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A study of playing video games, paying attention, and learning: how can we mold attentional development and impact learning?

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Abstract- ***The impact of gaming on cognitive development and attentional abilities are the primary foci of this study, which also examines the relationship between gaming and learning outcomes. The potential of video games to improve attentional control, cognitive flexibility, and learning—all of which could lead to novel approaches to treating developmental disorders—is discussed here. It would appear that video games, which were originally created for entertainment purposes, improve behaviour in areas as diverse as perception, attention, mental rotation, and task switching. A better signal-to-noise ratio and, by extension, better decisions, may be made possible by this unexpectedly extensive transfer, which is facilitated by improved attentional regulation. Computerised training or self-regulation approaches are two examples of targeted interventions that have the potential to improve attentional control. The incredible amount of time that people all over the globe spend with this medium makes the idea of incorporating such training into video game play all the more enticing. It has the potential to improve the utilisation of positive effect games, which in turn could increase patient compliance and student motivation. This work can be further developed and its impact on developmental diseases can be addressed by utilising computational models from developmental robotics or machine learning, which offer a rich theoretical foundation.***

Keywords- ***Video Game, Learning, Training, Attention, Child Development.***

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INTRODUCTION

With the widespread use of digital technology & gaming in modern life, studies investigating the connections between gaming, attention, and learning have been expanding. Research into the possible effects of video games on cognitive development, especially in the areas of attention & learning, has recently shifted the focus away from gaming as a solely entertaining medium. Learning how video games affect attentional skills could have far-reaching consequences for cognitive training, developmental psychology, & education because these abilities are foundational to learning and interacting with the environment.

Some studies have shown that playing video games can improve attention skills like sustained attention, selective attention, & multitasking due to the unique blend of immersive worlds, fast decision-making, and adaptive difficulties. In addition, research has connected playing specific types of games—most notably action & strategy games—to enhanced visual-spatial abilities and mental flexibility. But there's still some doubt as to whether these benefits come at a cost; for example, if playing video games on a regular basis encourages habits that impede critical thinking and deeper learning.

The emphasis on attentional control seems to veer off course from our original subject, which is play and learning, at first glance. Still, a common belief in educational theory & developmental robotics holds that one of the most important abilities for learning is the capacity to concentrate on details that are directly related to the job at hand while disregarding irrelevant details. A higher signal-to-noise ratio improves processing efficiency & learning by making it easier to understand the task at hand and tune out irrelevant stimuli [Bavelier D 2012].

LITERATURE REVIEW

Sifri, David et al. (2022) The popularity of video games, especially among younger generations, has skyrocketed in the last several decades. It is crucial to study the impacts of video games, especially on younger people, in order to influence best practices

during the developmental years. The researchers in this study used a narrative synthesis and systematic review approach to cover a lot of ground with this age group. This research looked at the consequences from a biopsychosocial perspective, which takes into consideration the three most important parts of a person's functioning. The results section incorporates 71 research papers culled from two primary sources, PsycInfo and PubMed. The results demonstrated that the likelihood that playing video games would have beneficial or detrimental impacts on the user was affected by a large number of mediating and moderating variables across all domains of functioning. Positive results were linked to having healthy social interactions, having adaptive emotion control abilities, and using games as a means of social connection. There were more negative consequences associated with using video games as an emotional avoidance mechanism, playing to the point of addiction, and playing games before bed. An outline of best practices is provided based on this review, and how these impacts fit within the framework of other screen-based research is also addressed.

Fatimah Alsaad et al. (2022) The popularity of action video games among young people has been on the rise recently. Researchers in the fields of behaviour & higher-level cognitive function have taken an interest in video gaming as a result of this. The current research sought to understand how action video games affect players' attention, anxiety, & sleep habits. The primary objective of the research was to look into any possible links between action video games and issues with focus, nervousness, and slumber. Subjects (N = 97) were requested to self-administer an online survey that included four parts: personal information, gaming habits, the Epworth Sleepiness Scale (with eight items), & Generalised Anxiety Disorders Scale (with seven items). Based on how much time each participant spent playing action video games, they were further separated into two categories: expert and non-expert. Patients took a validated psychological online battery test measuring sustained attention after completing the questionnaires; this exam was administered during an in-person session. The participants' average age was 21. The attention of expert & non-expert video gamers was notably different; when presented with stimuli, expert gamers showed noticeably faster reaction times than non-expert gamers ($p < 0.05$). A non-significant decline in attention span was observed over time in both groups. Both expert and non-expert gamers reported low to moderate levels of anxiety, and there was no statistically significant difference between the two groups in terms of daytime drowsiness or anxiety.

