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Computer Integrated Surgery II

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26 April 2016

Seminar Presentation Critical Review

The paper under review for this seminar presentation is the paper titled "Long-term Effects of Cognitive Training on Everyday Functional Outcomes in Older Adults", written by Sherry L. Willis et al. This study appeared in the Journal of the American Medical Association (JAMA) in December of 2006. The aim of the study was to investigate the effects of cognitive interventional training on both cognitive outcomes directly related to these areas of training and functional outcomes—tasks performed as a part of everyday life. Previous studies have shown that cognitive training improves cognitive abilities in older adults (mostly Caucasian), but the effects of cognitive training on everyday function have not been demonstrated. Additionally, no study has had as far-reaching a follow-up period as the 5-year period utilized in this study.

The sample consisted of older adults—all living independently and with good functional and cognitive status—recruited from senior housing, community centers, and hospitals and clinics in six different cities across the United States: Birmingham, Alabama; Detroit, Michigan; Boston, Massachusetts; Baltimore, Maryland; Indianapolis, Indiana; and State College, Pennsylvania. Patients with substantial functional impairment, cognitive decline, or various other deficits were excluded from the study, as this study aimed to investigate the effects of cognitive training on *healthy* older individuals rather than those already suffering from cognitive deficits. While other studies have focused on the effects of cognitive training as treatment for deficits, this study aimed to prove their efficacy and value to those individuals without deficits and to determine whether the benefits garnered from training lasted throughout the five-year study period. By proving cognitive training's effectiveness as a *preventative* tool rather than a reactionary tool, the investigators hoped to demonstrate that this training benefits even those individuals who have yet to suffer cognitive decline. Additionally, previous studies had been conducted on mainly white older adults, an emphasis was placed on recruiting individuals who identified as members of other racial and ethnic groups.

Participants were randomly placed into one of four groups, three of which received treatment and one of which served as the control. The three treatment groups received treatment in one cognitive area each: memory, reasoning, and speed of processing. Assessments were performed on each participant at multiple times throughout the study period: at baseline, following the intervention (treatment), and annually at 1, 2, 3, and 5 years. The interventions consisted of exercises in each of the treatment areas, specific to the group that the participant was assigned to. Each training intervention was 10 sessions, only 10% of which focused on applying the training strategies to solving everyday problems (eg, mnemonic strategies to remember a grocery list; reasoning strategies to understand the pattern in a bus schedule)[1]. For a randomly selected subset of study participants, booster training was

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[1] Willis, Sherry L., et al. "Long-term effects of cognitive training on everyday functional outcomes in older adults." *Jama* 296.23 (2006): 2805-2814.

performed at 11 and 35 months after the initial training sessions and involved four 75-minute sessions. The paper states that the goal of the booster sessions was to "maintain the improvement in cognitive ability and the content of these sessions was similar to the training sessions, again focusing on strategies related to the cognitive abilities not on functional outcomes."

The results of cognitive training were assessed in two ways: through cognitive and functional outcomes. The distinction between the two is best illustrated in Figure 1 from the paper, included below.

