Effects of Action Video Game Training on Spatial Attention

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Abstract

Studies suggest that action video game play improves top-down attentional control. A current *learning to learn* theory proposes that probabilistic inference, the ability to identify statistical patterns and create task-relevant perceptual templates to efficiently orient endogenous attention, underlies video game players' greater performance relative to non-gamers in a variety of tasks. The current study aimed to evaluate this theory using a target detection task known to induce a suboptimal number line top-down template, which results in spatial biases. Participants were trained for ten hours on either *Tetris* or *Medal of Honor*. Mean reaction time across all conditions was significantly improved in both groups. However, there was no evidence for enhanced top-down control due to video game training in this experiment.

Keywords: Endogenous attention; Top-down control; Action video games; Spatial bias; Visuospatial attention; Learning to learn.

Effects of Action Video Game Training on Spatial Attention

Playing certain types of video games has been associated with a multitude of benefits, especially in cognitive functioning according to a meta-analysis of 72 quasi-experimental studies and 46 experimental studies comparing frequent video game players to non-habitual players (Powers, Brooks, Aldrich, Palladino, & Alfieri, 2013). In the quasi-experimental studies, main effects ranged from medium to large in auditory and visual processing, whereas large effects in motor skills, tasking switching, multitasking ability and executive function subskills were found in the experimental studies (Powers et al., 2013). Additionally, action video game play may improve brain plasticity and gamers' ability to create optimal perceptual templates (Bavelier, Green, Pouget, & Schrater, 2012).

In everyday life, we constantly encounter situations where we must orient our visual attention optimally to react properly to our environment. Failing to do so during a task such as driving, for instance, might involve dire consequences. It would thus be tremendously beneficial to enhance our attentional capacities.

Green and Bavelier (2003) studied the effects of video game play on selective attention and found many skills learned during gameplay seem to be generalizable to novel tasks. In a flanker compatibility task which involved correctly identifying target shapes at specific locations in the presence of a very salient distractor, relative to non-video game players (NVGPs), video game players (VGPs) showed superior compatibility effects even in the most difficult trials, meaning that VGPs were able to process the distractor while responding accurately to the targets. This finding suggests that VGPs have extraneous attentional resources compared to NVGPs.

Furthermore, on an adaptation of the useful field of view task which measures distribution of spatial attention by identifying a target on spokes extending from a fixation point, VGPs greatly outperformed non-players even at visual eccentricities that aren't utilized or trained during gameplay (Green & Bavelier, 2003).

One potential confound of comparing VGPs to NVGPs in correlational studies is that individuals with greater natural attentional capacities may have success at video games and thus they continue to play these games. To address this potential confound, Green and Bavelier (2003) coordinated a training study where the experimental group played *Medal of Honor* while the control group played *Tetris* for ten consecutive days for one hour per day. *Tetris* was selected as a control because it sufficiently challenges visuo-motor coordination to the same degree as action video games, but it only involves tracking of a single object, whereas action video games demand a wider attentional deployment: tracking of allies, enemies, map position, objectives and explosives among other stimuli, that is, constant multiple object tracking throughout the game. After training, the *Medal of Honor* group performed significantly better than the *Tetris* group in the useful field of view task, and they were also more resistant to the attentional blink than the *Tetris* group. The attentional blink is the phenomenon where individuals have difficulty accurately reporting a second target that appears within a few hundred milliseconds after an initial target, it is thus a measure of temporal attention (Green & Bavelier, 2003). These findings suggest that action video game training improve distribution of attention in time and space.

Hubert-Wallander, Green, and Bavelier (2011) attest that fast-paced action video games which include many distractors and effectively divide attention yield the greatest benefits and improvements in visual attention capacities compared to other video game genres. As such, action video games are the most popular videogame genre, representing 31.9% of total game sales in 2013 (Entertainment Software Association, 2014). Hubert-Wallander et al. (2011) argued that the enhanced visual attention in space and in time and other video game-induced improvements are the result of increased top-down attentional resources among video game players. Additionally, they suggested that the vast generalizability of skills that are learned from gameplay may be useful in education, rehabilitation training and in vocations that require abundant visual attentional capacities such as pilots and military professionals (Hubert-Wallander et al., 2011). Continuing from this line of research, many studies have since examined whether video game play influences exogenous attention, endogenous attention or a combination of the two.

To determine differences between VGPs and NVGPs' responses to exogenous stimuli, West, Stevens, Pun, and Pratt (2008) tested participants on a swimmer task, which involved identifying a sudden change in movement of a stickman 'swimming' among many stickmen in circles at 10°, 20°, and 30° eccentricities from a central fixation point. VGPs were much quicker to identify the change in motion. Stated otherwise, they were more sensitive to sudden attentional capture of exogenous cues compared to NVGPs which suggests that video game experience increases sensitivity to sudden changes in a dynamic environment (West et al., 2008).

However, the results of a study by Chisholm and Kingstone (2012) indicate that VGPs and NVGPs differ in top-down control of exogenous stimuli and not strictly in attentional capture. Chisholm and Kingstone (2012) tracked the eye-movements of VGPs and novices who were asked to respond when one of six grey circles surrounding an imaginary central circle would be replaced by a coloured circle. In half of the trials the 'imaginary' central circle was replaced by a grey circle. The VGPs showed fewer oculomotor attentional shifts to the distractor and fewer initial saccades to the target. These results suggest that top-down executive functions can be employed before attention is actually drawn to uninformative distractors. They concluded that action video game play enhances top-down control and that it can be employed to inhibit bottom-up capture (Chisholm & Kingstone, 2012).

