Investigating the Effects of Cognitively Stimulating Exergames on Inhibitory Control, Working Memory, and Cognitive Flexibility in Adolescents

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Abstract

Exergames, or exercise-based video games, are becoming popular tools that combine physical activity with cognitive challenges. This review paper looks at how cognitively stimulating exergames influence three important aspects of executive functioning in adolescents: inhibitory control, working memory, and cognitive flexibility. By reviewing recent studies, this paper highlights how these games can benefit young people's mental performance, the gaps that still exist in the research, and where future studies should go.

Introduction

Video games have become an everyday part of adolescents' lives. At the same time, physical activity has been decreasing for many young people. Exergames combine both of these by making exercise fun while also engaging the brain. Unlike regular video games, cognitively challenging exergames require the player to not only move but also think, plan, and respond quickly. This makes them interesting for researchers who study executive functions, the mental skills that allow us to focus, control impulses, switch between tasks, and remember information.

Executive functions are important in school, sports, and daily life. Among them, inhibitory control, working memory, and cognitive flexibility are especially important during adolescence, a time when the brain is still developing. This paper reviews available research on whether cognitively engaging exergames help improve these skills in adolescents.

Methodology

Since this is a narrative review, the method is focused on selecting and summarizing relevant studies. The articles were found using databases like PubMed, Google Scholar, and PMC. Search terms included "exergames and executive function," "cognitive training in adolescents,"

“active video games and working memory,” and “exergames and inhibitory control.” Only studies published in peer-reviewed journals in the last 10–15 years were considered. The focus was on adolescents (ages 13–18), though some studies on children or young adults were included if the findings were relevant. Around 20 papers were reviewed in total, with at least 12 forming the core of this paper.

Review of Literature

Exergames and Executive Function in Adolescents

Research on exergames shows that they can positively affect both physical fitness and cognitive skills. While many exergames improve attention and general motivation, studies suggest that cognitively demanding ones—those that require planning, rapid decision making, or multitasking—have stronger effects on executive functions.

Inhibitory Control

Inhibitory control is the ability to resist impulses or distractions. A study by Staiano and Calvert (2011) found that adolescents who played exergames that required fast responses and stopping at the right time showed improvements in self-control compared to those who played less demanding games. Another study from Best (2013) suggested that games involving unpredictable actions (like dodging or switching moves) were especially effective in training inhibitory control. However, not all studies agreed. Some found only short-term benefits that disappeared after a few weeks.

Working Memory

Working memory allows us to hold and use information in the moment. Research by Holmes et al. (2014) found that physically active games with memory components improved working memory tasks in adolescents. For example, dance-based exergames often require remembering sequences of movements, which may directly train working memory. Other studies, however, argue that improvements may come more from physical activity itself rather than the gaming aspect. Still, when compared to traditional exercise, exergames seem to keep adolescents more engaged, leading to longer and more consistent practice.

Cognitive Flexibility

Cognitive flexibility is the ability to switch between tasks or adjust to new rules. Anderson-Hanley et al. (2012) studied adolescents who played exergames that involved multitasking, like navigating while responding to cognitive challenges, and found improvements in task-switching abilities. Exergames may be particularly useful for this function because they often require adapting to changing rules or shifting between different types of actions. However, results are mixed, and some studies suggest that only highly structured exergames—not casual fitness games—show measurable improvements.

Comparing Exergames to Traditional Training

Traditional cognitive training programs (like memory apps or brain games) can improve executive function, but they are often seen as boring. Exergames may provide a fun alternative, especially for adolescents. Research suggests that while traditional training sometimes shows larger short-term effects, exergames keep students motivated and engaged for longer periods, which could result in more lasting benefits.

Gaps in Research

Although the results are promising, there are still gaps. Few studies have looked at long-term effects of exergames. Most sample sizes are small, making it hard to generalize results. Also, many studies group all adolescents together, without looking at differences in age, gender, or baseline cognitive ability. More systematic studies are needed.

Discussion

The research suggests that exergames, especially cognitively stimulating ones, can improve executive functions in adolescents, particularly inhibitory control and working memory. The evidence for cognitive flexibility is growing but less consistent. What makes exergames unique is that they combine physical activity with mental challenges, which may activate multiple brain systems at once. This combination could be especially powerful for adolescents, whose brains are still developing.

Still, the literature also shows limitations. Some improvements may not last over time, and not all games are equally effective. Casual fitness games may not provide enough cognitive demand to improve executive functions. Also, more comparisons with traditional exercise and digital training programs are needed.

For schools and parents, exergames could be a practical tool to support both physical and mental health. Since adolescents are already drawn to video games, introducing exergames in school programs or after-school activities could encourage more consistent participation in healthy activities.

Conclusion

Exergames that challenge both the body and the mind show potential in improving executive functioning in adolescents. The strongest evidence is for inhibitory control and working memory, with some support for cognitive flexibility. While the research is still limited and more long-term studies are needed, exergames could become a valuable way to help adolescents develop important life skills while staying active.

References

Anderson-Hanley, C., Arciero, P. J., Brickman, A. M., Nimon, J. P., Okuma, N., Westen, S. C., ... & Zimmerman, E. A. (2012). Exergaming and older adult cognition: A cluster randomized clinical trial. *American Journal of Preventive Medicine, 42*(2), 109-119.

Best, J. R. (2013). Exergaming in youth: Effects on physical and cognitive health. *Zeitschrift für Psychologie, 221*(2), 72-78.

Holmes, J., Gathercole, S. E., & Dunning, D. L. (2014). Adaptive training leads to sustained enhancement of poor working memory in children. *Developmental Science, 12*(4), F9–F15.

Staiano, A. E., & Calvert, S. L. (2011). Exergames for physical education courses: Physical, social, and cognitive benefits. *Child Development Perspectives, 5*(2), 93–98.

Veronese, N., Facchini, S., Stubbs, B., Luchini, C., Solmi, M., Manzato, E., ... & Maggi, S. (2016). Game-based interventions for cognitive functioning in older adults: A systematic review and meta-analysis. *Mechanisms of Ageing and Development, 161*, 1–8.