Fran C Blumberg et al. (2020) Children's attention habits & learning objectives were studied in relation to their performance in video games. Each student in second and fifth grade was given the option to play with an evaluative, process, result, or no explicit objective focus before the game began. After that, we asked the kids to fill out an interview detailing their gaming plans & aspects of the game that piqued their interest. The results were greater for older kids and regular players. Instructions to process goals improved performance among regular players. The use of process goals in interviews with younger children was similarly associated with improved performance. On the other hand, when compared to older children, their references to focus methods were a predictor of lower performance. The effectiveness of process goals for learning is demonstrated by these findings with both younger and older children.

Yamil O. Ortiz-Ortiz et al. (2018) Among the many forms of ludic enjoyment used by young people nowadays, video games rank high. Many have questioned the impact of these technologies on players' growth due to their popularity. Effects on social behaviour & cognition are two of the most studied aspects of video games. A dissertation attempting to analyse these consequences is presented here. In order to achieve this goal, two research were conducted: (1) the first set of studies is a meta-analysis of two types: one looks at how video games affect aggressiveness and the other at how they affect cognitive functions. The aggressiveness meta-analysis set out to quantify the impact of violent video games on aggressive behaviour in general. To further assess its potential influence on our estimations, included aggressiveness type as a mediator. In order to quantify the impact of video games on general cognition, researchers conducted a cognition meta-analysis. The cognitive meta-analysis additionally considered a mediator variable. Cognitive process type served as the mediator variable. Within the sample of this research, 31 separate papers were considered; 22 of these studies were part of the aggression meta-analysis, and 9 were part of the cognitive meta-analysis. Video games are known to enhance aggressiveness and intellect, according to the first study. Having said that, we did find that video gaming does not have an equal effect on all forms of aggression and cognitive functions. The study's findings add to the ongoing conversation on the impact of these technologies & provide suggestions for maximising video games' beneficial aspects while minimising their negative aspects. The second study's stated goal was to assess how a video game-based neurocognitive intervention affected the reading comprehension and mental processes of ESL students from Puerto Rico.

Granic et al. (2014) In the United States, nearly all children and adolescents play video games at least once a day; in fact, nearly all of them play for at least an hour. Most studies conducted by psychologists on the topic of "gaming" have focused on its negative aspects, specifically the risks associated with aggression, addiction, and depression. We acknowledge the work of the researchers involved, but we contend that a more nuanced view is required, one that takes into account the potential advantages as well as the potential drawbacks of these games. The exponential growth in complexity, diversity, realism, and social aspects of these games

over the past decade makes it all the more crucial to think about these possible advantages. A modest but substantial corpus of literature has emerged, primarily in the past five years, attesting to these advantages. Here we review the literature on video game benefits, breaking them down into four categories: mental, emotional, social, & motivating. We present a number of potential pathways by which gaming may promote real-life psychosocial advantages by combining findings from media psychology with those of developmental, positive, and social psychology. Our hope is that this work will lay the groundwork for future studies into the hitherto unstudied positive effects of gaming on mental health. We conclude by urging intervention researchers and practitioners to investigate video games' potential benefits and by outlining some exciting new avenues for this kind of research.

Walter R. Boot et al. (2008) When compared to non-players, expert video game players typically do better on tests of attention & performance. These variations could be the product of playing video games more often or they could be a reflection of other group differences. According to recent studies, playing action video games can enhance visual and attentional skills. For example, one study found that playing these games improved participants' visual selective attention. This study aimed to confirm and expand upon these findings by comparing gamers with non-gamers and by studying how playing video games affected tasks that tested a broader variety of cognitive functions, such as memory, attention, and executive control. 20+ hours of action, puzzle, or real-time strategy video game play was logged by non-gamers. There were a variety of fundamental cognitive abilities where professional gamers and non-gamers varied. For example, experts could mentally rotate items more efficiently, switch tasks more rapidly, identify changes to objects held in visual short-term memory better, and track objects moving at greater speeds. Most cognitive tasks showed no significant improvement in performance for non-gamers after lengthy video game practice, although mental rotation performance did improve slightly. Our findings imply that some disparities in basic cognitive performance between gamers and non-gamers are due to either innate group differences in ability leading to a self-selection effect or significantly greater time spent playing video games.