An eye-tracking study by West, Al-Aidroos and Pratt (2013) showed that VGPs orient their vision away from distractors more slowly compared to NVGPs. They found no difference in stimulus-driven attentional capture between groups, but rather in sustained oculomotor inhibition of exogenous distractors. They concluded that video game playing trains executive faculties and that those extraneous attentional resources can be used to attend and encode distractors (West et al., 2013). Thus, it seems that VGPs can utilize exogenous information to make efficient decisions in tasks under the guidance of task-optimal top-down processing.

To offer a parsimonious explanation for the vast benefits of gameplay, Bavelier et al. (2012) proposed a *learning to learn* which posits that action video game play may cultivate brain plasticity and improves *probabilistic inference*, which is the ability to identify and extract statistical patterns in a given task or in the environment to create a perceptual template, or cognitive map that more accurately parallels task demands. As such, the perceptual templates can be transferred to novel tasks to identify relevant information while inhibiting irrelevant information, resulting in rapid learning and increased performance on the given task. This theory precisely explains why video game players consistently outperform non-players on many tasks, including those that neither group has ever encountered (Bavelier et al., 2012).

The current study aimed to evaluate this theory using a variation of the target detection task utilized by Fischer, Castel, Dodd, and Pratt (2003). The task involved the presentation of a central low-magnitude digit cue (1 or 2) or a high-magnitude digit cue (8 or 9) on a computer monitor, after which a small blue circle target appeared with equal probability to the left or the right of the cue. Participants were instructed to press the spacebar with their right hand as quickly as possible in response to the target, and they were accurately forewarned that the digits did not predict the location of the target. In normative studies, participants were shown to be slower to react when a low-magnitude digit cue was followed by a right target (low-right spatial bias) and when a high-magnitude digit cue was followed by a right target (high-left spatial bias) (Fischer et al., 2003).

Ristic, Wright, and Kingstone (2006) contested the interpretation of Fischer et al. (2003) that digit cues exogenously (automatically) induce spatial shifts to the left or to the right, without top-down control on the spatial biases. Ristic et al. (2006) instructed participants to envision a number line from right-to-left, such that the numbers 8 and 9 would correspond to the left side of the computer monitor and that numbers 1 and 2 would correspond to the right side. This resulted in a reversal of spatial biases. Thus, participants would spontaneously adopt a number-line top-down attentional template, even if digit cues were task-irrelevant. The fact that spatial biases could be reversed with instruction robustly suggests that attentional shifts in response to numbers are driven by top-down information processing (Ristic et al., 2006).

The present study is an extension of the study by Rousseau, Healy, and Berman (2014) which compared non-action video game players (novices) and habitual action video game players (AVGs) on the target detection task. In the Rousseau et al. (2014) study, habitual action video game players were unbiased in their reactions to the target regardless of the digit cue magnitude. In contrast, novices were significantly slower to react in low-right, high-left conditions, thereby exhibiting spatial biases consistent with the normative number-line effect. However, only correlational relationships could be drawn from this study.

The current study seeks to provide experimental evidence for enhanced top-down control in visuospatial tasks due to action video game training per se. If the learning to learn hypothesis is correct, the *Medal of Honor*-trained (action video game) group will recognize that the digits do not predict the target's location and suppress the number-line template induced by low/high-magnitude digit cues which would be evidenced by a reduction of low-left, high-right spatial biases in the post-test.

Method

Participants

Using a convenience sampling method, nineteen women (*M* = 20.4 years, age range: 18-25 years) were recruited on the Laurentian University campus by providing contact information on the recruitment form (Appendix B) which was posted on the recruitment board of the Laurentian University Psychology Department. Women were recruited because they are less likely to regularly play action video games, and because they represent a significant majority of the student body, especially in the Psychology Department. Participants received course credit where applicable, $5 per hour of participation and an additional $20 for completing the study. Participants were asked to bring corrective eyewear for each session of the experiment if necessary to ensure normal or corrected-to-normal vision. The participants' Edinburgh Handedness Inventory (Appendix C) scores indicated that every participant is right-handed (Oldfield, 1971). To be considered a non-action video game player, participants had to report 2 h or less of first-person or third-person shooting game play during the last year on the video game questionnaire (Appendix D) which was modified from Dye, Green and Bavelier's (2009) video game questionnaire. The majority of the participants (n = 19) played no first-person or third-person shooting video games at all (n = 16). The Psychology Departmental Ethics Committee approved this study.

Procedure and Apparatus

The experiment took place in the Cognitive Health Research Laboratory at Laurentian University. Participants completed twelve sessions which were generally separated by one to three days (M = 36.9 days). Participants were tested on the target detection task for the pre-test session; then they played either *Tetris* or *Medal of Honor Allied Assault* for ten individual 1-hour sessions after which they completed the target detection task for the post-test session.

The target detection task was designed after the task used by Fischer et al. (2003) (Appendix A). The display featured a black screen with a cross at the center and two boxes (1.5^o x 1.5^o) to the left and the right of the cross at 8.5^o of eccentricity from the center. Participants were instructed to fixate on the white cross (0.5^o) for the duration of the experiment (Appendix E). For each trial, the cross was displayed for 500ms and then replaced by a digit cue, either a low-magnitude digit (1, 2) or a high0magnitude digit (8,

9) for 300ms. Afterward, the blue dot (0.5^o) appeared in the left or the right box after a variable delay of 50, 100, 300, 400, 500 or 900ms. For this task, participants were instructed to press the spacebar key with their right hand as quickly as possible after the presentation of the dark blue circle target that appeared with equal probability on the left or the right of the computer screen. The participants were accurately instructed that the digit cues do not predict the target's location. For catch trials where no target appeared, participants were instructed to refrain from responding. The display reset to the fixation cross frame after each response or after 1,000 ms.

