The Effect of Video Games on Memory: A Meta-Analysis

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Abstract

There is an extensive amount of research on video games (VGs) and their effects on aggressive behavior in teens and children. However, research on the influence of VGs on cognitive abilities has been limited, but there are numerous articles suggesting VGs may enhance memory in both children and adults. Therefore, in this study, the researcher conducted a meta-analysis and used a Cohen’s d to measure the effect size of eight previously published articles to obtain a better understanding of the impact VGs have on memory in participants. The researcher hypothesized that there would be an enhancement of memory. Results indicate a moderate, positive effect on memory post playing a VG, regardless of the age, gender of the player, or the type of game played. Although the meta-analysis demonstrated a positive relationship between VG playing and memory, results were only based on eight peer-reviewed articles.

The wide-ranging amount of research that has been realized on the effects of video games (VGs) on cognitive abilities is overwhelming. Studies on memory (Roberts et al. 2011), attention (Irons, Remington, and McLean 2011), response time (Graves et al. 2007), executive control (Liu, Saito, and Oi 2012), and accuracy/processing speed (Dye, Green, and Bavelier 2009) can be found throughout scientific journals and on the internet. However, the results on whether or not playing video games enhance memory have been mixed.

Therefore, a meta-analysis will be utilized to collectively examine the results of eight studies, measuring the effect that video games have on memory in subjects ranging from 10-65 years of age. The studies that were utilized in the meta-analysis had to meet criteria including the use of VGs (including interactive games such as Wii) as their independent variable and a measure of memory (spatial) as their dependent variable.

The use of VGs is growing in popularity throughout our society, especially in this decade, with the introduction of interactive video games like Wii and Xbox. Many argue that children who play VGs do not spend enough time on other important tasks such as homework (Williams 2006). When it comes to parents and educators, this topic regarding the use of VGs is controversial. However, some parents feel that their children benefit, and even learn, from VGs, while others feel that their children are being set back and not learning as well.

In reality, VGs play a different role in every life. Most students use them to take a break and to relax, but sometimes the games are more of a distraction (Richtel 2012). Others engage in VGs to exercise, learn, or even to connect to other individuals (Baxter 2011). The researcher of the present study defines a VG as an electronic game displayed on a screen, which involves the player to be able to visually see a screen and move items or characters that are displayed by using a device such as a remote or mouse. The types of screens VGs are displayed on can vary: TV, computer, specific game devices (PSP, DSi, etc.), or even a cell phone.

The age of the average gamer is 32 years, and two out of five gamers are female (Online education.net). This demonstrates that the demographics of the VG audience have expanded significantly in the past decade. This may be why so many studies are devoted to understanding the attraction VGs have to humans and how games stimulate the brain.

Liu, Saito, and Oi (2012) conducted research that explains the brain activity during a session of VG playing. In their study, they used the simulated activity of driving a car, which mimics a natural environment. During a turning period of the driving VG, the prefrontal activations of the left hemispheres were higher than before turning. Also, cerebral blood oxygenation changed in the prefrontal cortex (PFC). Their results indicate that brain activity enhances during a task carried out virtually over the same task carried out physically.

Other research replicates natural environments by using virtual ones as well. Baumeister et al. (2010) sought to find the brain activity of a simulated game of golf on a Nintendo Wii console system. Since the participants were more accustomed to a natural setting of golf, they had to activate unfamiliar cues to respond better during the golf game, which required more neuronal resources in their parietal cortex (Baumeister et al. 2010). This explains that brain activity occurs when performing a task, but when the task is simulated through an electronic device or a VG, such as playing Wii golf, the brain activity increases. Perhaps if playing Wii stimulates the brain, it may facilitate memory as well?

Some researchers have found that there is a benefit of playing VGs. Boot et al. (2010) explored what skills would transfer in different contexts of training rather than by the amount of practice during training. They had a group perform tasks in Full Emphasis Training (FET) and another in Variable Priority Training (VPT). FET and VPT had the same training, just different environments (physical vs. virtual). VPT used a VG (Space Fortress) which not only accelerated their learning, but also produced superior mastery of tasks involving manual control and memory. This shows that the VG aspect enhances the brain activity, thus possibly benefiting learning and memory.
Previous studies including a meta-analysis study conducted by Sherry (2001) found that the effect of playing violent video games increased aggression and had a small effect size with a Cohen’s $d = .30$ (424). Sherry’s meta-analysis was based on 25 articles retrieved from scientific journals, with a collective sample size (N) of 2722. The benefit of a meta-analysis is that it can take many studies collectively so there is a larger sample size to determine if there is a cumulative effect of size from many studies.