Suzanne De Castell et al. (2004) The new technological infrastructure of the economy ushers in a new "attentional economy" where every "connected" adult or child owns and controls a full economic share of their own attention, challenging formal education's traditional monopoly over the mass-scale acculturation of youth. As educators struggle to find ways to captivate, rather than coerce, their students' voluntary attention, today's youth, who have never lived in a text-bound world like their parents or grandparents did, have far more agency and far broader rights thanks to technological advancements. This paper discusses many ways of putting "attentional economy" into words, and it strongly suggests looking at how people use technology to play. Technology has a way of getting kids involved, and when they're playing, they learn more than the kind of soulless button-mashing that people who haven't tried to comprehend the educational potential of video games complain about.

ATTENTION DEVELOPMENT: MULTIPLE FORMS OF ATTENTION & MILESTONES

With few resources available, paying close attention is essential for directing the processing of information. Automatic resource capture for the quick processing of salient or unexpected stimuli, such as when startled by a sudden alarm, can be either stimulus-driven or exogenous. On the other hand, some forms of attention—such as reading on a packed bus—are endogenous, or top-down, voluntary, and goal-oriented. Both the spatial & temporal domains, in addition to objects, are capable of expressing this type of attention. The attentional blink task, for instance, asks participants to identify target stimuli among a series of primarily nontarget stimuli; this allows researchers to measure the temporal resolution of attention. It has been noted that the ability to notice a second target presented soon after recognising the first object decreases, as if attention had blinked, and this phenomenon is known as the attentional blink phenmenon.

According to Rueda (2013), various types of attention depend on distinct brain networks and progress along distinct developmental pathways. Contrary to other types of external attention, which are regulated by the cortex and do not mature until around the ages of 10 to 11 [Waszak 2010], orientation towards abrupt onsets appears to be present at birth & mediated by subcortical regions. In contrast, the attentional blink task [Shapiro 2003] demonstrates that top-down attention, which depends on the maturation of a fronto-parietal network, continues to improve until at least puberty. When tested with easy activities, top-down spatial attention seems to develop more quickly, reaching asymptotic levels at about the age of 7, but when tested with more difficult tasks, it can be demonstrated to mature well beyond puberty. While most studies assessing top-down attention use visual cues, a significant variation employs dichotic listening, in which subjects hear two stories played back to them in stereo. Before asking participants questions regarding the stories, they are instructed to focus on one ear. Crucially, while the stories play, one ear is exposed to target sounds, allowing one to evaluate the event-related potentials (ERPs) to these unimportant stimuli and the impact of attention [Sanders LD 2006]. From preschool through adulthood, this paradigm might be used to characterise markers of top-down attention, which would involve tracking the amplification of the stream that needs attention & suppression of the stream that is irrelevant or distracting.

There are two kinds of attention that are crucial for learning: top-down attention, which controls the allocation of processing resources to the current task, & bottom-up attention, which is necessary for declarative learning and helps with most skilled

learning (though some learning can happen without attention, too) [Seitz A. 2005]. - A Together with sustained attention, which is defined as the capacity to maintain concentrate for a period of seconds to minutes [Chen W. 2012], an understudied yet crucial academic skill, particularly in relation to methods to improve it. We reassemble the processes that underlie these two types of attention as "attentional control" below. Problems with these systems contribute to impulsivity and other types of inattention, which are symptoms of attention disorders like ADHD & ADD.

INCONVENIENT FINDINGS RELATED TO ATTENTIVE CONTROL IN VIDEO GAMES

Improving attentional control: what steps can be taken? When it comes to developing self-regulation skills, does play have any particular place? The French psychologist Alfred Binet took use of the fact that children can learn to focus their attention through playing games in order to help them succeed in school. Binet records the game "statue," in which kids try to retain a certain stance for the longest amount of time, as an instructive example. While the classroom is filled with laughing & small talk at the beginning of the lesson, the students eventually join in and do their best to beat their classmates. Students who had previously failed the school system were able to make up two years' worth of work in one sitting because to the usage of these games, according to Binet [1909]. Interestingly, research has shown that playing commercially available fast-paced, action-packed video games, like first- or third-person shooters, can improve attentional control in various ways [Green CS 2012]. This has prompted researchers to wonder if playing these games during development positively impacts attention in the brain [Dye MWG 2009].