The program ran on a 15 in. monitor with a 12-ms refresh time. A forehead and chin-rest was used to ensure a standard viewing distance of 57 cm and 8º of eccentricity. Participants completed four blocks of 120 trials; 96 trials (4 digit cues x 2 target locations x 6 delays x 2 replications) contained a target and 24 catch trials (4 digit cues x 6 delays) did not. In between blocks, participants were given a 1-minute break that could be extended upon request. The target detection task lasted approximately 25 min.

Participants were assigned to either the *Medal of Honor Allied Assault* group (n = 10) or the *Tetris* (n = 9) group based on their mean reaction time (RT) in the initial target detection task. To achieve approximate equal mean RT between groups, participants with the fastest, average and slowest mean RTs, relatively speaking, were divided and assigned to each group. This is important because relatively equal mean pre-test RTs between groups would signify that both groups started from a relatively equal baseline on the target detection task, which would help infer causal effects due to training if there are significant differences between the RTs of both groups in the post-test.

Participants played their respective game on 15 in. computer monitors in the Cognitive Health Laboratory using a standard keyboard for game controls and Sony headphones adjusted to their preferred volume. The sessions lasted one hour each. On the first day, participants began on the first level or mission of their respective game. Their files were saved at the end of each session, and at the beginning of each new session they began at the last saved point of the previous session. To complete a level in *Tetris*, participants had to complete the given number of lines within two minutes. After the last two minutes of each video game session, I noted the participants' current level, the number of lines completed and the time required to complete the lines. For the *Medal of Honor* group the hits per kill ratio (number of times hit by an enemy/number of deaths) were recorded at the end of each mission. On the tenth and final training session, the participants' scores were recorded on the same level or mission they completed on the first day.

This study is a mixed experimental design. There are five independent variables in this study: group (*Medal of Honor* [*MOH*], *Tetris*), time (pre-test, post-test), digit cue magnitude (low, high) and stimulus onset asynchrony (350, 400, 600, 700, 800, 1200 ms). Stimulus onset asynchrony (SOA) is the sum of 300ms digit cue presentation and the variable delays preceding the blue circle target (50, 100, 300, 400, 500, 900 ms). The dependent variable in this study is RT, which is the amount of time elapsed between the presentation of the dark blue dot target and the participant's response by pressing the spacebar. The E-Prime software allows the participant's responses to be recorded to the nearest millisecond.

Results

To ensure that there weren't significant differences in the mean RTs between both groups on the target detection task at the pre-test, the mean RTs were compared using an independent samples t-test (Appendix F). On average, the participants in the *Tetris* group (*M* = 400.7, *SE* = 17.6) reacted slower than the participants of the *Medal Of Honor* group (*M* = 392.8, *SE* = 15.6). However, this difference was not significant $t(17) = 0.34$, $p > .05$, and the effect size was small $r = .08$.

To confirm that participants in both groups improved significantly at their respective games from the first training session to the tenth session, dependent sample t-tests were ran for each group. Participants in the *Medal Of Honor* group (Appendix G) significantly reduced the number of hits taken per enemy killed from pre-test (*M* = 2.58, *SE* = 0.60) to post-test (*M* = 0.98, *SE* = 0.98), $t(9) = 2.50$, $p < .05$, $r = .64$. Likewise, participants in the *Tetris* (Appendix H) group improved significantly in the number of lines completed per minute from pre-test (*M* = 9.01, *SE* = 2.12) to post-test (*M* = 13.97, *SE* = 0.77), $t(8) = -2.94$, $p < .05$, $r = .72$. The effect sizes were large in both cases.

In terms of analysis concerning the target detection task, catch trials, responses during the presentation of the fixation cross, the digit cue presentation or during any of the delays were not analysed. RTs less than 100 ms (anticipation) and greater than 1000 ms (lack of sustained attention) were also removed from the analysis.

First, data was analysed for the signature number line-effect (Appendix I). Participants reacted slower to right targets preceded by low digits (*M* = 370.02, *SE* = 11.82) compared to left targets preceded by low digits (*M* = 373.59, *SE* = 10.80). Participants reacted slower to left targets preceded by high digits (*M* = 382.95, *SE* =

11.99) compared to right targets preceded by high digits (*M* = 373.15, *SE* = 11.37). $F(1,17) = 1.88$, $p > .05$, $\eta_p^2 = .10$.

The results were analysed using a 2x2x2x2 (cue [low, high] x target position [left, right] x group [*Tetris*, *MOH*] x Time [pre-test, post-test]) mixed-factors analysis of variance (ANOVA). A four-way interaction was predicted but was not observed $F(1,17) = 1.42$, $p > .05$, $\eta_p^2 = .077$.