In summary, the research question for this study is whether or not VGs have a positive or negative impact on memory. Therefore, the purpose of this meta-analysis is to determine whether or not VGs enhance memory in those who play, or interfere with memory storage. The statistics and the number of subjects will be considered in the overall analysis. However, the type of VG, either interactive or non-interactive will both be included.

**Literature Review**

There are many past studies suggesting that playing video games improves cognitive abilities in both children and adults. When examining the effect these VGs have on memory alone, the researcher faced a challenge for this study. The broad amount of information available does not focus solely on VGs and memory, but on other cognitive abilities as well, such as attention, response time, performance, task-switching and emotional memories.

Many investigators have studied attention and how it is affected by VGs. Green and Bavelier (2003) found that attentional capacity is enhanced by VG playing after conducting two experiments with the same participants (between participants method). This is not surprising because in reality, when an individual is playing a VG, the concentration level is high, such that s/he may hardly notice those around them. Trying to get the attention of a video game player (VGP) away from the game can be a difficult task and annoying to parents and friends. When the player is concentrating, s/he not only focuses his/her attention, but can also keep track of multiple objects and tasks within the game. In Green and Bavelier’s (2003) experiments, VGs showed more accuracy and obtained better scores than Non Video Game Players (NVGPs). However, NVGPs gained the ability to enhance their attention due to the experiment.

Attention goes hand in hand with response time as well. If an individual is engrossed in a VG, they are more likely to respond faster than those who are not concentrating on a game. Green et al. (2012) studied response time between VGPs and NVGPs. VGPs had shorter response times than NVGPs. The researchers concluded that playing a VG makes one’s reaction time faster.

In the study conducted by Barlett et al. (2009), cognitive performance in the form of reaction time is measured. The findings display an increase in cognitive performance after five trials of a VG, each trial score higher than the previous one. However, the researchers found no significant difference in the scores of VGPs and NVGPs, indicating that the players had similar cognitive gain. Another finding of Barlett et al.'s (2009) research was that the amount of time spent on playing a VG did not significantly affect the final scores of the participants. This information is important to the present study because it reflects what the researcher seeks through the hypothesis of the effect of moderate VG playing on the chosen cognitive ability of memory. It does so in the way that VG playing will have a positive effect on memory with little time spent playing the VG.

VGPs tend to multi-task a great amount of time when engaging in a game. Green et al. (2012) call this ‘task-switching’. The authors state,

*Results demonstrate that the increased ability a VGP to switch was not restricted to the manual response mode that is likely highly over-trained in AVGVs [Average Video Game Players], but also generalized to vocal responses, which are not part of the typical game activities. The strong positive correlation across all subjects between manual and vocal response switch costs ($r = .59$) is also consistent with the idea that these tasks are tapping a similar underlying mechanism.* (987)

This idea that VGPs can react to stimuli quickly, even novel stimuli, such as vocalization is also consistent with previous research indicating that VG playing enhances cognitive performance, possibly by stimulating the brain (Liu, Saito, and Oi 2012). Also, Green and his colleagues (2012) found that the average VGPs were more accurate on tasks as well as quicker. In addition, Garcia, Nussbaum, and Preiss (2011) found that VGPs performed better on a digit span test (the longest list of numbers a person can repeat back in correct order), which is included in part of the Wechsler’s Intelligence Scale for children.

In summary, the main cognitive ability the researcher focuses on in this current study is the influence VGs have on memory. Memory can be triggered or stored in different forms: short-term, long-term, verbal, visuospatial and emotional. Emotional memory is often triggered by images. Bowen and Spaniol (2011) utilized VGs to find which images aroused the participants’ emotional memory. They utilized violent, negative, positive, and neutral images within the VGs. Bowen and Spaniol (2011) found that the violet images rated more arousing than the rest. However, the researchers claim the number of images showed to the participants was too small, and the stimulation of memory cannot be directly linked to violent images.