Dye and Bavelier [2010] examined the top-down attentional abilities of individuals aged 7–22 in three different paradigms: visual search, attentional blink, and multiple object tracking. In the former, participants were shown a series of moving objects that were identical to one another, and they were asked to maintain track of a subset of these objects. Children who reported playing action video games consistently performed better than their non-gaming peers on all of these activities. This age gap first appeared between 7 and 10 and continued to widen after that. Notably, by the ages of 7–10 and 11–13 years old, children who played action video games achieved adult nonplayer levels of performance for attentional blink and MOT, respectively (see also [Trick LM 2005]). The usage of technology is obviously changing the developmental time-course of attention. Playing this kind of video game makes it happen faster, but research shows that kids who use technology have worse attentional control, not better. Many parents have noticed an uptick in ADHD and other health problems among their children [Swing EL 2010]. Researchers have not yet determined what is causing this increase. Many people believe that playing video games is to blame for ADHD, but research using the Test of Variables of Attention (TOVA)—which measures impulsivity and sustained attention—found no correlation between gaming and these disorders. According to research ([Dye MWG, Green CS 2009], see Fig. 1), players of action video games demonstrated a remarkable capacity to make more accurate decisions per unit of time when assessed on the TOVA, as they were faster without sacrificing accuracy compared to nonaction game players.

Last but not least, playing action video games does not have the same effect on different parts of the attention system. Despite improvements in attentional control, action video games do not alter external attention, often known as the involuntary pull on attention caused by sudden onsets [Hubert-Wallander 2011; Castel AD 2005]. Despite the abundance of sudden starts in these games, this remains true. These findings emphasise the need for additional controlled laboratory research that differentiate between the various applications of technology, rather than relying on intuitive assessments of their effects on the brain. Doing so is essential if we want to get the degree of detail necessary to comprehend the effects of different technological applications on the brain and behaviour.

Lots of studies on adults have gone beyond just comparing groups based on how much time they spend playing action video games (>5 hours per week for at least 6 weeks vs. less than 1 hour per week). A direct correlation between playing action video games & improved attentional abilities has been demonstrated in training studies where non-video game players were asked to play for half an hour to an hour five days a week for two to ten weeks. This outperforms a control group that was asked to play other types of commercial video games [Oei AC 2013; Cohen JE 2017]. The usual brutality in action video games makes training studies on children immoral, so there needs to be an effort to make games that are suitable for kids' ages.

This assignment is not a green light to play video games nonstop. Consistent with the significance of distributed practice in learning, it only takes a few weeks of brief daily sessions to bring about good changes that last. Research has shown that training with action video games can have long-lasting impacts, lasting months or even years after the program has ended. It is important to acknowledge that playing video games impacts the brain on various time scales. Small quantities of training produce some results, whereas large levels of practice produce others. After just two hours of playing an action-video car-racing game, players experienced alterations in both grey and white matter [Hofstetter S., 2013], highlighting the potential for video game play to cause neuroplastic changes. The effects on the brain are determined by both the amount of time spent on task & specific way a game is played. This is because these changes were only noticed when participants raced the same track multiple times, allowing them to learn its spatial

layout. On the other hand, when the track changed continuously, no changes were observed.

Computer programs developed specifically for training children have been employed in all previous research on the topic (e.g., [Mackey AP 2011, Brem S 2010]). An attention training game developed by NASA to train monkeys for space flight or video watching was given to four and six-year-olds in a study by Rueda et al. [2012]. During ERP recording, both groups had pre- and post-tests of an attention task. Following training, the game group's brain signs of attention were similar to adult brain markers, whereas the movie group's markers were different. The behavioural level showed no effect, which is interesting (for more on this, see [Rueda MR 2012]). The idea of "preparation for future learning" is consistent with this finding; according to Schwartz (2013), games have hidden impacts that make future learning easier. Preschoolers' executive function can be honed with the use of computer games [Klingberg 2010]. While not all of these research focused on attention specifically, Thorell LB (2009) found that training working memory had a positive effect on attentional control tasks.
It follows that top-down attention is both susceptible to and a potent target for intervention due to its apparent high plasticity, particularly throughout development.

