Distinguished Fellowship Project Brief


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Research Question: How does working memory training improve cognitive ability?

Interdisciplinary Approach: This fellowship project combined cognitive and clinical psychology with electrophysiological methods to determine how working memory training is effective in improving general cognitive ability, and how deficits in attention influence training outcomes.

Potential Implications of Research: The results of this research help us understand how working memory training improves cognitive abilities. The results inform theories of learning and memory and provide new directions for improving training programs for specific populations with working memory deficits, such as individuals with ADHD.

Imagine looking at a map or hearing a list of directions and having to keep that information in mind while you navigate somewhere new. This ability to “hold” information in mind is known as working memory (WM). WM plays an important role in our ability to learn and function in society. However, WM is very limited and we can only hold 3-4 items in WM at once. If you are given 10 directions to remember, chances are you’re going to get lost because you can’t keep all 10 items in mind. Importantly, this “WM capacity” predicts a broad array of cognitive abilities such as intelligence and educational achievement and is known to be smaller in individuals with attention deficits.

Despite WM’s limitations, we can improve our WM through practice. Moreover, recent work has begun to show that WM training may be effective in improving learning and memory across the lifespan for both healthy individuals and those affected by neurological disorders. Yet it is still unclear how such training improves cognitive abilities. In the current project, we compared two types of WM training and saw whether either type of training resulted in improvements to a variety of cognitive abilities, such as WM itself, intelligence...etc. Half of our participants trained on a dual n-back task, which requires the relationships between memory items to be remembered (Figure 1A). The other half of our participants trained on a span task, which requires control of attention between memory items (Figure 1B).

We found that both training on the dual n-back and the span tasks resulted in improvements to WM performance on novel WM tasks that the participants had not trained on. However, we did not see any improvement in intelligence following WM training. We used electroencephalography (EEG) to explore how these two types of training cause different brain activation patterns. We found that individuals in the dual n-back training group showed significant changes in their EEG activity after training, but individuals in the span training group did not show these same changes. This suggests that dual n-back training is better at eliciting brain changes associated with WM compared to span training. Finally, we found that individuals who reported more ADHD symptoms saw greater improvements in WM following training. This exciting result suggests that WM training may be an effective tool for individuals with attention deficits.

Figure 1. Two WM training tasks used in the current project. (A) Dual n-back: an example “2-back” trial where observers must decide if a letter and the location of a square are the same as the one they saw 2 before. (B) Span Task: Observers must remember the location and order of red squares while deciding if an image is symmetrical in between each red square presentation. Both training tasks are adaptive, meaning the difficulty adjusts based on an individuals’ performance.