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Research Report

Cognitive enhancement in video game players: The role of video game genre

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ABSTRACT

Several cross-section and training studies have shown that video game play can improve cognitive functions such as visual attention, cognitive control, visual short-term memory, and general processing speed. Unfortunately the replication of these effects is not always successful, even when using similar cognitive tests to measure performance. We investigated an important aspect of this field that has not yet been empirically addressed: the role of video game genre. Our comparison of two video game player groups of specific genres (first-person shooter and real-time strategy) indicates that cognitive abilities (measured by task switching and multiple object tracking) may be differentially enhanced depending on the genre of video game being played. This result is significant as research to this point has focused on "action video games", a loosely defined category that encompasses several video game genres, without controlling for effects potentially stemming from differences in mechanics between these video games. It also provides some evidence for the specificity of video game play benefits as a function of actions performed within the game, which is not in line with a generalized "learning to learn" accounting of these enhancements.

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1. Introduction

It is now well established that video game players (VGP's) outperform non-video game players (NVGP's) on a wide range of cognitive abilities, including visual attention (Durlach, Kring, & Bowens, 2009; Green & Bavelier, 2006a, 2006b, 2007), aspects of cognitive control (Colzato, van Leeuwen, van den Wildenberg, & Hommel, 2010; Glass, Maddox, & Love, 2013; Strobach, Frensch, & Shubert, 2012), visual short-term memory (Blacker & Curby, 2013; McDermott, Bavelier, & Green, 2014; Wilms, Peterson, & Vangkilde, 2013), and general processing speed (Dye, Green, & Bavelier, 2009). Several training studies have also shown that relatively short video game training sessions can improve the functioning of NVGP's (Basak, Boot, Voss, & Kramer, 2008; Feng, Spence, & Pratt, 2007; Green, Sugarman, Medford, Klobusicky, & Bavelier, 2012; Li, Polat, Scalzo, & Bavelier, 2010).

However, in the case of both cross-section and training designs, the occurrence and replication of video game effects has been inconsistent (Boot, Kramer, Simons, Fabiani, & Gratton, 2008; Irons, Remington, & McLean, 2011; Murphy & Spencer, 2009). A number of methodological issues present in both cross-section and training designs have been pointed out which may be contributing to this inconsistency, including the use of unspecified recruiting methods and differential placebo effects in training studies (Boot, Blakely, & Simons, 2011). We would like to address one additional factor that has not yet been explored which could be a significant contributor to the occurrence of cognitive enhancements stemming from video game play: the role of video game genre.

Most researchers use the term "action video game", defined by Green and Bavelier (2003) as "those (video games) that have fast motion, require vigilant monitoring of the visual periphery, and often require simultaneous tracking of multiple targets", when describing the video games played by their participants. As this definition is quite broad, many different video game genres can qualify as action video games. Video games are categorized into genres based on their gameplay mechanics, or the in-game tasks and rules that players must attend, and the qualitative differences between game genres can be considerable. Boot et al. (2013) suggest that this may be why training studies produce inconsistent results, as differences in game mechanics between video games used during training likely produce differential requirements of cognitive functions.

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In the case of past cross-section studies, video game genre has not been controlled (with the notable exception of Colzato, van den Wildenberg, Zmigrod, & Hommel, 2012, who used first-person shooter players only) and groups of VGP's who play different video games genres have never been compared. This makes it difficult to determine whether video game genre, beyond the general "action video game" categorization, is also a significant determinant of the cognitive functioning advantages found in VGP's when compared to NVGP's. Latham, Patston, and Tippett (2013) point out that expertise related changes likely reflect not only the length of video game experience but also the nature of that experience, and suggest that greater care should be taken when classifying "expert" video game players in light of the many "action" video game genres.

Showing that the type of video game genre being played has a significant role in determining which cognitive functions are improved would provide evidence in favor of a task-specific accounting of these enhancements. The current view is that action video game play improves a skill known as "learning to learn" by increasing the ability to extract patterns or regularities from an environment (Bavelier, Green, Pouget, & Schrater, 2012). This implies that video games improve general learning mechanisms which then carry over to improved performance on various, unrelated cognitive tests.

In a recent review of studies on action and non-action video games, Oei and Patterson (2014) propose an alternative accounting in which functions are trained separately due to the similarities between video game and cognitive tasks. They cite evidence in the form of training data that demonstrates specific, limited transfer effects in cases where the video game and cognitive tasks share common demands, as well as neuroimaging data showing that transfer is more likely when both tasks recruit overlapping neural regions. This "common demands" hypothesis also accounts for previously found transfer effects in non-action video games, in which evidence for transfer was equivocal when video game and task did not share common demands.