The *Tetris* participants' mean reaction times for the high-left (*M* = 403.19, *SE* = 20.37), high-right (*M* = 384.18, *SE* = 20.66), low-left (*M* = 390.86, *SE* = 17.64) and low-right (*M* = 387.0, *SE* = 19.92) conditions and the *MOH* participants' mean RTs high-left (*M* = 393.32.19, *SE* = 19.33), high-right (*M* = 389.89, *SE* = 19.60), low-left (*M* = 377.91, *SE* = 16.74) and low-right (*M* = 370.64, *SE* = 18.90) mean RTs for each of the four conditions (Appendix J) were compared to the post-test results (Figure 5, Appendix J).

The post-test *Tetris* participants' mean reaction times for the high-left (*M* = 370.26, *SE* = 15.12), high-right (*M* = 367.34, *SE* = 14.11), low-left (*M* = 368.52, *SE* = 14.90) and low-right (*M* = 371.52, *SE* = 15.09) conditions and the *MOH* participants' mean RTs high-left (*M* = 365.05, *SE* = 14.34), high-right (*M* = 351.19, *SE* = 13.39), low-left (*M* = 357.09, *SE* = 14.14) and low-right (*M* = 350.93, *SE* = 14.31) mean RTs for each of the four conditions (Figure 6, Appendix K).

Discussion

As can be seen in Figure 4 (Appendix J), the number-line effect was only partially observed. That is, participants reacted slower to right targets preceded by low but they did not react slower to left targets preceded by high digits. Since, the number-line effect was not observed, it was not possible to draw any conclusions regarding whether action video game training resulted in enhanced top-down control in visuospatial tasks since there was no evidence that the top-down the number-line template was automatically induced in participants as had been the case in many previous experiments.

The salience of the target stimulus may have had a great impact on the results of this study and may have played critical role in the number-line effect, which was only partially observed. The difference between the asterisk target used in many other experiments and the blue circle appears to be significant. This warrants the comparison of stimuli of various saliencies on the number-line effect in future research.

By comparing Figures 5 and 6, it is evident that participants in both groups responded significantly faster in all post-test conditions. Thus, video game training did have an effect on reaction time, but significant differences weren't observed between groups as they both improved similarly.

There are various compelling reasons why participants in the Medal of Honor group did not attain a high level a high level of top-down control to inhibit task-irrelevant cues. First, ten hours of training are not adequate for an individual to be considered a habitual video game player. Participants recruited in correlational studies undoubtedly play action video games for more than ten hours per week, or at least per month. I believe that a significant four-way interaction would be observed in an experiment where participants would be trained for 30 to 50 hours. Similarly, there were on average, too many days in between sessions which may have also reduced the effectiveness of training. In the study by Green and Bavelier (2003), participants were trained for 10 consecutive days. Thus, perhaps an effect would have been observed had the training sessions been on consecutive days, assuming ten hours of training.

Conclusions

This experiment showed that even limited experience on video games that require a high-level of visuospatial engagement can significantly increase reaction time to spatial stimuli. However, the experiment was not sensitive enough to establish a causal effect for enhanced endogenous resources among action video game players due to training.

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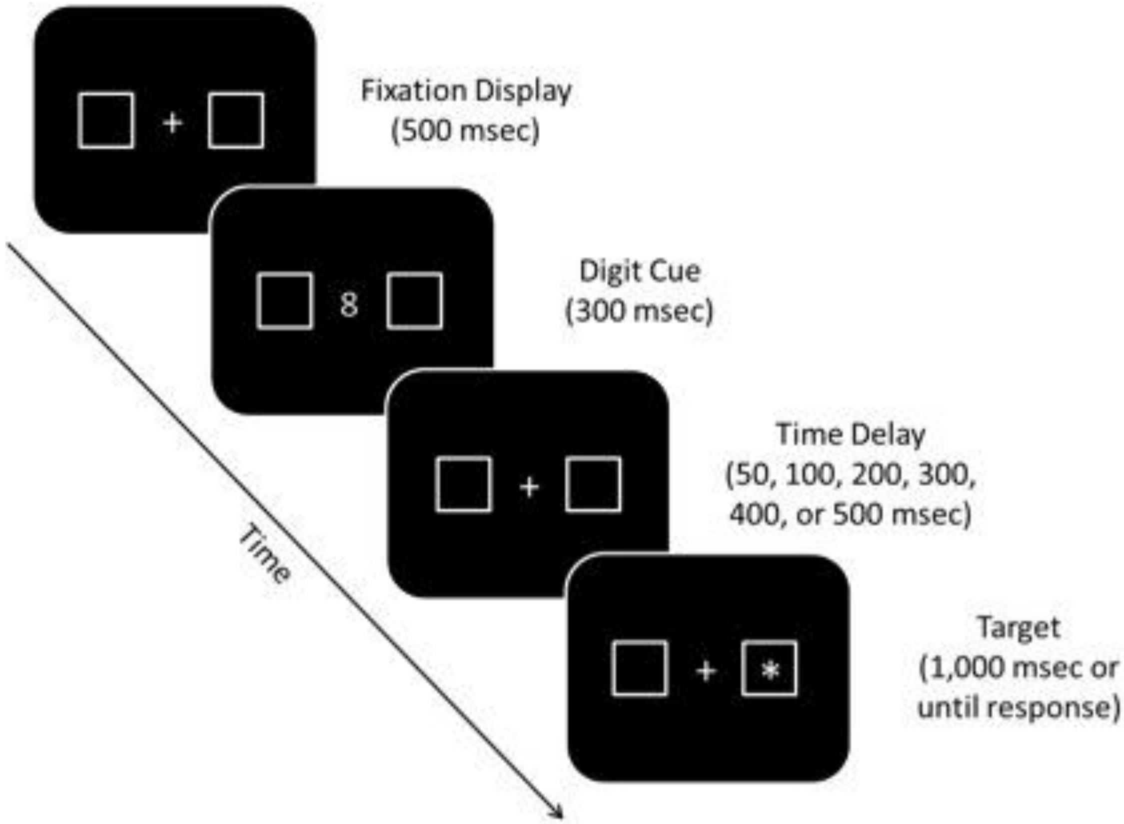
Appendix A: Target Detection Task Stimuli



