Cognitive Training and ADHD: Sizing up the Evidence

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Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental condition that is typically first diagnosed in childhood and tends to persist into adolescence and adulthood (DSM-5, American Psychiatric Association, 2013). There has been a lot of recent interest in cognitive training as a treatment option for ADHD. Most theories and neuropsychological profiles of ADHD include executive and cognitive processes that are thought to underlie observed deficits and problems in ADHD (Barkley, 2006; Nigg, 2006; Sonuga-Barke, 2002; 2003). Thus, it makes sense to consider methods and strategies to try to improve cognitive processes in ADHD and to conduct research to determine the efficacy of such programs. The focus of this article is on cognitive training research in ADHD. We will begin with explaining what cognitive training involves and what the research evidence has indicated so far about these programs. Then we more specifically discuss the evidence for these programs in individuals with ADHD and wrap up with some general points about cognitive remediation.

Cognitive Training Overview

In general, cognitive training refers to the use of cognitive tasks or games to improve performance on other tasks. These programs have also been referred to as “brain-training interventions” or “brain games”. Some of the more well-known programs include Cogmed and Luminosity. The popularity of these training programs has not just been limited to ADHD, but

they have been proposed for several special populations and for the general public, including aging adults.

We want to acknowledge that this has been, and continues to be, a very contentious topic among researchers and scientists. There are many scientists on both sides of the issue (Simons et al., 2016). There are at least a couple of reasons why researchers have been so divided. Research on treatments and interventions for behavioural change is very challenging to conduct. This type of research is very labour intensive for everyone involved, including the researchers and participants. There are a lot of practical challenges that make it extremely difficult to get large sample sizes in order to properly evaluate a treatment. There are complicated issues related to having proper control groups, ensuring that the treatment is delivered and received as intended and trying to prevent dropouts during the treatment program. Given these challenges, it is actually quite difficult to demonstrate the efficacy of such programs. Even if all of these issues have been dealt with effectively, there remains the challenge of demonstrating that the treatment shows effects beyond the program. That is, it is expected that clients can use their new skills and tools in their everyday lives, an issue often referred to as transfer effects.

Several meta-analyses have now been published reviewing the efficacy of cognitive training programs (Melby-Lervåg, Redick, & Hulme, 2016; Simons et al., 2016; Shipstead, Hicks, & Engle, 2012). Meta-analyses are a summary or compilation of several different studies, which systematically combine the data from these different studies to determine effects. Efficacy studies refer to those studies conducted in optimal circumstances, which basically means the studies have been conducted by researchers in more controlled settings. The gold standard for evaluating the effectiveness of any intervention involves using a double blind, placebo-controlled, randomized clinical trial. In such a design, participants are randomly assigned to a

treatment or control group, participants do not know if they are receiving the treatment or a placebo, and the person conducting the testing does not know whether the participant being tested is in the treatment or control condition. If these conditions are met and the treatment shows better effects than a comparable control group, this is the first step towards showing that a treatment is effective.

Based on recent meta-analyses, there is relatively strong evidence that these interventions improve performance on the trained tasks (Melby-Lervåg, Redick, & Hulme, 2016; Simons et al., 2016; Shipstead, Hicks, & Engle, 2012). There is less evidence that these interventions improve performance on closely related tasks. There is little evidence that training enhances performance on distantly related tasks or on tasks that require cognitive skills in every day activities. These reviews have concluded that:

> "Based on our extensive review of the literature cited by the brain-training companies in support of their claims, coupled with our review of related brain-training literatures that are not currently associated with a company or product, there does not yet appear to be sufficient evidence to justify the claim that brain training is an effective tool for enhancing real-world cognition." (p. 172, Simons et al., 2016).

Additionally, scientists on both sides of this issue agree that brain-training companies have "overreached" in their marketing strategies based on the current state of the evidence on brain-training programs:

> "Two consensus statements about brain training, both signed by dozens of scientists, offered conflicting views on the state of the evidence. One argued that no compelling evidence exists to support the claims of brain-training companies that brain games enhance cognition or stave off the cognitive consequences of aging. A rebuttal letter acknowledged that some marketing by brain-training companies has overreached, but cited extensive support for scientifically grounded brain-training interventions. (p. 172, Simons et al., 2016).

