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The Effects of Covert Recruitment on Cognitive Processing in Action Video Game Players

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Abstract

Cognitive processing among video game players has been widely investigated. However, there has been serious debate regarding how methodological issues could be affecting these results. Our study is being conducted to assess the effects of covertly recruiting participants on performance in a Multiple Object Tracking (MOT) task. Covert recruitment conceals the role of video game experience in our study until after the cognitive task is completed. Additionally, we extend our research to include female participants, who have historically been omitted from cognitive video game research. The experiment began by administering the MOT task first, followed by a brief survey. The survey asked questions about how many hours each participant played, per week, of different genres of video games, as well as demographic information. Our results suggest that video game players (VGPs) of both genders perform better than non-video game players (NVGPs) when tracking a larger number of objects. This suggests that VGPs have an advantage in environmental awareness and visual short-term memory skills.

The Effects of Covert Recruitment on Cognitive Processing in Action Video Game Players

Video game research within the past couple of decades has examined the cognitive benefits associated with video game playing. Numerous studies have provided strong evidence that indicate playing video games increase performance on cognitive tasks (Buelow, Okdie, & Cooper, 2015; Cain, Landau, & Shimamura, 2012; Chisholm & Kingstone, 2015; Connors, Chrastil, Sánchez, & Merabet, 2014; Green & Bavelier, 2003, 2006a, 2006b, 2007, 2012; Bavelier, Green, Pouget, & Schrater, 2012). These studies suggest that the cognitive processing associated with playing action video games enhances mental abilities. For example, Chisholm and Kingstone (2015) aimed to assess if visual search performance in VGPs is associated with improvements in target selection and/or target response (Chisholm & Kingstone, 2015). Participants were asked to complete a saccade task in order to assess their attentional processing. In the study, the participants were asked to make an eye movement towards a target, gray circle. After target selection occurred, participants indicated whether there was an indent to the left or right of a square within the target. Participants were presented five, blue, non-target circles in addition to the single target circle. Additionally, a distractor (another blue circle) was introduced into the task without informing the participants to assess their attentional processing of extra stimuli. An illustration of the saccade design is shown in Appendix A. The results suggest that VGPs produced more accurate saccades than NVGPs when the distractor stimuli was introduced (Chisholm & Kingstone, 2015). In this case, VGPs were able to identify where the indentation was more accurately than NVGPs.

Multiple studies conducted by Green and Bavelier provide evidence for an improvement of visuospatial, attentional, and learning processes in video game players (VGPs) versus non video game players (NVGPs) while performing various mental tasks (Green & Bavelier, 2003, 2006a, 2006b, 2007, 2012; Bavelier, Green, Pouget, & Schrater, 2012; Bejjanki, Zhang, Li, Pouget, Green, Lu, & Bavelier, 2014). Green and Bavelier (2003) investigated whether VGPs outperformed NVGPs on several cognitive tasks such as attentional blink, enumeration, and visual attentional capacity. Participants were administered four different cognitive tasks: flanker compatibility, enumeration, useful field of view, and attentional blink. The results of the study suggest that VGPs performed significantly better on all the cognitive tasks.

The fifth experiment examined training effects on cognitive performance on all of the tasks except flanker compatibility. The study was conducted as a pre-test, post-test design to examine the effects of video game training. Participants were required to train one hour per day, for a total of 10 days with one of two different video game types: Tetris served as a control, while Medal of Honor served as an experimental manipulation. Between days one through eight, the participants played the game until completion. On days nine and ten, participants were required to repeat the start of the game. By repeating the beginning missions in the games, Green and Bavelier were able to examine the participants' improvement from their initial run through of the game. Post-test results provided evidence that video game training showed significant improvement on participants' cognitive scores (Green and Bavelier, 2003).

However, in the light of all the research proposing increased cognition in video game players, opposing research has been conducted that refutes those previous results (Boot, Blakely, & Simons, 2011; Boot, Kramer, Simons, Fabiani, & Gratton, 2008; Murphy & Spencer, 2009; Ravenzwaajj, Boekel, Forstmann, Ratcliff, & Wagenmakers, 2014; Unsworth, Redick, McMillan, Hambrick, Kane, & Engle, 2015). Unsworth et al., (2015) observed action video game research only analyzes extreme groups. The study was aimed to assess some issues with previous research designs, such as extreme-groups studies. Participants completed 11 different cognitive tasks which were categorized into three groups: working memory tasks, fluid intelligence tasks, and attention-control tasks. It was concluded that some results were replicated when examining correlations between cognitive performance and game types (Symmetry span, Raven's matrices, Reading span, Letter sets, Number series). However, a majority were not found to show any significant associations between cognitive processing and increased video game playing (Flankers, Stroop, Operation span, Symmetry span, Reading span, Raven's matrices, Letter sets, Number series, Antisaccade, SART *SD*, SART accuracy, PVT) (Unsworth, et al., 2015).