Appendix B : Recruitment Form

Recruitment Form Winter 2015

Title of Project: **Effects of Videogame Experience on Reaction Time**

Female participants with less than one hour of shooting video game experience per week during the last year are needed for this study. Participants will be paid $50 ($5 per hour) for their involvement and will receive course credit where applicable. An additional $20 will be paid to participants who complete all of the sessions of this study. This study will involve **two, 30-minute testing sessions** and **ten, one-hour sessions** of training on the video game *Medal of Honor: Pacific Assault* **or** ten, one-hour sessions of training on *Tetris*. Prior to and following the training period, reaction times to visual stimuli will be measured. During the testing sessions, you will be asked to press a spacebar as quickly as possible after you see a visual target appear on the monitor. This study will take approximately two to three weeks (ten, one hour sessions plus two testing sessions prior to and following training). If you feel uncomfortable, or no longer want to continue for any reason, you may withdraw at any time without penalty and will receive compensation/course credit for the time you have put in.

If you have any questions pertaining to this research, contact one of the researchers:

Student: Michel Thibeault
Department of Psychology
Laurentian University
my_thibeault@laurentian.ca

Supervisor: Dr. Luc Rousseau
Department of Psychology
Laurentian University

Appendix C: Edinburgh Handedness Inventory

EDINBURGH HANDEDNESS INVENTORY

First Name: ______________________

Last Name: ______________________

Date of Birth: ______________________

Please indicate your preferences in the use of hands in the following activities *by putting + in the appropriate column*. Where the preference is so strong that you would never try to use the other hand unless absolutely forced to, *put* + +. If in any case you are really indifferent *put + in both columns.*

Some of the activities require both hands. In these cases the part of the task, or object, for which hand-preference is wanted is indicated in brackets.

Please try to answer all the questions, and only leave a blank if you have no experience at all with the object or task.

		Left	**Right**
1	Writing		
2	Drawing		
3	Throwing		
4	Scissors		
5	Toothbrush		
6	Knife (without fork)		
7	Spoon		
8	Broom (upper hand)		
9	Striking Match (match)		
10	Opening box (lid)		
I	Which foot do you prefer to kick with?		

ii	Which eye do you use when only one?		

Leave this space blank	L.Q.	

Scoring instructions:

Add up the number of “+”s in the Left (L) and Right (R) columns.

Use the following formula:

R – L / R + L * 100 = Laterality Quotient (L.Q.)

- 100 = totally left-handed

+ 100 = totally right-handed

0 = ambidextrous

Appendix D: Video Game Questionnaire

Video Game Playing Questionnaire

Name: ____________________________________ Email: ____

Please list the video games that you have spent the most time playing over the past year (up to 8)

Game Types:

- **Action** (FPS, others with lots of motion – i.e. Burnout, Call of Duty, Counter-Strike, Crysis, Far Cry, Grand Theft Auto, Half-Life, Halo, Left 4 Dead, Marvel vs. Capcom, Resident Evil, Rogue Spear, Super Mario Kart, Unreal Tournament, etc)
- **Fighting** (Soul Caliber, Mortal Combat, Street Fighter, etc)
- **Strategy** (Warcraft, Civilization, Sims, etc)
- **Fantasy** (Zelda, Final Fantasy, KOTOR, etc)
- **Sports** (Madden Football, FIFA Soccer, etc)
- **Other** (any not listed, cards, pinball, snood, etc)