In order to address the topic of video game genre, we have designed a study comparing the cognitive functioning of first-person shooter (FPS) and real-time strategy (RTS) players. It should be noted that both FPS and RTS games qualify as action video games despite bearing relatively little resemblance to each other.

FPS games are played from the first-person (egocentric) perspective of a single protagonist who is generally charged with combating enemies while navigating through a three dimensional environment. Players must rapidly adjust to changes in weapon, vehicle, and enemy characteristics as each of these can require specific strategies and handling.

RTS games are played from a top-down (allocentric) perspective and require players to manage a host of units and buildings placed within an expansive environment. Games of this type are typically comprised of three separate tasks that must be managed simultaneously: gathering resources (by assigning units to do so), spending the resources to create units (which vary in terms of cost to create and abilities), and directing fighting units in battle against the enemy.

Both FPS and RTS games have previously been shown to improve cognitive functioning in training studies, but players of each genre have never been compared. We propose that the differences in game mechanics found between FPS and RTS games will be reflected in cognitive performance. Our reasoning behind this prediction is quantitative. While both FPS and RTS games require frequent switching and tracking of multiple stimuli, the egocentric perspective of FPS games places restrictions on the number of stimuli that can appear on screen simultaneously (and in the players field of view).

A typical FPS game may contain up to 64 players (moving stimuli) in a single area, though the player rarely has more than a few within their field of view. In contrast, RTS games can have a much higher number of moving stimuli. The highly popular StarCraft II: Wings of Liberty has a unit cap of 200, meaning that the player may have to attend up to 400 units (including those of his opponent). Furthermore, due to the allocentric viewpoint, players can view most or all of these units within their field of view. This viewpoint also allows for greater task switching demands as players are often required to switch between very different "screen states", or viewpoint positions on the map, in order to attend to various task demands. In FPS games players attend to a continuously changing screen state.

As we are suggesting that game mechanics are related to functioning improvements, we have chosen to measure performance on two cognitive tasks which we suspect are trained more by one game type over the other due to the reasons outlined above: task switching and multiple object tracking.

Task switching is a measure of mental flexibility that is frequently used to study the shifting aspect of executive functions, referring to the ability to flexibly and quickly switch between different tasks or mental sets (Miyake et al., 2000). Multiple object tracking (MOT) measures the ability to keep track of the positions of a number of moving target items among a set of distractors (Trick, Jaspers-Fayer, & Sethi, 2005). This task requires visual attention to be actively allocated towards target stimuli among competing distractors (Green & Bavelier, 2006b) and is thought to contain a large dynamic attentional component (Scholl, Pylyshyn, & Feldman, 2001).

We hypothesize that the more complex switching and object tracking requirements of RTS gameplay should provide greater engagement of those functions when compared to FPS gameplay, leading to comparatively better cognitive performance.

2. Method

2.1. Participants

90 participants (out of 1806 respondents) were recruited via an online questionnaire advertised on local bulletin boards and at the University of Social Sciences and Humanities in Warsaw, Poland. These participants were placed into one of three groups ($n = 30$ per group, two females in each group) based on our recruitment criteria: FPS players, RTS players, and a control group of NVGP's. RTS players were required to have played seven or more hours per week of RTS games in the past six months and 5 h or less of FPS games per week during the same time frame. FPS players had the same requirements but reversed. NVGP's were required to have played less than 2 h per week of both FPS and RTS games in the past six months, and no more than 5 h of video game play weekly in total.

Mean age was 22.1 ($SD = 3.9$) for FPS players, 22.2 ($SD = 4.5$) for RTS players, and 25.4 ($SD = 4.4$) for NVGP's. The developmental literature on task switching (e.g. Kray & Lindenberger, 2000; Reimers & Maylor, 2005) and multiple objects tracking (e.g. Kennedy, Tripathy, & Barrett, 2009) suggests that the three year age gap between our NVGP and VGP groups is unlikely to factor into performance. Mean playtime was 18.83 h for FPS players and 19.10 h for RTS players (see Table 1 for full report on gameplay times). We also collected data on the number of hours weekly spent playing the following game genres: platform, fighting, adventure, turn-based strategy, role-playing, racing, puzzle, and multiplayer online battle arena. Participants were not excluded on the basis of gameplay time in these video game genres. As our primary interest was in FPS and RTS players, we only required that participants play the genre of their group more frequently than any of the other genres.

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