Continuing, a study by Stothart (2014) expanded upon the research by Green & Bavelier (2006a) to assess the link between recruiting styles and improved cognition (Stothart, Boot, Simons, & Beyko, 2014). The study was conducted with the key focus of examining if there is an increase in performance of participants who were overtly recruited. Stothart (2014) recruited participants overtly, purposefully asking for VGPs, as well as covertly, never suggesting their need for VGPs. The study hypothesized that overt recruitment would lead to over performance from VGPs while covert recruitment would show no significant differences between VGPs and NVGPs. Depending on what recruitment style being implemented, participants either completed a Multiple Object Tracking (MOT) task before or after a survey was provided. The research found no significant differences between VGPs and NVGPs even when performing overt and covert recruitment styles. When looking at the results presented from his study, all the trials were averaged together. Essentially, Stothart combined all levels of the MOT task to examine if VGPs performed better than NVGPs in general. The problem that arises from generalizing all of the information is that individual differences could be lost. A perfect score when tracking three circles could mask a low score of tracking six circles. When looking at Green and Bavelier, (2006a), cognitive performance was compared between VGPs and NVGPs across all difficulties in the MOT task; VGPs were measured against NVGPs when tracking one circle or VGPs were measured against NVGPs when tracking six circles. Therefore, further research needs to be conducted in order to investigate the specific effects of covert recruitment on cognitive performance in action video game players. If Stothart's results are accurate, then additional questions, such as why his results did not match his predictions and why his results did not provide support for the groundwork laid by other research, needs to be investigated additionally (Stothart et al., 2014; Boot et al., 2008; Boot et al., 2011; Unsworth et al., 2015).

Our study aims to examine two different factors. First, we are examining the effects of covert recruitment on cognition of action video game players. Based on the information provided from previous research, the results suggest there is a performance bias when participants are overtly recruited (Boot et al., 2008; Boot, Blakely, & Simons, 2011).

Second, we are seeking to investigate the difference in cognitive processing of male and female VGPs and NVGPs. Previous studies have not provided a detail explanation behind cognitive processes of different genders when related to action video gameplay (Buelow et al., 2015; Cain et al., 2012; Connors et al., 2014; Green & Bavelier, 2003, 2006a, 2006b, 2007, 2012; Bavelier et al., 2012; Boot et al., 2011; Boot et al., 2008; Murphy & Spencer, 2009; Ravenzwaajj et al., 2014; Stothart et al., 2014; Unsworth et al., 2015). These studies account for gender when examining generalizations to the population; however, they do not extensively look at gender differences. Primarily, men have been the majority of participants in previous research designs due to their higher ratio in the gaming field. However, it is imperative to understand the cognitive processing of men and women so that we have a greater idea of how video games might have an effect on all individuals.

The experimental design is a replication study of Green and Bavelier (Green & Bavelier, 2006a). According to their research, action video game play leads to increases in the number of items that can be tracked and enumerated simultaneously over time (Green & Bavelier, 2006a). The MOT task was used from Green and Bavelier (2006a) to conduct the replication. In the study, participants completed a series of MOT tasks varying by the number of target squares they had to track. The MOT task was programmed as closely as possible to Green and Bavelier as to not introduce other third variables. Immediately following the cognitive task, participants were questioned about their gaming history in a short survey. The short survey sought to assess the level of gaming each participant can be categorized to as well as the demographic information important to our study; primarily gender. Each participant was provided the number of hours per week they play of each genre of video games so that we were able to get a good understanding of their interaction in a game environment. The idea behind the pilot study is to not introduce a recruitment effect that could cause increased performance from the VGPs (Boot et al., 2011). Selective recruiting can enhance player performance simply because participants feel “special” when being picked as a VGP. In order to avoid those recruitment effects, participants will only know the importance of selecting video game players until after the task is completed.