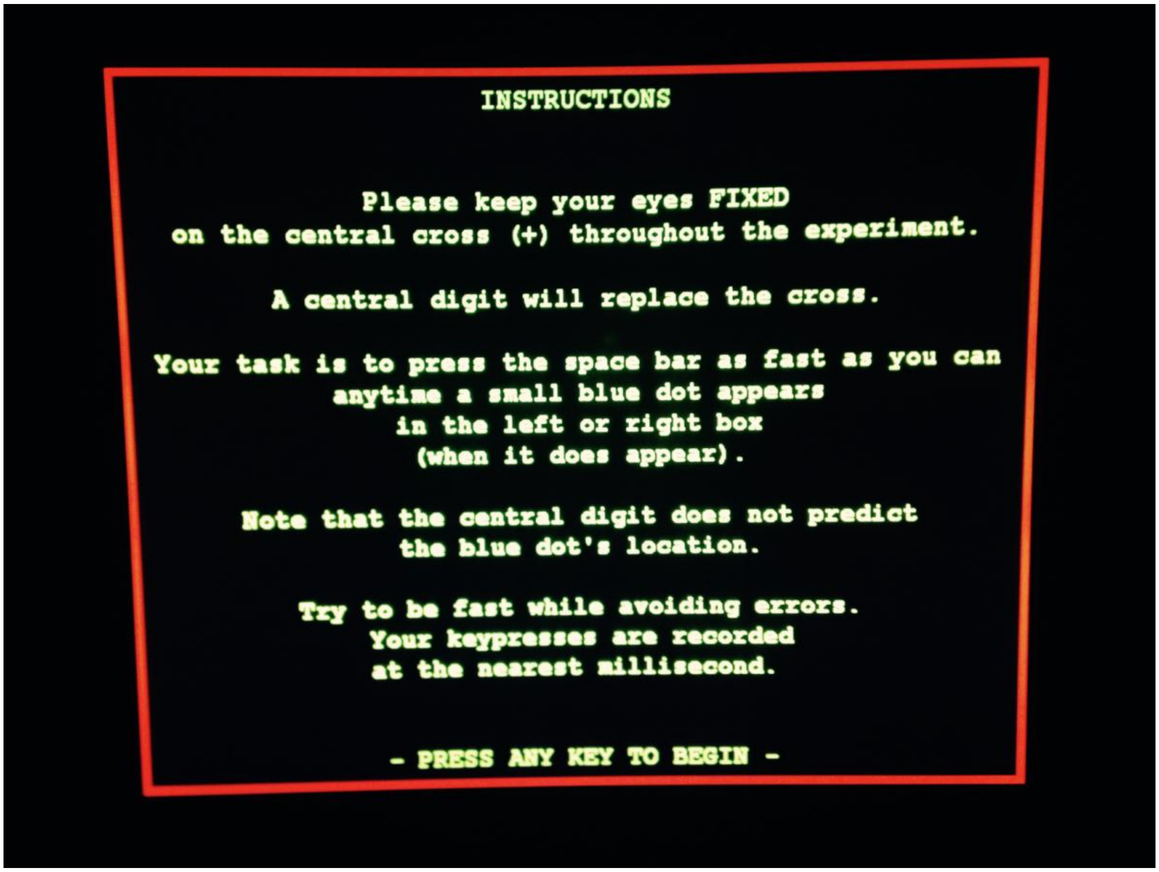
	Name of Game	**Game Type**	**Average # hours / session**	**Average # sessions / week**	**Console**
Ex1	Madden 2004	Sports	1	6	PS2
Ex2	Counterstrike	Action	2	4	PC
1					
2					
3					
4					
5					
6					
7					
8					

If applicable, at what age did you play your first video game? ___________

If applicable, please list any other hobbies (playing a musical instrument, athletics, etc.) that you do more than 5 hours a week:

1)____ 3)____
2)____ 4)____

Appendix E: Target Detection Task Instructions



Appendix F: Mean Reaction Times for the *Tetris* and *Medal Of Honor Groups* at Pre-test

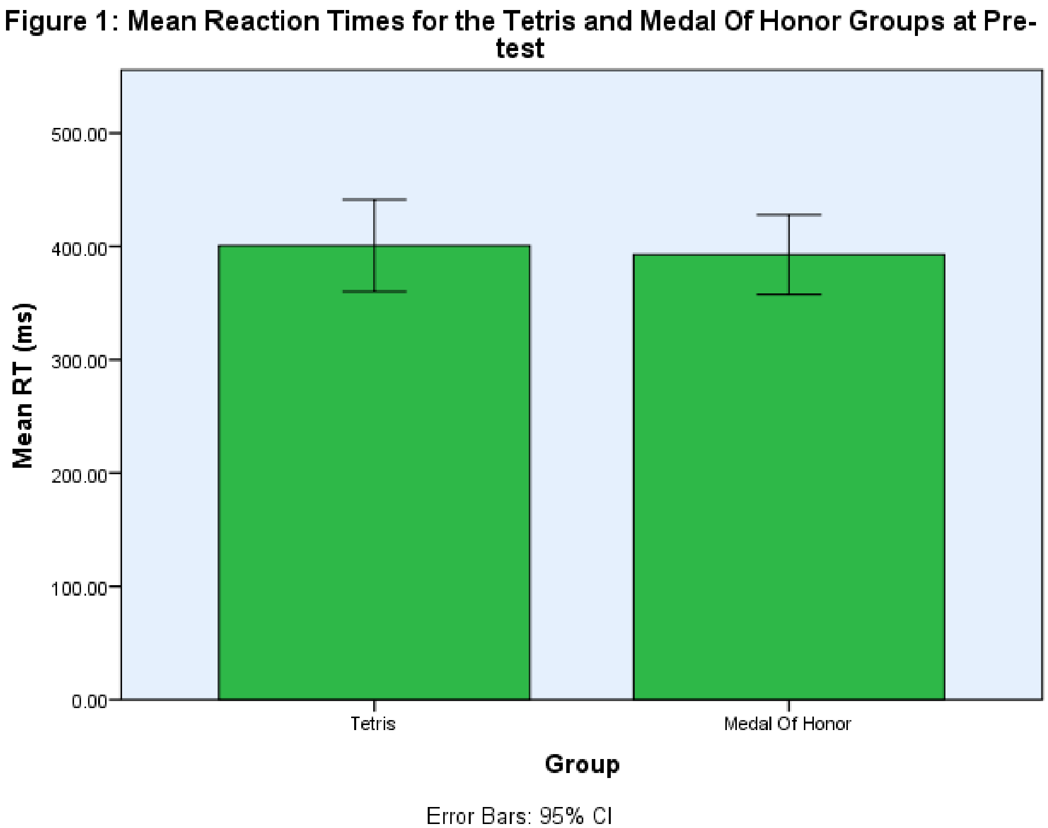


Figure 1. On average, the participants in the *Tetris* group (*M* = 400.7, *SE* = 17.6) reacted slower than the participants of the *Medal Of Honor* group for the pre-test (*M* = 392.8, *SE* = 15.6). This difference was not significant $t(17) = 0.34$, $p > .05$. The effect size was small $r = .08$.