Other research has focused on analyzing memory in the form of recognition. Seung-Chul and Peña (2011) studied the number of brands their participants
recalled after playing a VG. The brands (logos) were encountered during the
time of play of the VG. Seung-Chul and Peña (2011) focused on the difference
between a violent VG vs. a non-violent VG and found that the players engaging
in the non-violent games had a higher recall of brands. However, they could
not link this finding to the experience of play (amount of time spent on playing
the VG) participants, which reflects the present study’s hypothesis of moderate
playing. Maass et al. (2011) conducted similar research, but used a list of words
for the participants to recall instead of images. The results indicate an increase in
memory recall post playing a VG, with female participants scoring higher than
male participants.

Caglio et al. (2009) conducted a case study on a participant who had suffered a
brain injury and had damaged his verbal memory. With the use of a VG, which
virtually mimicked driving a car, the participant was given tests to enhance his
verbal memory. The researchers found that the participant’s verbal memory
improved significantly and even after months of the experiments, the verbal
memory remained stable. The participant’s score for the Rey Auditory Verbal
Learning increased from 0 to 3.

However, not all research has positive findings regarding playing VGs and
cognitive improvement. A study on computer gaming and memory load displays a
negative relationship between the two variables. Porter (1991) found significantly
negative results in the measure of memory load after his participants played the
VG and linked this to the participants’ verbal knowledge. Porter (1991) states,
however, that “there was no significant difference in subjects’ performance of the
side tasks itself across either practice or priority conditions” (7).

Other research presents similar results. Valadez and Ferguson (2012) researched the
effect violent VGs have on visuospatial memory and concluded that there was no
effect. The researchers stated, “the current study did not find evidence for a causal
link between violent video game exposure and visuospatial cognition” (Valadez and
Ferguson, 2012, 615). However, these findings could be due to the type of VGs the
researcher utilized. When subjects engage in an interactive game, spatial memory
indicates improvement (Richardson, Powers, and Bousquet 2011).

The purpose of this meta-analysis is to collectively analyze research that has
measured memory in VGPs in order to determine whether or not VGs enhance
memory in those who play, or interfere with memory storage. The researcher
hypothesizes there will be an enhancement of memory (positive effect).

Methods

For this study, a meta-analysis of previously published research was conducted.
Therefore, no human participants were necessary to collect data. In order to

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Previously Published Articles: Authors, Sample Sizes (N), F Values (ANOVA) and r Values

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<th>AUTHORS</th>
<th>SAMPLE (N)</th>
<th>F</th>
<th>r</th>
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<td>Marina Krcmar, Kirstie Farrar, Rory McGloin (2011)</td>
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<td>Christopher J. Ferguson, Amanda M. Cruz, Stephanie M. Rueda (2008)</td>
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<td>F (1, 70) =8.51</td>
<td>.11</td>
</tr>
<tr>
<td>C.S. Green, D. Bavelier (2006)</td>
<td>20</td>
<td>F(1, 18) =9.2</td>
<td>.33</td>
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Discussion

The meta-analysis resulted in a Cohen’s d of .50, indicating that playing VGs had a moderate effect and improved cognitive function in subjects tested. This suggests there is a moderate effect size indicating that playing VGs has some impact on memory. On the effect size scale of 0-2.0, .50 is only at a quarter of the scale. In order to have a significant effect size, the desirable results should fall anywhere from .70 and above. The d of .50 is positive, but not significant. Therefore, the hypothesis of video game playing having a positive effect on memory was not supported.

Limitations

The researcher feels that the number of articles available to conduct this research (literature review and meta-analysis) was not enough. This could be due to the limitations of the databases the researcher had access to. Also, the time available to carry out the research (approximately four months) could have been another factor that limits the findings. In addition, the researcher included interactive VGs (e.g., Wii) and non-interactive VGs (e.g., Nintendo). Another limitation is the fact the studies included in this meta-analysis included experiments that measured spatial memory, Digit span memory and Group embedded figures tests (Garcia, Nussbaum and Preiss 2011) as well as Multiple object tracking test (Green and Bavelier 2006).

Direction for future research

Now that there is some evidence of the effect video games have on memory, researchers can set up experiments to further study this phenomenon and perhaps determine if interactive VGs on devices like Wii and Xbox are more likely to enhance memory compared to VGs on devices like Nintendo.
References


