Intersect, Vol 14, No 1 (2020)

The Short-Term Effects of Action and Non-Action Video Game Play on Attention

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Recent advancements in the quality and popularity of video games have stimulated much research in the psychological sciences. Research that investigates associations between violence in video games and aggression is common. Less frequent is research examining the potentially positive outcomes of video game play. There are several aspects of video games that can be cognitively stimulating: the movement of targets, memory for pathways, solving of puzzles, coordination of hand eye movements and often, speed of decision making (Hubert-Wallander, Green & Bavelier 2011; Spence & Feng, 2010). Most games have one aspect of cognition in common; they require attention. To be successful during game play one must allocate their attention to the game, the players, and the spatial environment (El-Nasr & Yan, 2006; Hubert-Wallander et al., 2011; Spence & Feng, 2010). Perhaps experience with these tasks could lead to improvements in attentional skills over time.

Tasks that Measure Visual Attention

Visual attention can be broken down into three categories that are most related to video game playing: attentional resources, field of view and temporal processing (Spence & Feng, 2010). Researchers have identified several different tasks that measure these different types of attention. The first, attentional resources, is one's overall capacity or how much a person can process at one time. The second, field of view, refers to the amount of the area within view that one can attend to without having to intentionally shift their gaze. The third, temporal processing, refers to how well one can keep track of items correctly over time. To measure attentional resources, the flanker task (Eriksen & Eriksen, 1974), visual search (Treisman & Gelade, 1980) and enumeration (Jevons, 1871) have been used. To measure the size of one's visual field the useful field of view task (Sekuler & Ball, 1986) has been used. To measure temporal processing, the attentional blink task (Raymond, Shapiro, &Arnell, 1992) has been used. All three of these aspects of attention are used when playing video games. By using these various tasks either in isolation or in combination, one can investigate whether video game playing has a beneficial effect on each of these different types of attention.

Why Improve Attention?

Video game playing may be beneficial in terms of attention, in specific contexts or populations and may improve attention (Hubert-Wallander et al., 2011). While some research correlate video game play to attentional problems in children (Gentile et al., 2012; Swing et al. 2010), research on English speaking children with dyslexia also show improvements in reading skills after playing action video games (Bavelier, Green & Seidenberg, 2013; Franceschini et al., 2017; Franceschini & Bertoni, 2019).

Video games may be useful in order to train populations to enhance visual attention skills. In the case of the elderly, old age often comes with degradation of certain functions in the brain. Further, elderly people often experience a narrowing of the visual field, which can be associated with more motor vehicle accidents (Spence & Feng, 2010). Certain occupations that require high levels attention than others, such as military personnel, pilots, or surgeons, may also benefit from video game playing (Hubert-Wallander et al., 2011). If video games do improve attention, perhaps implementing training programs using video games could improve attention in these contexts and occupations (Basak, Boot, Voss & Kramer, 2008; Green & Bavelier, 2006b; Gopher, Well & Bareket, 1994; Hubert-Wallander et al., 2011).

Video Game Players Compared to Non-Video Game Players

Traditionally researchers have examined the potential attentional benefits of video games by examining differences between video game players (VGP) and non-video game players (NVGP). VGPs have displayed better attentional skills in various tasks compared to NVGPs. For example, VGPs perform better than NVGPs players on attentional blink, useful field of view, flanker compatibility of view, visual search, enumeration and attentional network tasks (Castel, Pratt & Drumond, 2005; Dye, Green & Bavelier, 2009; Green & Bavelier, 2003). Thus, video game players have better attentional skills than NVGPs in all three of the previously mentioned aspects of attention (attentional resources, field of view, temporal processing). It should be noted that some have not been able to replicate this drastic difference between VGPs and NVGPs, as Murphy & Spencer (2009) were only able to find small differences between VGPs and NVGPs in an attentional blink task (note that this difference still shows greater performance for VGPS). However, this difference could be due to the ways in which authors define VGPs and NVGPs.

Despite these group differences, it cannot be assumed that it is the effect of the video game play that improves attention. A group selection effect could be taking place. That is to say that VGPs already have better attentional skills than NVGPs and are drawn to play video games more often due to their greater skills. Therefore, studies that train non players to be players would help answer this question.

