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Computer gaming and ADHD: Potential positive influences on behavior

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Abstract

Parents often express concerns about that technology, particularly video has on their children. Indeed, have been associated with problems social isolation and a drop-off in academic achievement, and games containing violence shown to increase aggressive thoughts and. Frequent interaction with video games been associated with subsequent problems functions such as attention and impulse-control However, it is important to note that technology and video games can also be used to improve behavior. During my 15 years of research examining the brain electrical activity and behavior of children with Attention Deficit Hyperactivity Disorder (ADHD), there has been an increase in the use of technology and gaming in the treatment of this disorder.

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Technology and gaming can have a positive influence on behaviour

Parents often express concerns about the effect that technology, particularly video games, has on their children. Indeed, video games have been associated with problems such as social isolation and a drop-off in academic achievement, and games containing violence have been shown to increase aggressive thoughts and behaviour [1]. Frequent interaction with video games has also been associated with subsequent problems in cognitive functions such as attention and impulse-control [2]. However, it is important to note that technology and video games can also be used to improve behaviour.

During my 15 years of research examining the brain electrical activity and behaviour of children with Attention Deficit Hyperactivity Disorder (AD/HD), there has been an increase in the use of technology and gaming in the treatment of this disorder. Children with AD/HD show high levels of inattentive, impulsive and hyperactive behaviour and as a consequence struggle in their daily lives, particularly in academic and social areas. The most common treatment involves daily stimulant-based medication, which has a short-term impact on the behavioural symptoms. However, there are also high drop-out rates and a drop-off in effect [3], as well as side effects of stimulant-based medication treatment including headaches, palpitations, insomnia, growth retardation and increased negative behavioural symptoms [4]. During data collection sessions in our labs, worried parents would often enquire about alternatives to medication-based treatments for AD/HD, concerned about the long-term effects. Ten years ago there were few evidence-based alternatives, but there are now several technology-based treatment approaches with good supporting evidence.

The most interesting of these technology-based approaches, which are in fact very compatible, are cognitive training and neurofeedback. Cognitive training involves using purpose-designed computer software to promote the use of particular psychological abilities (for example, memory, attention, inhibitory control) with the aim of improving them with practice. These tasks typically include performance feedback and have algorithms that vary difficulty level according to the child's performance to promote challenge, engagement and learning. Neurofeedback involves the non-invasive measurement of an individual's live brain activity (EEG) using electrodes on the scalp, with the user provided with ongoing simplified feedback about that activity via computer. As an example, the current level of attention could be shown as a number, a bar graph, or an engaging visual display. The aim of neurofeedback is to promote awareness and control of psychological "state" factors that are reliably reflected in the EEG, such as high versus low attention or being relaxed versus tense.

Each of these approaches has research support as a method to reduce symptoms of AD/HD and improve behaviour [5, 6]. These approaches are technology-dependent and are made possible by the processing capacity of the computer to simultaneously handle multiple processes such as applying algorithms to EEG data in real-time, accurately measuring task performance information,

presenting variations of training/feedback scenarios, and storing large amounts of data. Developments in consumer-level EEG measurement technology have also facilitated this area of research, presenting devices that are easy to use and measure EEG accurately [7].

Our research aim is to bring these two treatment approaches together to enhance the behavioural benefits to children with AD/HD. As the principles apply equally to remediation of deficient processes as to enhancement of intact processes, we are also interested in extending this training research to children without AD/HD. Our approach is technology-based and targeted towards particular fundamental cognitive processes such as working memory and inhibitory control, as well as psychological state factors such as attention and relaxation levels. It is these cognitive and state factors that provide a foundation for our effective engagement with the information in our external world. For example, being able to keep information in memory and use it flexibly, respond and withhold responses as appropriate, ignore distractions and stay focussed and calm provides an ideal psychological context for learning in a classroom situation. Note that our targeted approach differs from the generalist approach seen in popular commercial brain training products, which have been shown to have little effect on behaviour [8]. Our targeted and technology-based approach has been investigated in two studies.

The first study built on existing working memory training research to include another fundamental and closely-related psychological factor, inhibitory control [9]. Inhibitory control is the process that mediates our ability to restrain an action or response when it isn't appropriate, as exemplified in the game "Simon says". Training inhibitory control has been shown to improve behavioural control in other domains, such as increasing resistance to sweet foods and alcohol [10]. In our study children with AD/HD carried out training at home using purpose-built software for twenty five sessions over a five week period with each session lasting about twenty minutes. Along with improving at the training tasks, parents and another potentially less-biased adult observer reported significant behavioural improvements after training, with larger improvements for those who trained with a variable, as compared to fixed, difficulty level.

The second study used a much larger sample, including children without AD/HD, as well as a reward system, greatly improved GUI, and attention-monitoring via a portable, wireless, dry-sensor EEG recording device [11]. The software aimed to promote an awareness of attention during cognitive training, with reward for good performance in the context of focussed attention. The objective nature of the attention information is crucial, and helps children understand that their level of attention fluctuates second-by-second and that there is an association between attention and performance. Again, task and behavioural improvements were reported, with these improvements being larger for those with AD/HD than without, and slightly larger for children who did cognitive training with attention monitoring.

Feedback from the children in our studies called for more varied and interesting training scenarios, given that usage is quite intense in the training period. The challenge issued by the children, some as young as 7 years, was to "make the training more fun". Given their access to and experience with console- and web-based gaming, they asked for industry-standard gaming features such as a unifying theme, compelling graphics and audio, scenario variations, achievement monitoring, unlocks. This challenge was taken up by an independent software development company in conjunction with the university. Game developers with experience in the use of EEG feedback in gaming applications

were given the brief of designing a series of games that adhered closely to the research training mechanisms and principles, and hid the training in the fun.

The advantages of this type of technology-based approach to behavioural control training are numerous. Importantly, from a health perspective, the dependence on drug-based treatment approaches and related side-effects may be reduced. The training can be used as a stand-alone intervention or as an adjunct to existing intervention approaches. From an implementation perspective, the training can be designed to be fun and easy to understand and complete, not necessarily requiring professional assistance and therefore could be low-cost to the end-user. From an access perspective, dissemination could be widespread as the training tasks could be used on personal computers, smart-phones and even the new-generation of smart-TVs, thus improving the reach of these interventions.

The principles that underlie this targeted approach to training fundamental psychological processes in children might also be applied to adolescents and adults, and extend to the health domain where behavioural control is affected; for example in unhealthy behaviours such alcohol consumption, smoking and over-eating. This area of research is in its infancy. There is much work to be done to more fully understand the mechanisms of action of these approaches to improving behaviour, and to determine how to optimise the outcomes for users. Our approach is just one example of how technology and gaming can have a positive influence on behaviour. It is an exciting time to be working in a research area that will benefit greatly from the rapid ongoing advances in communications, computer, and EEG technology.

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