We hypothesized that there would be a substantial difference in cognitive scores of the MOT task between VGPs and NVGPs. Action video games require attentional processing of the entire screen when playing. In first person shooters, it is common for players to maintain awareness of all the enemies in front, as well as behind their primary field of view. Other genres of games, such as puzzle and RPGs, showcase similar stimulus awareness. Therefore, we expect VGPs to significantly outperform NVGPs in the MOT task even when eliminating participation recruitment effects. In relation to the task itself, VGPs will show a higher number of squares they are accurately able to track while NVGPs will demonstrate a lower number of tracked squares. Additionally, we hypothesize that there will be a significant difference in cognitive performance of female VGPs versus NVGPs. If there is a difference in cognitive processing between VGPs and NVGPs, then it should hold true that the female VGPs would have a significant increase in cognitive processing due to their support in the results of the first hypothesis.

Methods

Design

The study was conducted as a pilot study with a cognitive task administered before an assessment survey was given. Various other demographic and categorical information from the survey acted as independent variables; primarily gender and the number of hours per week each participant played. A Multiple Object Tracking (MOT) task was used in order to assess participants' visuospatial abilities. The scores of each participant was measured as the dependent variable. After data collection, [Insert statistical analyses and their relevance as well as explain which IV was used]

Participants

Participants were selected from Amazon Mechanical Turk. Mechanical Turk is a program, provided by Amazon, where individuals can complete certain tasks and receive compensation for their work. The participants consisted of 13 females and 31 males (N=44). The average age of each participant was calculated to be 27.92 years old. The participants received compensation of $2.00, for a task that should take only 30 minutes to complete, for contributing to the study. If a participant was unable to follow survey guidelines or failed to correctly answer 50% when tracking three objects, he/she was omitted from the study.

Materials

Each participant required access to an internet connection and a computer in order for the study to be completed. At the beginning of the study, participants were asked to read over an informed consent. Acceptance of the informed consent was necessary for continuation in the study. The informed consent can be found in Appendix A. Next, a self-designed JavaScript program was used as the program to administer the MOT task to the participants.

At the start of the task, participants were presented with 16 green squares. All the squares were placed against a black background. The squares were measured to be 15 pixels and moved at a rate of 2.5 pixels per frame. One square flashed red, indicating that it was the target. Next, the target square changed to green. In this manner, the target square is impossible to distinguish from the non-target squares. Squares then began to move around in a randomized fashion for five seconds before coming to a stop. In order to avoid collisions, squares would repel each other before contact. Avoidance of square collision provided a randomized, movement effect so participants would not learn square pathing. Once five seconds had passed, a single square was lit white. At this point, participants were asked to provide their response to whether the white square was a target or non-target. The MOT task is illustrated in Appendix A. In the study, to answer “target”, the participant hit the F key on their keyboard; to answer “non-target” the participant hit the J key. If correct, the answer box would light up green; if incorrect, the answer box would light up red.

The MOT program implemented four different scenarios for square tracking: 3,4,5 or 6 target squares. Each square scenario was presented 12 times, for a total of 48 trials. Each of the four trials were split into 50% target and 50% non-target answers. Therefore, the different square scenarios were divided into two “target” answers and two “non-target” answers. All scenarios were randomized in the program in order to prevent learning effects. In order to ensure fatigue or boredom wasn’t affecting the results, a brief message halfway through the trials was presented to participants informing them of their current progress. Additionally, the message provided general information on the status of their score. This way, participants were aware of whether or not they were meeting a certain criteria demanded of the researchers without explicitly stating what the criteria was.

Finally, the assessment survey was provided to participants. The survey was designed with an initial, table format that lead into some multiple choice and a single short answer question. The table consisted of 11, different genres of video games. Each participant was asked to indicate how many hours they played of each genre, per week. The hours were divided into five categories: “0-1 hours”, “1-3 hours”, “3-5 hours”, “5-10 hours”, and “More than 10 hours”. After providing their hours of gameplay, participants were asked a short-answer question. The question asked participants if they played video games or not. If yes, the participants provided three titles they play the most and approximately how often they play them. If no, the short-answer was not completed. Finally, the survey asked for the gender and age of each participant. Gender was divided into either “male”, “female”, or “other”; age was divided into “18-21”, “22-25”, “26-30”, “31-40”, “Over 40”. The study survey can be found in Appendix B.