Video Game Training

Assuming that there is a difference between VGPs and NVGPs, one can ask whether or not NVGPs will show improved attentional skills post training. Some research has found that NVGPs's attention cannot be improved with game training, implying that observed differences between VGPs and NVGPs is simply due to a group selection effect (Boot, Kramer & Simons 2008). In other cases, NVGPs show improved attention post video game play. When NVGPs were exposed to video game play over an extended period (at least one hour for each of 10 days), they scored better on all aspects of attention than they scored pre video game playing (Green & Bavelier, 2003; Green & Bavelier, 2006a; Oei & Patterson, 2013). When using an action video game, there is improvement in all three of the aspects of attention mentioned above (attentional resources, field of view, temporal processing). Research using a non-action video game has shown improvement in some aspects of attention, specifically attentional resources (Oei & Patterson, 2013). Action video games, usually first-person shooters (FPS), specifically, seem to improve scores on attentional tasks, but non action video games, usually puzzle games, also seem to improve scores on some attentional tasks.

It is theorized by some that this effect occurs because certain video games have particular attentional requirements to play effectively and efficiently (Green & Bavelier, 2006b; Hubert-Wallander et al., 2010; Spence & Feng, 2010). Most video games require one’s attention, but action video games require more attention than non-action video games do. This may explain why the effects of attentional improvement are more evident with action video games.

Current Study

Despite these results, there are problems with current methodology. The effects of non-action video games on attention are less studied than the effects of action video games on attention. If the implication of video game training research is to improve attentional skills, then there must be research exploring the short-term effects of video game play. Otherwise, video game training will not be accessible if it can only be implemented in a long-term training context. Additionally, non-action video games used in the literature are often flat 2D, impersonal games (see Green & Bavelier, 2003; Green & Bavelier, 2006; Oei & Patterson, 2013; Boot, Kramer & Simons, 2008) similar to *Tetris*. Most action games have 3D environments where people have to actively navigate and play as a person. This makes action video games and non-action video games less comparable in research contexts. I suggest using a first-person 3D puzzle game (Figure 1), *Portal: Still Alive* and compare it to a standard first-person 3D action game, *Halo 3*. By comparing two video games that use first-person perspectives, I hope to explore the effects of video game play on visual attention with more control than previously used.

FIGURE 1. *Portal* is a First-Person Puzzle Video Game

The research on non-action video games has also only shown to improve one aspect of attention, attentional resources. We also investigated whether non action video game play can improve temporal processing by using an attentional blink task. A visual search task will also be administered to revisit non action video game play on attentional resources. Most of the research has also focused on longer term play. The current study proposes to explore short term effects of video game play on attention (both 10 minutes and 30 minutes of exposure). We predicted that the action video game will produce better scores on attentional tasks than the non-action game and 30 minutes of game play will produce better scores on attentional tasks than 10 minutes of play. By using a more comparable non action game, measuring another aspect of attention and exploring short term effects of video game play, we hope to expand the practical implications for video game research on attention.

Methods

Participants

Participants were recruited through first-year and second-year psychology classes at Algoma University in Sault Ste. Marie, Ontario, Canada. Participants had to be 18 years or older in order to participate in this study. Participants consisted of 19 males and 42 females, and 2 preferred not to answer. One female participant was excluded from the analysis due to a lack of understanding the instructions to complete the attentional task (N=62).

Apparatus

The video game setup included an Xbox 360 E console and controller hooked up to a 32’’ 4003 Series LED TV Samsung Television. The games consisted of *Portal* and *Halo 3*. The attentional tasks were administered on MacBook Pro running Yosemite 10.10.1. Attentional blink and visual search tasks were retrieved from https://coglab.cengage.com.

Procedure

Participants were randomly placed in one of four groups. This study was a 2 x 2 between groups design. The independent variables consisted of video game type (action or non-action) and time played (10 minutes or 30 minutes). If participants were assigned to the *Halo* group, they were given the option of switching to *Portal* if they preferred a less violent option. No participants asked to be moved from the *Halo* group to the *Portal* group. Once participants arrived at the room, they were first presented with a consent form that briefly outlined the study and any potential risks associated with it.