Appendix G: Reduction in the Mean Number of Hits Taken Per Enemy Killed in *Medal Of Honor* Group After Training

Figure 2. Participants in the *Medal Of Honor* significantly reduced the number of hits taken per enemy killed from pre-test (M = 2.58, SE = 0.60) to post-test (M = 0.98, SE = 0.98), $t(9) = 2.50$, $p < .05$, $r = .64$.

Appendix H: Improvement in Mean Number of Lines Completed Per Minute in the *Tetris* Group After Training

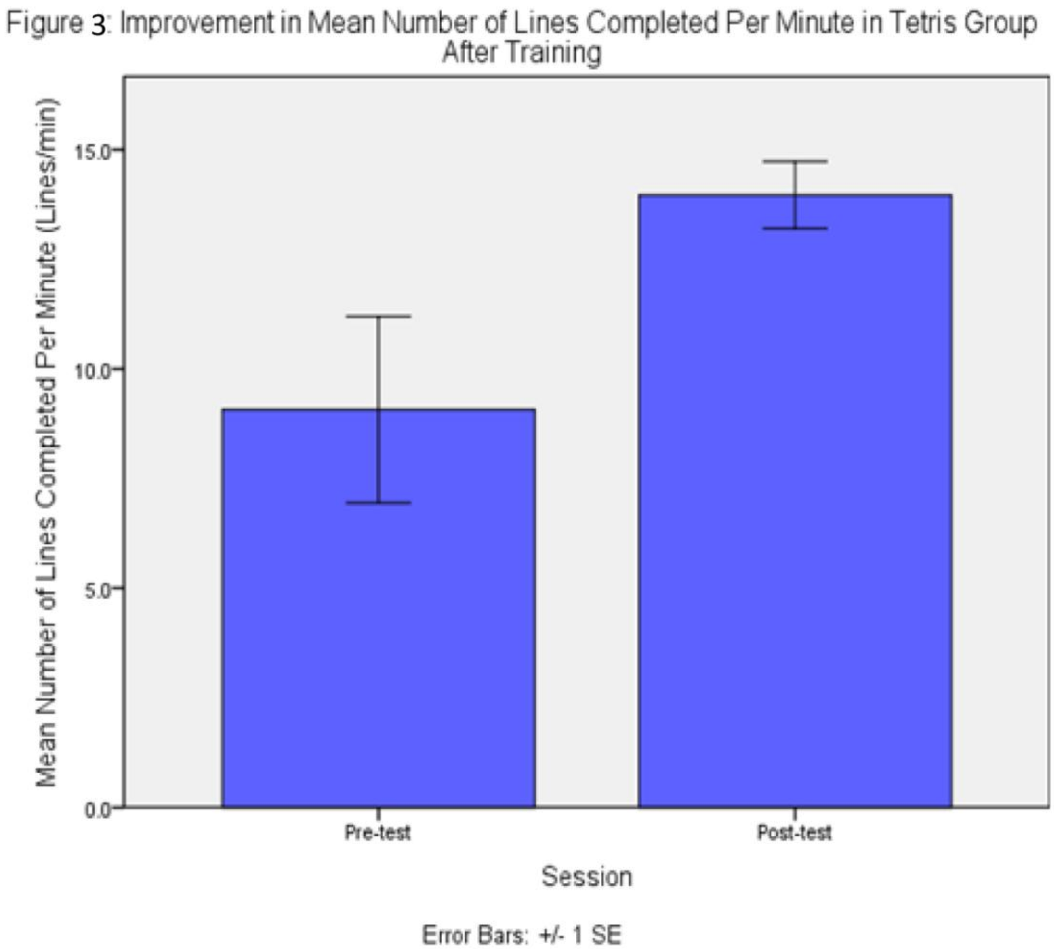


Figure 3. Participants in the *Tetris* group improved significantly in number of lines completed per min from pre-test (M = 9.01, SE = 2.12) to post-test (M = 13.97, SE = 0.77), $t(8) = -2.94$, $p < .05$, $r = .72$.

Appendix I: Mean RT of participants for All Four Digit Magnitude by Target Location Conditions.