Procedure

When participants selected to complete the study and signed the informed consent, they were linked to the MOT program where they were asked to complete a series of four, warm-up trials. Participants would continuously cycle through the warm-up trials until they answered all four consecutively without a mistake. After completion of warm-up trials, participants were informed the real cognitive task would begin. When accepting to move on, participants were linked to the MOT task where each number of target squares (3-6) were presented.

Completion of the MOT task sent participants to the gaming survey. Failure to complete a specific section would result in a redirection of the participant back to the survey where the incomplete items were highlighted in red. After answering all the necessary survey questions, participants were linked to a debriefing page and thanked for their participation in the study. The debriefing statement is shown in Appendix C.

Results

The results were divided into two parts for calculation. First, a bivariate Pearson correlation of the scores on the MOT task versus the total hours of video games played was analyzed. Table 1 shows the calculation of the correlation analysis divided into three groups. The first group is notated as the "Combined" group. The "Combined" group is the addition of all participants into one correlation set. The last two groups are divided into "Males" and "Females" in order to assess if there was a difference in cognitive processing of genders with increased hours of gameplay. Gender was only compared to its individual parts. That is to say, we did not compare how well males did to how well females did. Instead, we simply looked at the relationship between the scores of the MOT task versus the number of hours females played video games. The same situation applies to the males. Next, each group contained two levels labeled "Total Hours" and "Total Action Hours". "Total Hours" is the combined number of hours played in every genre of video games indicated in the survey. "Total Action Hours" incorporates all of the following genres: shooter, action/adventure, role-playing games, fighting, music and party, sports, racing, and simulation. Action video games, as specified by researchers' standards, constitute fast-paced, high intensity games. Therefore, strategy, puzzle, and education were omitted because they did not cover the qualities of "action" video games.

The results from Table 1 indicate that at the hardest level of the task (six squares being tracked) there was a significant, positive association in the combined group for both levels, (Total: r=.29, p=.029; Total Action: r=.38, p=.005). The relationship indicates that increasing the hours of video games played, was also associated with better scores when tracking six objects in the MOT task. Additionally, gender differences showed no significant relationships in male or female groups due to smaller sample sizes.

The second set of results measured the relationship between the scores on the MOT task and the number hours played of each specific genre. Table 2 illustrates the bivariate Pearson correlation analysis of the number of hours played for each genre versus the MOT scores. Overall, there were five categories that reached significance: shooter at six squares (r=.28, p=.034), role-playing games at three squares (r=.27, p=.044), fighting at four squares (r=-.28, p=.037), music and party at six squares (r=.37, p=.007), and strategy at five squares (r=-.28, p=.033).

Discussion

Table 1 demonstrates an effect when performing overt recruitment styles. Green and Bavelier (2006a) found significant results on practically all levels of their MOT task when examining the differences between VGPs and NVGPs (Green and Bavelier, 2006a). On the other hand, Stothart (2014) discovered no significant differences when both overtly and covertly recruiting participants (Stothart et al., 2014). Our results indicate that there is only a positive correlation between the hours of game play per week and the scores on the MOT task when participants tracked six items. The data we collected suggests that there isn't a significant difference between the cognitive processing of VGPs versus NVGPs, and everyone in between, until the difficulty of the task is at the highest level. This is to say that when participants played more video games, they were able to track six items much better than participants who played less video games. Therefore, it can be suggested that neither Green and Bavelier nor Stothart are incorrect in their proposals. There is a significant relationship between the number of video game hours played and increased cognitive processing; however, overt recruitment styles seem to cause over performance in at least one application of cognitive studies on action video game players.

Table 1 also shows there was no significant differences amongst genders, although female there was a strong association between the hours each female played and the scores when tracking six squares as well (include statistics). Therefore, men and woman are essentially equal when performing cognitive tasks associated to how many hours of video games they play.

Table 2 illustrates the associations made between the number of hours played and specific genres of video games. We examined the results of Table 2 in order to determine if specific genres had a larger effect or indicated a significant relationship on how well players performed on the MOT task. The largest amount of hours played by all participants was localized to the shooter genre and there was a significant association found when participants tracked six squares. Correlations found in the shooter category showed an increasing association as the task became more difficult. Therefore, we can suggest there was a positive association between hours of gameplay and increased cognitive processing when participants play more shooter games. However, the remaining results were so sporadic that it is almost impossible to objectively determine a specific genre that proved more beneficial to higher or lower hours of gameplay.