One criticism commonly stated among our own colleagues is that these programs became commercialized much too early, before there was proper evidence for their efficacy. Research is indeed a slow process, and sometimes it takes years to carry out a proper treatment study starting from the initial idea to publishing the final findings. We know that parents and families are eager to try new treatment approaches, but the standard and expectation once a program is commercialized is that the evidence on efficacy has been established. The companies that have commercialized these products have varied in their pursuit and commitment to provide proper evidence for their programs (Simons et al., 2016). For example, some companies cite multiple peer-reviewed publications reporting on the effectiveness of their product, such as Cogmed and Luminosity. Other companies cite no peer reviewed evidence from intervention studies, such as Focus Education and Games for the Brain. Peer review means that the actual study has been reviewed and approved by other qualified scientists in the field, which attests to the quality of the study and evidence. Consumers of these programs need to be aware of the importance of peer-reviewed evidence for demonstrating efficacy of these programs.

Cognitive Training in ADHD

Enthusiasm for brain-training programs emerged quite early in the field of ADHD. The original study using Cogmed was actually conducted in a sample of seven children with ADHD (Klingberg & Forssberg, 2002). Cogmed is probably the most commonly known working memory training program that has been used for ADHD. The training activities are presented on a computer and involve activities such as recalling increasingly longer sequences presented in a visual or verbal format. The trainees can complete exercises at home or in other settings. The program is typically administered five days each week for a period of five weeks, but there can

be variations in the protocol. The program is available for preschoolers, school-aged children and adults.

Two meta-analytic reviews have been conducted on cognitive training and ADHD (Rapport, Orban, Kofler, & Friedman, 2013; Sonuga-Barke et al., 2013). These reviews included studies of different programs, including Cogmed and other less commonly known programs, including experimental programs designed exclusively for a particular study. Similar to the meta-analyses described previously, cognitive training programs reportedly improved short-term memory, but not attention and broader executive function processes in ADHD (Rapport et al., 2013). Similarly, far transfer effects were not found in this review. That is, the cognitive training did not lead to improvements in academic functioning, improvements in ratings of behaviour based on blinded reviews and improvements on other cognitive tests. The studies in ADHD have had similar methodological issues as the more general work that has been in cognitive training. The sample sizes have been quite small (often under 30 participants), lack of a proper control group, or included non-blinded raters of behaviour and symptoms. It is challenging to obtain blinded raters of behaviour in this type of research, but this is an important criteria as these individuals/parents may perceive positive effects because they expect and hope they or their children will improve or because they have made a substantial investment in the training and/or because the training may act as a placebo (Cortese et al., 2015; Sonuga-Barke et al., 2013; Foroughi et al., 2016). For example, one study found that after working memory training, there were significant reductions in the parent ratings of their child's ADHD symptoms, although teacher ratings of ADHD symptoms did not change (Beck et al., 2010).

Although some researchers have argued that working memory training is a "possibly efficacious training for youth with ADHD" (Chacko et al., 2014, p.14), the results of current

reviews suggest that the research to date suggest that cognitive training programs are unsupported in ADHD (Rapport et al., 2013) and that better evidence from blinded assessments is needed before these treatments can be regarded as effective for ADHD symptoms (Sonuga-Barke et al., 2013).

Does this mean that there is no merit to these programs? There is evidence to suggest that the training does work on the types of tasks that are trained in the program. Is there other value in these programs that we do not fully understand? There may be other useful aspects to these programs, including building persistence and frustration tolerance on effortful tasks, but building these types of skills may or may not be unique to such programs. There also may be other ways to develop these skills that are less expensive and less resource intensive. There continues to be research conducted on these programs, and this paper should be considered an interim update on some of the most relevant and key meta-analyses on this work.