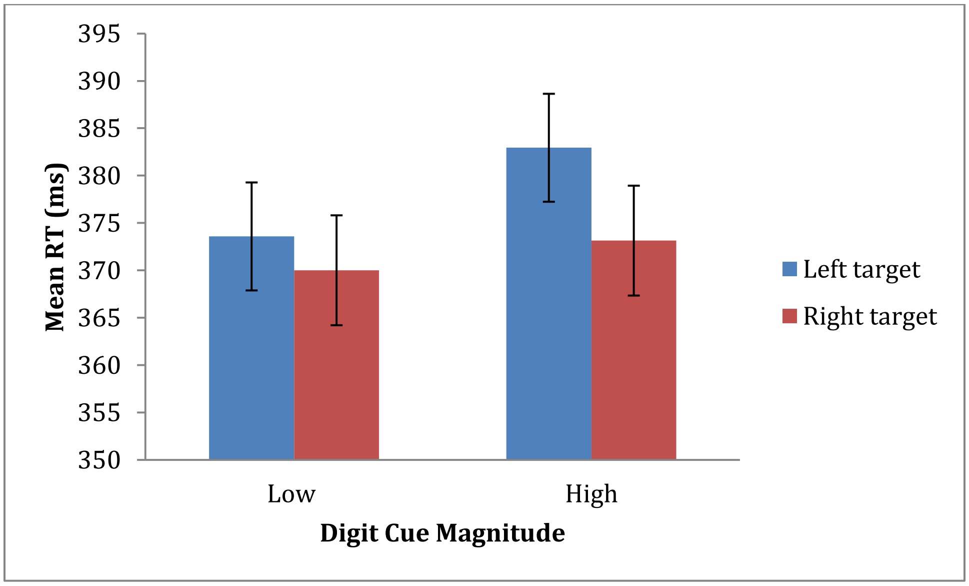


Figure 4. Participants reacted slower to right targets preceded by low digits (*M* = 370.02, *SE* = 11.82) compared to left targets preceded by low digits (*M* = 373.59, *SE* = 10.80). Participants reacted slower to left targets preceded by high digits (*M* = 382.95, *SE* = 11.99) compared to right targets preceded by high digits (*M* = 373.15, *SE* = 11.37). $F(1,17) = 1.88$, $p > .05$, $\eta_p^2 = .10$.

Appendix J: Mean RTs of Each Group at Pre-test and Post-test

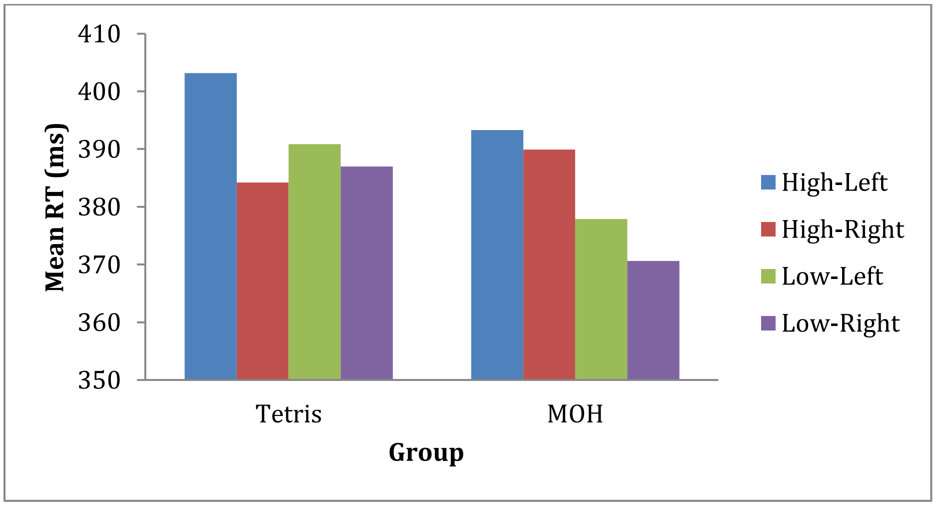


Figure 5. The pre-test *Tetris* participants' mean reaction times for the high-left (*M* = 403.19, *SE* = 20.37), high-right (*M* = 384.18, *SE* = 20.66), low-left (*M* = 390.86, *SE* = 17.64) and low-right (*M* = 387.0, *SE* = 19.92) conditions and the *MOH* participants' mean RTs high-left (*M* = 393.32.19, *SE* = 19.33), high-right (*M* = 389.89, *SE* = 19.60), low-left (*M* = 377.91, *SE* = 16.74) and low-right (*M* = 370.64, *SE* = 18.90) mean RTs for each of the four conditions.

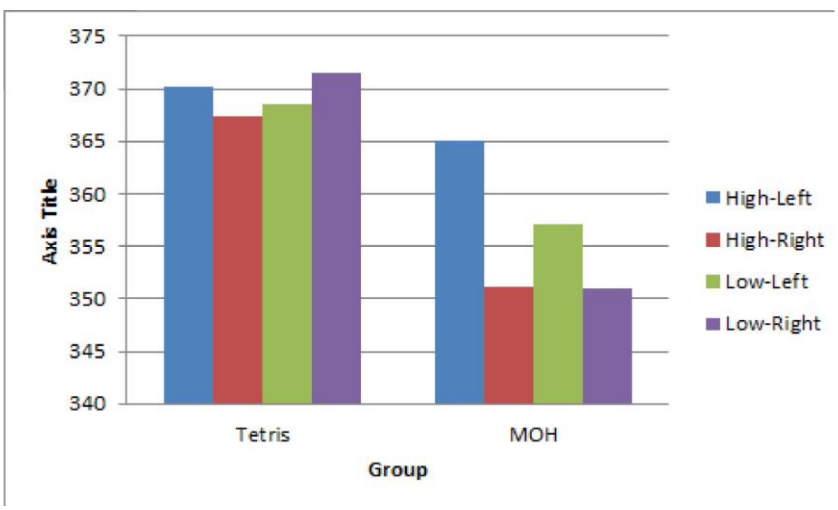


Figure 6. The post-test *Tetris* participants' mean reaction times for the high-left (*M* = 370.26, *SE* = 15.12), high-right (*M* = 367.34, *SE* = 14.11), low-left (*M* = 368.52, *SE* = 14.90) and low-right (*M* = 371.52, *SE* = 15.09) conditions and the *MOH* participants' mean RTs high-left (*M* = 365.05, *SE* = 14.34), high-right (*M* = 351.19, *SE* = 13.39), low-left (*M* = 357.09, *SE* = 14.14) and low-right (*M* = 350.93, *SE* = 14.31) mean RTs for each of the four conditions.