There were not very many experimental errors when conducting our research. The only evident problem is trusting participants to complete the task to the best of their ability when we were not in attendance. Ideally, we would prefer to distribute the study to participants. In this manner we can ensure that participants completed the tasks correctly rather than simply reaching completion in order to receive compensation. However, we avoided many situations of lackluster performance by maintaining a criterion that participants had to score past and various progress reports.

Based on the results of our study, we suggest that future studies implement covert recruitment techniques in order to avoid any performance biases that could lead to inaccurate data. We suggest more information on the effects of recruiting styles should also be observed in case there is only an effect in some cognitive tasks and not others. For example, cognitive tasks that take use of executive functioning may achieve different results than fluid-intelligence tasks when implementing covert recruitment. Additionally, our results suggest that both male and female participants are important when conducting future studies. Thus, incorporating an even amount of males and females should be extremely beneficial in increasing external validity and necessary to decrease the error in sampling distributions.

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Appendix A

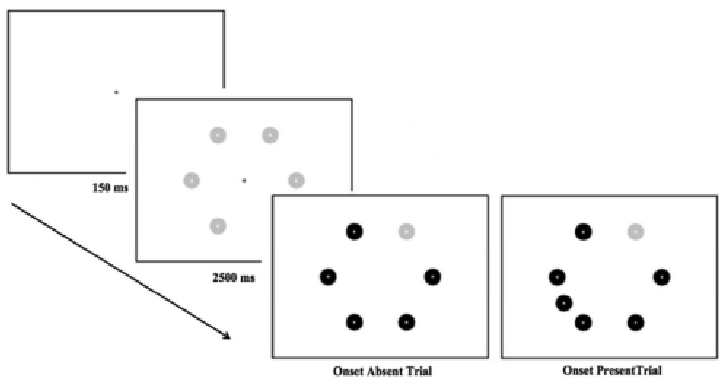

Figure 1. The progression of the saccade task introduced in Chisholm and Kingstone (2015).

Appendix B

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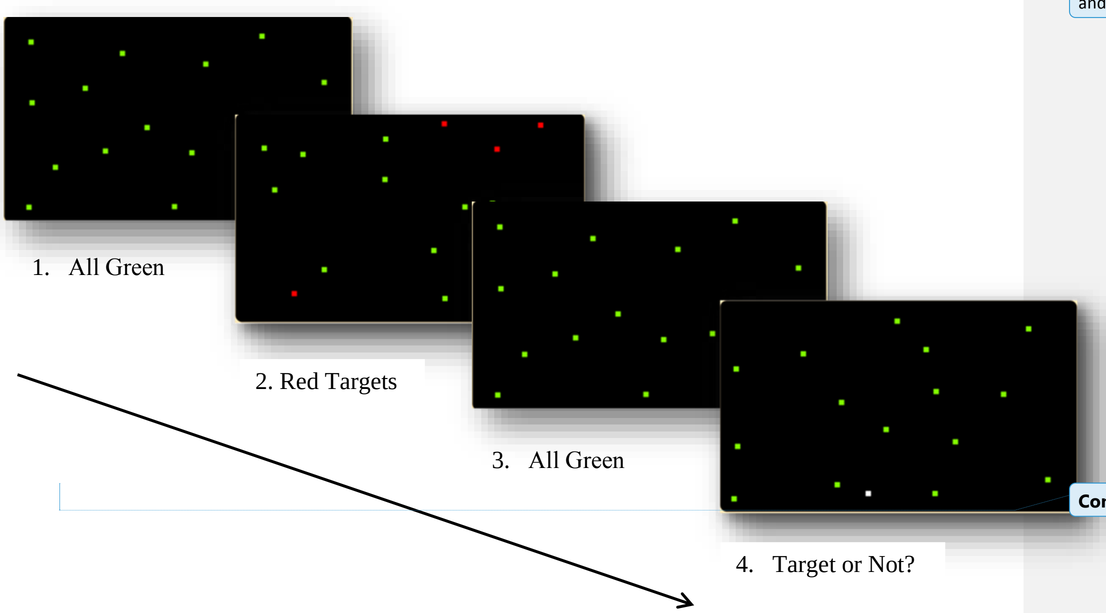

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Figure 2. The four levels of the MOT task given to each participant.

Appendix C

Below are listed several different types of video games, along with examples of each. For each item, please indicate **how much time each week** you typically spend playing that type of game.