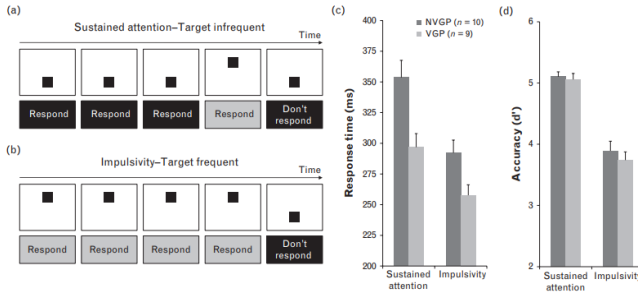

FIGURE 1. Impulsivity & sustained attention are evaluated by the TOVA. Test subjects sit in front of a computer and must quickly press a key in reaction to a target (the black square in the top right corner) while simultaneously ignoring nontarget stimuli (the black square in the bottom right corner). (a) Under one scenario, targets are few while nontargets are common. A measure of sustained attention is the degree to which individuals can remain focused and react rapidly to uncommon targets. (b) Nontargets were uncommon in one group of trials but targets were common in another. Impulsivity can be measured by how long it takes for participants to refrain from responding to nontargets. The TOVA was utilised by Dye et al. [2009] to evaluate variations in impulsivity and sustained attention among NVGPs and VGPs, or young people who did not play video games regularly. (c) Regardless of whether they were testing for sustained attention or impulsivity, their findings reveal that VGPs were always quicker than NVGPs. (d) The fact that neither group performed worse than the other on this accuracy measure suggests that VGPs generally have better attentional control, not that the speed boost was at the cost of accuracy. The bars represent the standard errors of the mean. The TOVA program incorrectly labels reactions of a duration less than 200 ms as anticipatory replies, which is worth noting. Even if NVGPs AQ10 had better attention than VGPs, the results would have been different because to the large number of RTs < 200 ms in VGPs. The 200-ms threshold for anticipation was not applied to the displayed data. Because different generations may not adhere to the same standards, it is crucial to update clinical tests & criteria for their use.

DIFFERENT WAYS OF TEACHING ATTENTIONAL CONTROL

Computers & video games aren't the only interventions out there. Whether it's through improved attentional control or emotional regulation, contemplative training like mindfulness meditation or compassion meditation can help one become more self-regulated (Klimecki OM, 2013; Posner MI, 2013). However, there is still a lack of research on the effects of these methods on youth, therefore more research is needed [Burke CA 2009].

When people, particularly those who are sedentary, exercise, it improves their physical and mental health. In addition to better physical health, older persons who exercise regularly for a few weeks show improvements in cognitive abilities, such as spatial cognition, attentional control, and executive functions, as well as faster reaction times [Colcombe S. 2003]. Paediatric exercise training studies are few and far between, but given the epidemic of childhood obesity and the all-too-common attention issues among children, as well as the ease with which exercise can be turned into a game (as seen by the recent explosion of exergames [Staiano 2011]), these treatments may hold particular promise [Hillman CH 2008].

In recent years, there has been growing support for the idea of reinstituting some of the most effective strategies proposed by research into attention and the neural mechanisms that regulate it in educational institutions. In "Tools of the Mind," for instance, participants act out brief scenarios, utilise private speech to control their thoughts, and rely on aids and tactics to help them concentrate, all of which are based on Vygotsky's theories about what makes learning effective. Executive functions & attentional control in school-aged populations are significantly improved by interventions that encourage self-regulation & focus, as these activities necessitate [Diamond A 2007]. Lastly, the home environment has a significant but frequently overlooked role in a child's cognitive development. Neville et al. [2013] compared two intervention strategies in a recent thought-provoking study. One strategy mostly targeted classroom training for children with less parent-directed training, whereas the other strategy included attention from parents with training for children. Behavioural and ERP markers of selective attention showed that the group that received the most parent training improved their attentional control, with better brain responses to attended stimuli. Because children from low-income families have impaired neurological bases for selective

attention, our study's emphasis on these kids makes it all the more relevant. The importance of family members in encouraging good behaviour in children is being more recognised, which has resulted in the creation of family video games that are tailored for children to play alongside their adults [Siyahhan S 2010]. Despite the rapid evolution of this type of games, controlled research are necessary to determine the exact effects on players' cognitive, social, and affective abilities.