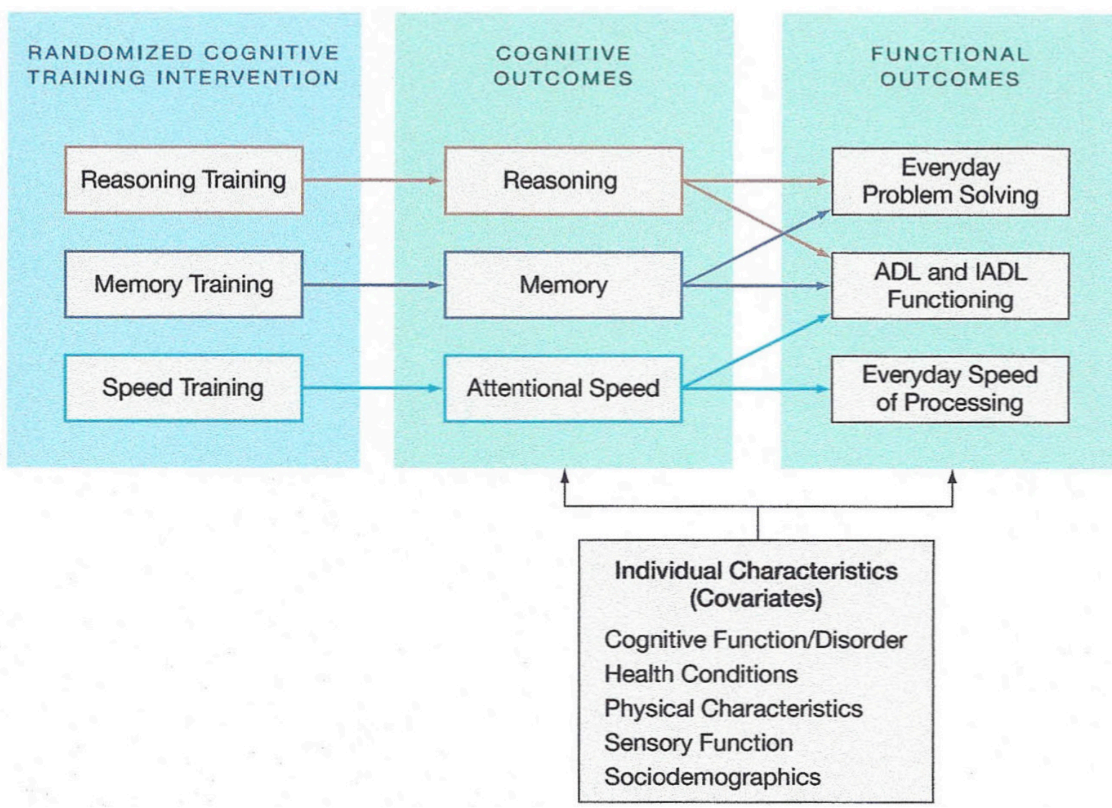

Figure 1: Conceptual Model of ACTIVE (Advanced Cognitive Training for Independent and Vital Elderly) Trial

While cognitive outcomes measure directly a patient's ability in that specific cognitive skill, functional outcomes move past that to attempt to measure their skill in performing everyday tasks such as those taken from the set of Instrumental Activities of Daily Living (IADLs). To assess cognitive outcomes, Willis et al. employed many established tests of verbal memory (Hopkins Verbal Learning Test, Rey Auditory-Verbal Learning Test, and the Rivermead Behavioral Paragraph Recall Test), reasoning (letter series, letter sets, and word series), and speed of processing (3 useful field of view subscales). In order to assess functional outcomes, researchers used participants' self-ratings of difficulty for various IADL tasks—ranging from "independent" to "total dependence" on a 6-point scale of difficulty—as well as two performance-based categories of daily function: everyday problem solving and everyday speed of processing. Everyday problem solving assessed the participant's ability to reason and comprehend information in common everyday tasks (such as identifying information on medication labels), while everyday speed of processing assessed his or her speed in interacting with real-world stimuli (such as looking up a telephone number or reacting to road signs).

Lastly, composite scores for these outcomes were formed via data reduction methods and standardized to baseline values, from which an average of equally weighted standardized scores was calculated. The investigators claim that these composite scores are more reliable than single measures and allow for inferences about training effects at the level of outcome rather than at the level of a single test. In reporting statistically significant training effects, the paper uses 99% confidence intervals (CIs; $p=0.008$). Hypotheses were tested by comparing the net effect at year 5 in each treatment group to the net effect in the control group.

The researchers state that each cognitive training intervention produced immediate improvement in the cognitive ability trained that was retained across all 5 years of the study. Furthermore, the additional booster training produced significantly better performance on their targeted cognitive outcomes that also remained significant at 5 years.

In terms of effects on daily functioning, participants in all three of the trained groups reported less difficulty with IADL tasks at the end of the 5 years when compared to the control group. This result, however, was only statistically significant for the reasoning group, which had an effect size of 0.29 (99% CI, 0.03-0.55) for difficulty in performing IADL compared to the control group. Neither memory training nor speed of processing had a significant effect on IADL difficulty. From this, the researchers concluded that training had no general effect on the performance-based measures of everyday problem solving or everyday speed of processing, prompting them to recommend further investigation.

The most important result of this study is that cognitive training provides an immediate benefit to cognitive function, even if the participant does not possess a cognitive impairment, and that this benefit has a **long-lasting impact** on cognitive performance. From this, the argument can be made for the use of cognitive training as a preventative measure to preempt cognitive decline rather than just as a reactionary measure as it is currently being used. While there was not statistically significant evidence that cognitive training had an impact on everyday functional performance, this could be due to the complex nature of functional assessment. Participant self-reporting of everyday performance is prone to error and hard to standardize—what one participant considers a 6 on a task-difficulty scale may register as merely a 4 on another participant's internal scale.

The pros of this study are that the researchers very clearly stated their aims, procedures, participant selection criteria and process, and what tools (including exact assessments) were used to perform the cognitive and functional assessments. Also, the statistics were well performed and documented, including p-values, effect size, and confidence intervals. The study was well-designed, with a clear and obtainable aim that was fairly easy to verify (other than the one subjective measure). The cons of this study are that one of the main measures of functional performance was self-reported by the participants and completely subjective. While the investigators tried to offset this by using some objective measures of everyday performance (including the IADL Minimum Data Set—Home Care), it is fundamentally difficult to quantify an improvement in one's everyday life. Lastly, the researchers were unable to articulate why the effects of cognitive training on function was modest and latent, only showing up at the 5-year follow up, speculating that it took until then for the patients to being experience cognitive deficits and leaving this as a topic for future research.

In relation to our project, this study provides valuable insight into the usefulness of cognitive training, not only for patients suffering from cognitive deficits. While the scope of our project at present only extends to patients with visuospatial deficits, our application can easily be expanded to all patients, providing even healthy individuals with exercises that can improve their cognitive abilities. Furthermore, these exercises can be used in a preemptive manner, to provided training before cognitive deficits are even present, instead of the reactionary manner in which they are provided now. Further research would be needed, but it is likely that the same may hold true for strictly visuospatial exercises.