Cognitive Training Strategies

While the evidence for cognitive training programs is still somewhat lacking for ADHD (and in general), this does not mean that efforts to ameliorate cognitive functioning in ADHD is not important or has been misplaced. The importance of developing skills and habits related to effective cognitive regulation are critical for ADHD. The avoidance of tasks that require sustained mental effort is one the symptoms of ADHD. The pervasiveness of these types of inattentive symptoms across tasks and domains of life are difficult to address, especially for individuals with ADHD to work past the aversion associated with engaging in such tasks.

There are several cognitive strategies that are well known and helpful. Finding ways to bring structure to the environment is beneficial for individuals with ADHD. Structure helps develop mastery and predictability. Structure can take many forms. Academically, putting a

boundary on work tasks can help children and youth know that they will need to work hard so they can better sustain those levels of effort for a certain number of questions or a certain period of time. For schoolwork, parents and teachers can model how to plan for homework sessions, show how to prepare all the necessary materials and have casual conversations ahead of time to make the task seem manageable and doable. Larger assignments can be particularly overwhelming, and these individuals often need explicit help to figure out how to break a task into smaller steps. For example, when writing a paper, a person should divide it into a bunch of smaller tasks: first, conduct research; second, brainstorm ideas, third, create an outline; fourth, write a rough draft; and fifth, revise and edit the paper.

Removing distractions is also critical. One of the biggest distractions for all youth now is cell phones, especially youth with ADHD. These phones are the "swiss army knife of the 21st century", equipped with all kinds of functions and tools, including calculators, texting functions, access to Youtube videos, downloading music and all of the other potential functions available on these devices. These devices increase the likelihood that a youth with ADHD will multi-task instead of focus on the task at hand. While multi-tasking gives off the appearance of getting more done in less time, in reality, performance efficiency on all tasks tends to become impaired, especially tasks that require new learning.

Banning these devices altogether seems a bit extreme, as almost everyone seems to have them and have come to rely on them. Another strategy is to teach our youth (and adults too) to use these devices responsibly. There is a time and a place for using these devices, and we need to provide our youth with this feedback, as it is not always obvious to them. Some tutoring services have started to put policies into place so that youth leave their devices at the door, as they will not need them for the next hour so that these youth can focus on their learning. Some families

have a charging station in places like the kitchen, and family members are required to leave their devices there at a particular hour each evening until the next morning, so that these youth (and adults in the family too) can have less distracted sleep.

While these devices are extremely useful, they are also extremely addictive and distracting, since applications and programs on these devices are often designed to intentionally grab a person's attention. These devices pose a significant risk to the already difficult task of learning and regulating our behaviour in our complex world, especially for children and youth with ADHD. It is also important to take developmental period into account, providing more support for younger children and fostering more autonomy and independence in adolescence. The best outcomes are for those youth who benefit from the external regulation provided by parents and teachers in preschool and childhood, and those youth who begin to internalize the strategies and habits they have learned to become more independent adults. It is more challenging to parent all youth with ADHD, and in adolescence helping these youth acquire milestones related to independence and autonomy. It is a work in progress for many families. While some of these strategies may seem basic, they are indeed cognitive regulation strategies. When one considers the types of real-world behaviours that we seek to improve in individuals with ADHD, it should bring us some pause as we consider the tall order we are expecting from cognitive training programs. That is, we expect that training of cognitive resources, such as working memory, will lead to better outcomes, such as better academic performance and follow-through with tasks and activities. These types of outcome behaviours are complex and are impacted by many factors. These are indeed worthy goals, but there is likely much work that still needs to be done to determine how to ameliorate cognitive regulation in every day environments.

Finally, we would like to acknowledge that we have no agendas, disclosures or conflicts of interest in writing this article. The only bias we have is that we see many families who struggle with children and youth who have ADHD, and we are very sympathetic to the challenges experienced by these families. Everyone's resources are limited, including time and money. Our purpose here was to provide the most up-to-date review of the research literature of cognitive training programs so far, to help parents and families make optimal treatment choices.

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