CLINICAL POPULATION IMPACTS

Children diagnosed with learning difficulties or ADHD may benefit greatly from this study since it offers hope for retraining attentional control and enhancing learning. However, treatments that work well with typically developing youngsters might not be appropriate for clinical populations. The question of whether people with ADHD or other forms of ADHD should be encouraged to play action video games is likely to provide the best example of this concept. Very unlikely! To start, there is cause for concern because multiple studies have linked excessive gaming time to ADHD & pathological gaming [Gentile DA 2011]. Secondly, improving attentional control in those whose regulatory brain systems are functioning normally is one thing and doing the same thing in people whose systems are defective is another. Lastly, video games have a tendency to attract a large audience since they offer a variety of game play styles and, by extension, techniques. This allows for two distinct approaches to the same game: one in which the player deliberately seeks to anticipate what's going to happen next, and another in which the player impulsively presses buttons without thinking. Although playing action video games improves performance in TOVA (see Fig. 1), it is a risk factor for ADHD.

This disparity in effects between the two genres may explain why some people report better results when playing these games than when playing other types. Results from a set of mini-games aimed at improving executive function and attentional control in people with ADHD have been encouraging [Klingberg T, Fernell 2005]. Neurofeedback, in which the patient learns to regulate their own brain waves, is, however, currently among the most promising technological interventions for ADD/ADHD [Lofthouse N 2012]. An obvious way to increase adherence to treatment would be to include neurofeedback into video games in a natural way [Mandryk 2013].

Some commercial video games actually have a beneficial effect on health, which is somewhat surprising. Games like The Sims, Tetris, or Unreal Tournament can help those with low eyesight, including amblyopic patients, improve their visual acuity. According to To L. and Thompson (2011), this was demonstrated in adults with amblyopia, who are generally believed to have passed the "critical period" for visual plasticity and are hence incurable. Retraining attentional control appears to help children with language impairment who have attentional issues. Italian youngsters with dyslexia participated in a 9-day, 12-hour study in which they played action minigames or nonaction minigames. According to Franceschini (2013), trainees who participated in action mini-games showed better attentional abilities and read more quickly than those who did not. Notably, "Rayman's Raving Rabbids," a commercial video game, included both types of mini-games. Minigames that focused on action required players to have good visuo-motor control, aim accurately, time their actions correctly, and split their attention & planning, whereas games that focused on control required players to execute their motor skills quickly and with minimal control. We need further cognitive task assessments of game play since the fact that various segments can have such diverse impacts shows how processing demands inherent to the game play shape the impact. A large-scale study of "brain games" in adults shown that not all games promote performance improvement & transfer in the same way.

The study found that participants made increases on the taught mini-games, but these gains were not transferred to other assessments that tested the same cognitive skills [Owen AM 2010]. All things considered, these results point to better attentional control as a potential key to opening the brain's plasticity and learning potential. However, it is still not clear whether better attentional control has a causal effect in the rehabilitation of visual or language impairments.

CONCLUSION

Video game play, attentional development, and learning are all intricately related, as this study shows. Video games have the ability to enhance attentional control and learning in a controlled and entertaining manner, making them a clear candidate for integration into educational practices. Although playing video games does have an effect on attention and learning, the real challenge is figuring out how to harness this influence for good. First, learning new things is beneficial to the individual and may provide benefits in and of itself. As a result, there may be optimal opportunities to display such intrinsically motivated behaviours during play. Secondly, in the complex environment that a child learns in, a desire for new knowledge or information is insufficient to propel effective learning. Children seldom get trapped attempting to learn utterly unpredictable occurrences, like white noise on a television screen; nevertheless, they will forever be both novel and unlearnable. The prevailing opinion holds that attentional control and other cognitive mechanisms are hardwired to optimise learning. If this is so, then encouraging the development of attentional control would have numerous beneficial effects. When taken as a whole, these two findings highlight the importance of play as a tool for improving patients' adherence to treatment plans, increasing the learning effects of treatment, and facilitating diagnosis and treatment titration based on

individual needs through continuous performance monitoring.

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