Participants providing informed consent continued with the experiment’s procedure. Before gameplay started, the goals of the game and background information on the game were given. A tutorial phase followed. In this phase participants were given instructions on how to play the game, and how the controller worked. Participants were also able to ask any questions about the gameplay. This phase did not contribute to the total play time. Because the length of tutorial completion would vary depending on the participant, the total amount of time it took for the participants to complete the tutorial was recorded. On average, the tutorial portion of the game took 5 minutes.

Once the participants reached the end of the tutorial, they were asked if they had any questions. Participants were notified that they were not allowed to do anything except play the game during their play time, unless they wished to discontinue the experiment. Participants were then left alone to play the game undisturbed for either 10 or 30 minutes. Participants were no longer allowed to ask questions about the gameplay during this portion, but a diagram of the controller and its controls was provided.

Immediately following participants’ gameplay an attentional blink task and a visual search task was administered, one after the other. Attentional blink measures temporal processing. White letters were rapidly presented (100 ms per letter, 19 letters per trial) one after the other in the middle of a black screen. Participants were instructed to report whether they saw a J, K, neither letter nor both letters by clicking on buttons with these responses using the mouse. Participants were not notified whether their answers were correct or incorrect. Once participants presented their answer, they had to start the next trial when they were ready by clicking the “Next Trial” button with the mouse. In reality, both a J and a K were presented on every trial. Only reaction times to the second target, K, were recorded. This task has 4 differing levels of difficulty. On a given trial, in a full sequence of 19 letters, the J and K were presented with a lag of 2, 6, 4 or 8 letters (for example, "JGDK, JTIDJFK, etc.). As the lag between the J and K increases, participants are more likely to report detecting the K.

Visual search measures attentional resources. Either blue or green shapes were presented on a black screen simultaneously. The participant's goal was to report whether they saw a green circle amidst the other presented shapes. Participants were instructed to respond as quickly as possible using the "m" key on the keyboard to represent a response of "present" and the "z" key on the keyboard to represent a response of "absent". Participants were notified whether their answer was correct or incorrect and would start the next trial when they were ready using the "n" key. This task has 4 differing levels of difficulty. On a given trial, the target circle may be present or absent, surrounded by a different number of distractors (green triangles and blue circles). As the number of distractors (4, 16, 32 & 64) increases, the task becomes more difficult.

Once the attentional tasks were completed, participants completed a survey. The survey posed basic questions on one's history of video game play; used to determine whether participants were defined as video game players or not. The survey also posed questions regarding whether participants enjoyed, were frustrated by, or bored by the game that they had played. Lastly, participants were debriefed and invited to attend the thesis conference to view the results of the experiment on March 20th 2015.

Results

The sample included 62 participants, 16 fit the criteria to be labeled as video game players, and 46 were labeled as non-video game players. Because of the low amount of video game players in the sample, no analyses were run on differences between video game players and non-video game players. The experiment had four groups with different participants in each group (i.e. no participant was included in more than one group). The four groups included combinations of game type (action versus non action), and length of play (10 minutes versus 30 minutes). Therefore, the four groups were 1) Action game for 10 minutes, 2) Action game for 30 minutes, 3) Non-action game for 10 minutes, 4) Non-action game for 30 minutes. Each attentional task had 4 levels of difficulty. With regards to the attentional blink task, there were 4 differing levels of difficulty that each participant was presented with (lag of 2, 4, 6 and 8). The visual search had 4 differing levels of difficulty (4, 16, 32 and 64 distractors) that all participants were presented with. Therefore, for both attentional tasks, separate 2 (two levels of Game) x 2 (two levels of time) x 4 (four levels of difficulty) mixed analyses of variance (ANOVA) were run.