Action/Adventure
Examples: Legend of Zelda, God of War
○ 0-1 hours ○ 1-3 hours ○ 3-5 hours ○ 5-10 hours ○ More than 10 hours

Role-Playing
Examples: Mass Effect, World of Warcraft
○ 0-1 hours ○ 1-3 hours ○ 3-5 hours ○ 5-10 hours ○ More than 10 hours

Simulation
Examples: Flight Simulator, The Sims
○ 0-1 hours ○ 1-3 hours ○ 3-5 hours ○ 5-10 hours ○ More than 10 hours

Fighting
Examples: Mortal Combat, Street Fighter
○ 0-1 hours ○ 1-3 hours ○ 3-5 hours ○ 5-10 hours ○ More than 10 hours

Music & Party
Examples: Just Dance, Kinect
○ 0-1 hours ○ 1-3 hours ○ 3-5 hours ○ 5-10 hours ○ More than 10 hours

Racing
Examples: Mario Kart, Grand Tourismo
○ 0-1 hours ○ 1-3 hours ○ 3-5 hours ○ 5-10 hours ○ More than 10 hours

Shooter
Examples: Halo, Call of Duty
○ 0-1 hours ○ 1-3 hours ○ 3-5 hours ○ 5-10 hours ○ More than 10 hours

Sports
Examples: Madden, NBA
○ 0-1 hours ○ 1-3 hours ○ 3-5 hours ○ 5-10 hours ○ More than 10 hours

Strategy
Examples: Starcraft, Civilization
○ 0-1 hours ○ 1-3 hours ○ 3-5 hours ○ 5-10 hours ○ More than 10 hours

Education
Examples: Big Brain Academy, Oregon Trail
○ 0-1 hours ○ 1-3 hours ○ 3-5 hours ○ 5-10 hours ○ More than 10 hours

Puzzle
Examples: Tetris, Portal
○ 0-1 hours ○ 1-3 hours ○ 3-5 hours ○ 5-10 hours ○ More than 10 hours

If you play video games on a regular basis, please tell us which specific titles you play or have played the most and about how much you play each one.
(Otherwise just leave this section blank.)

Type here

Finally, please tell us a little bit about yourself.

Gender
○ Male ○ Female ○ Other

Age
○ 18-21 ○ 22-25 ○ 26-30 ○ 31-40 ○ Over 40

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Figure 3. The survey administered to participants after the MOT task was given.

Appendix D

Thank you for participating in this study! We are investigating whether experience playing action video games has a benefit on perceptual and attentional abilities. Performance on the object tracking task will be analyzed as a function of how often each individual plays these sorts of games. The results of this study will aid in our understanding of how cognitive abilities may change and develop as a result of experience. If you have any questions regarding our study, please contact Ian Endresen via email at endresen@susqu.edu.

Appendix E

Table 1

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Correlations of Total Video Game Hours/Action Video Game Hours to Scores on MOT Task

	Combined		Males		Females	
Number of Squares Tracked	Total Hours	Total Action Hours	Total Hours	Total Action Hours	Total Hours	Total Action Hours
3	0.17	0.18	0.21	0.21	-0.06	-0.13
4	-0.04	0.03	-0.01	0.06	-0.53	-0.71
5	0.11	0.21	0.05	0.20	0.09	-0.01
6	0.29*	0.38*	0.15	0.26	0.51	0.50

Note: p<.05*

Table 2

Correlations of Scores on MOT Task to Hours Played of Each Genre

Number of Squares Tracked	Shooter	Action/Adventure	Role-Playing Games	Fighting	Music and Party	Sports	Racing	Simulation	Strategy	Puzzle	Education
3	0.14	0.04	0.27*	-0.25	0.14	-0.01	0.09	-0.08	0.05	-0.03	0.07
4	0.18	0.08	0.01	-0.28*	0.21	0.05	-0.25	-0.22	-0.10	-0.21	0.14
5	0.13	0.08	0.06	0.02	0.18	0.19	0.11	0.07	-0.28*	0.02	0.19
6	0.28*	0.19	0.21	-0.02	0.37**	0.15	0.05	0.06	-0.14	-0.07	0.23

Note: $p<.05$*; $p<.01$**. All sections outlined in green were used in measuring the number of "Total Action Hours". Every genre of video games was used in measuring "Total Hours".