was the fourth time he had done so and felt that he could go without. He also stated that his use of compensatory skills has increased his hearing abilities. For example, he will move closer to a speaker at a lecture, has picked up on some lip reading, chooses quieter settings to meet with people, and will even ask places to turn down the music some if it is too loud for him. In sum, it was clear following the cognitive and audiological evaluations and interviews that MG's hearing had not gotten better like he perceived it had: instead he was simply compensating better for his loss.

Discussion:

Informing the relationship between hearing and cognition:

Testing proved that MG's hearing did not improve, he was simply compensating better for his hearing loss. Looking at his scores on the APT-II questionnaire (Table 3) you can see a dramatic increase in his view of his attention. Could this change of view, or increased self-efficacy have to do with his belief that his hearing was better?

New or more effective ways to treat or help individuals with hearing loss:

Kricos (2006) stated that self-efficacy is an important part of intervention when treating older adults with hearing loss. MG's first report on the APT-II compared to his latest, showed a considerable amount of functional deficits. After receiving his cognitive training his perception of his attention changed. He realized he could do the task required of the cognitive training, which in turn made him realize he was able to do other tasks better than he previously thought. When working with older adults with hearing loss audiologists should include nurturing self-efficacy to help with success in other forms of rehabilitation (Kricos, 2006) as MG has perfectly demonstrated.

Kramer et al. (2003) found that self-efficacy in older adults is also predictive of devotion to exercise plans. There was a greater exercise attendance rate in groups with efficacy-enhancing strategies, than in a control group. Social support can also influence self-efficacy. Self-efficacy can be trained and implemented into cognitive therapy programs. Tasks included in therapy could incorporate goal-setting, knowledge of progress in therapy, education about outcomes, and modeling. Including these tasks have been found to significantly increase participants' benefits in protocol (Kramer et al. 2003; Mayer & Bishop, 2012).

Although this is a single case study, increased self-efficacy has seemed to increase this individual's perception of his hearing. For this to be applied to others with hearing loss and have them state hearing improvement would be completely speculative, and would involve a more in-depth research study.

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