ANOVA table	*SS*	*DF*	*MS*	*F (DFn, DFd)*	*P value*
Difficulty	18872	3	6291	F (3, 174) = 28.23	P<0.0001
Time	74.69	1	74.69	F (1, 58) = 0.1632	P=0.6877
Game	603.1	1	603.1	F (1, 58) = 1.318	P=0.2557
Difficulty x Time	603.3	3	201.1	F (3, 174) = 0.9024	P=0.4412
Difficulty x Game	368.1	3	122.7	F (3, 174) = 0.5506	P=0.6484
Time x Game	3173	1	3173	F (1, 58) = 6.932	P=0.0108
Difficulty x Time x Game	1056	3	352	F (3, 174) = 1.579	P=0.1961
Subject	26546	58	457.7		
Residual	38777	174	222.9		

TABLE 2. ANOVA Table for Attentional Blink Task

ANOVA table	*SS*	*DF*	*MS*	*F (DFn, DFd)*	*P value*
Difficulty	34569729	3	11523243	F (1.579, 91.59) = 244.4	P<0.0001
Time	1519950	1	1519950	F (1, 58) = 4.053	P=0.0487
Game	908088	1	908088	F (1, 58) = 2.421	P=0.1251
Difficulty x Time	618860	3	206287	F (3, 174) = 4.376	P=0.0054
Difficulty x Game	233684	3	77895	F (3, 174) = 1.652	P=0.1791
Time x Game	1013836	1	1013836	F (1, 58) = 2.703	P=0.1056
Difficulty x Time x Game	509452	3	169817	F (3, 174) = 3.602	P=0.0147
Subject	21752184	58	375038		
Residual	8202478	174	47141		

TABLE 2. ANOVA Table for Visual Search Task

Game and Time

There were no significant main effects for game type on the attentional blink task or visual search task (See Table 1, Table 2). There was a significant main effect of time played on the visual search task $F(1, 58)=4.053$, $p=0.0487$. At 30 minutes of play, participants had significantly longer reaction times (M=1494, SD=613) than those only playing for 10 minutes (M=1337, SD=422). This main effect seems to be driven by the longer reaction times from the non-action group and is further explained by the three way interaction explained below. There was no significant main effect of time played on the attentional blink task.

Game by Time

There was a significant interaction for game by time on the attentional blink task $F(1, 58)=6.93$, $p=.01$ (See Table 1, Figure 2). At 30 minutes of play, participants had significantly lower percent correct scores on the attentional blink task if they were playing the non-action game (M=45.00, SD=16.54) compared to the action game (M=55.28, SD=20.92). There was no difference for game type found at 10 minutes.

Game by Time by Difficulty

There was a significant three way interaction for game by time by difficulty on the visual search task $F(3, 174)=3.602$, $p=0.0147$ (See Table 2, Figure 3). At 10 minutes of play, participants scored similarly regardless of if they had played the action (M=1340 SD=435) or non-action game (M=1334, SD=411). However, participants with 30 minutes of non-action game play (M=1618, SD=740) had longer reaction times than participants with 30 minutes of action game play (M=1369, SD=423). This effect of longer reaction times was also dependent on the difficulty of the task (that is, the number of distractors).

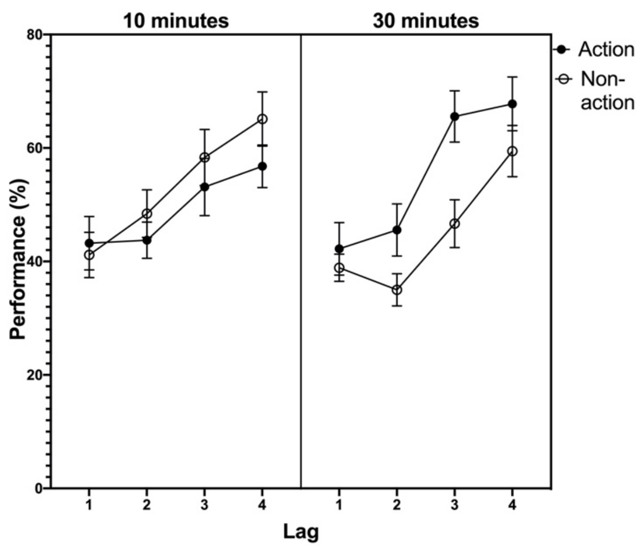

FIGURE 2. Percentage Correct Performance on Attentional Blink Task[1]

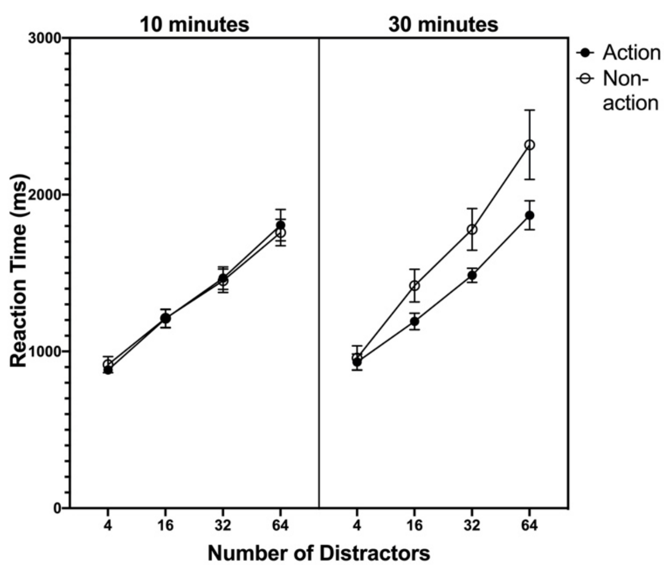

FIGURE 3. Reaction Time Performance on Visual Search Task[2]

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[1] Error bars represent standard error of the mean (SEM). Increasing lag translates to increasing difficulty of the task.
[2] Error bars represent SEM. Increasing distractor number translates to increasing difficulty of the task.

Discussion

We predicted that action video games would produce better performance on attentional tasks than non-action video games. This prediction was supported, considering the interaction found between time and game type on the attentional blink task at 30 minutes of play. When participants played the action game for 30 minutes, they performed better on the attentional blink task than when they played the non-action game for 30 minutes. The lack of a difference at 10 minutes of play may indicate that 10 minutes is too little playing time to create a difference in attentional task scores. The three-way interaction between time, game type and difficulty on the visual search task also supports this prediction. When participants played the action game for 30 minutes, they performed better on the attentional blink task than when they played the non-action game for 30 minutes, or either game for 10 minutes.

Previous research has shown that participants score better on attentional tasks after extended play with action game more so than with non-action games (Green & Bavelier, 2003; Green & Bavelier, 2006a; Oei & Patterson, 2013). Action video games require more attention simultaneously and sequentially, as there are more targets to pay attention to under pressure than in non-action games (Spence & Feng, 2010; Green & Bavelier, 2006b). More experience with targets in the action game serves as more training with these targets. The non-action game used, *Portal*, had little risk associated with it: puzzles did not need to be solved in a particular time, nor was the death of the character a common occurrence. A combination of less pressure and less training with targets may explain why participants had better attentional scores in the action group that the non-action groups.

However, our results could be interpreted in an opposite fashion. Perhaps it is not that action video game play produces greater attentional scores, but that non action game play produces worse attentional scores. In order to properly understand this finding, the research would need to be replicated with more time lags (for example: 10 minutes, 30 minutes, 1 hour, 2 hours) to properly understand this effect. Another way to understand this finding would be to include a control group. Without a control group it cannot be implied that action video games improve attention, as the two games are only being compared to each other. Having an unrelated task, such as reading an article on a screen for both 10 and 30 minutes before administering attentional tasks would provide a useful control comparison.

VGPs score better on attentional tasks than NVGPs (Castel, Pratt & Drumond, 2005; Dye, Green & Bavelier, 2009; Green & Bavelier, 2003). From these findings it was predicted that participants who played for 30 minutes would do better on the tasks than those who played for 10 minutes because they would have more experience with the game play. However, in the non-action 30-minute condition, participants had higher reaction times on the visual search task in the 10-minute conditions and the 30-

minute action condition. Again, this research would need to be replicated with more time lags to properly understand this effect.

This was the first study that compared short term effects of video game play on attentional task performance in both action and non-action games. By understanding short term effects of video game play on attention, more inferences can be made on how much play is required to create effects on attention. In conclusion, action games do produce better attentional task performance than non-action games in a short-term context.

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