Computers in Human Behavior 58 (2016) 398–406

Contents lists available at ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

Full length article

The effects of video game use on performance in a virtual navigation task

Kara Murias [a, b, *], Kathy Kwok [a], Adrian Gil Castillejo [a], Irene Liu [a], Giuseppe Iaria [a]

[a] Neurolab–Department of Psychology, Hotchkiss Brain Institute & Alberta Children's Hospital Research Institute–University of Calgary, A062–2500 University Dr. NW, Calgary, T2N 1N4 AB, Canada

[b] Paediatric Neurology–Alberta Children's Hospital, 2888 Shaganappi Tr NW, Calgary T3B 6A9 AB, Canada

ARTICLE INFO

Article history:
Received 24 August 2015
Received in revised form 13 January 2016
Accepted 16 January 2016
Available online xxx

Keywords:
Topographical orientation
Virtual environment
Video game controls
Cognitive map
Motor skills

ABSTRACT

Video games are a popular form of entertainment, but computerized tasks, often resembling video games or built off of video game platforms, are increasingly being used in research. Previous studies have indicated a correlation between video game use and performance on many virtual tasks, including tasks of navigation and orientation. By more completely characterizing previous video game experience and controlling for increased dexterity with game controls, this study endeavored to clarify the nature of such improvements in performance. The findings confirmed that individuals with a longer history of video game play have better performance on a virtual navigation task; however, this effect was greatest in players of video games with a navigational component, and it was not due solely to better use of game controls. Furthermore, participants who play navigational video games more often reported using more efficient navigational strategies, such as using cognitive maps or adopting procedural approaches through learned routes. The findings reported in this study provide evidence that better navigation and topographical orientation skills in individuals playing video games are likely due to the consistent practice of those skills while playing for the purpose of entertainment.

1. Introduction

Video games have become a significant part of every day life for many people. According to industry information, 80% households in the United States have a device used to play video games (an increase from 69% only five years earlier) and 42% of Americans play video games for three or more hours per week (Entertainment Software Association, 2015). The proliferation of video games, with different individuals exposing themselves to a wide range of different types and amounts of gaming, raises the question of how this experience may affect related cognitive processes and the performance of these skills in both research studies and in everyday life.

In conjunction with increases in entertainment use, video games and virtual reality presentations have been increasingly utilized in research and neurorehabilitiation protocols (Bohil, Alicea, & Biocca, 2011). Advancing technology allows realism and flexibility in task design at a decreasing cost. Progressively naturalistic displays and input devices elicit realistic behavioral responses while also recording detailed information about these responses. In addition, inherently motivating elements of video game (such as points or virtual rewards) can be built into the task, increasing attention and compliance during performance (Gatica-Rojas & Mendez-Rebolledo, 2014; Green, Li, & Bavelier, 2010). Many tasks can be run with little or no manipulation from experimenters, so video games can also be used for automated testing of otherwise inaccessible or unengaged populations (Stanton, Foreman, & Wilson, 1998). However, quickly changing advanced technology introduces the issue of a “digital divide” where individuals with extensive exposure to technology perform differently in virtual environment tasks as compared to those participants who do not have the same familiarity with video games and computerized tasks (Donohue, Woldorff, & Mitroff, 2010).

Previous investigations have attempted to determine the effect of video game exposure on the underlying cognitive skills that may contribute to improved performance in a virtual environment task.

Abbreviations: SBSOD, Santa Barbara Sense of Direction scale; VG, video game.

* Corresponding author. Paediatric Neurology–Alberta Children's Hospital, 2888 Shaganappi Tr NW, Calgary T3B 6A9 AB, Canada.

E-mail address: Kara.Murias@albertahealthservices.ca (K. Murias).

http://dx.doi.org/10.1016/j.chb.2016.01.020
0747-5632/

For example, “action” video games (games that involve fast, high intensity sensory processing) improve the ability to track multiple moving objects (Green & Bavelier, 2006b), heighten visual acuity (Green & Bavelier, 2007), enhance contrast sensitivity (Li, Polat, Makous, & Bavelier, 2009), improve abilities to maintain divided attention (Greenfield, deWinstanley, Kilpatrick, & Kaye, 1994), and improve eye-hand motor coordination (Griffith, Voloschin, Gibb, & Bailey, 1983). While improvements in underlying sensory processing and integration (for which there is evidence from both correlational and randomized controlled studies) have been shown to contribute to performance on other computerized tasks, it remains uncertain if those improvements generalize to other processes or affect daily life activities.

One important behavior that depends on a number of cognitive skills, including memory, attention, perception, and sensory processing (Arnold et al., 2013; Burgess, 2008; Palermo, Iaria, & Guariglia, 2008), is topographical orientation – the ability of individuals to orient within and navigate through a large-scale environment (Wang & Spelke, 2002). This complex, multi-dimensional cognitive process relies on the integrity of different brain regions (Aguirre & D'Esposito, 1999; Arnold, Protzner, Bray, Levy, & Iaria, 2013; Barrash, 1998; Maguire, 1997; Schedlbauer, Copara, Watrous, & Ekstrom, 2014) and is an important component of some video games. Because topographical orientation is a relevant skill to everyday life, but is also actively employed in many popular video games, it is an ideal cognitive process in which to study the effect of video game practice on behavioural performance. As virtual tasks are increasingly utilized in research and rehabilitation of clinical populations (Bohil, Alicea, & Biocca, 2011), it is important to determine how previous experience affects current performance and if practice influences expression of the behavior in everyday life.

A recent study by Ventura and colleagues demonstrated a correlation between video game use and performance on a virtual navigation task (Ventura, Shute, Wright, & Zhao, 2013). In this study, the authors developed a first-person video game in which participants explored an environment and learned the locations of three different targets (gems). Participants were then required to find the gems again as quickly as possible. Previous video game usage was measured using a 7-point ordinal scale (from 1 for no video game experience, to 7 for greater than 3 h every day). Participants were also asked to report the degree of similarity between the experimental task and the video games they regularly played. Video game use was significantly correlated with performance on the navigation task. Furthermore, when the authors controlled for task-game similarity, the correlation between video game play and task performance persisted but was reduced, indicating that the type of video games an individual regularly used modulated the relationship between video game play and task execution. This provides indications that video game use may have an influence on navigation skills. However, the question of how video games influence performance in virtual behavioural testing remains unresolved because the questions regarding video game play were rather broad and the authors did not control for other factors that could contribute to better performance.

There are a number of reasons that video game experience could correlate with performance on a virtual navigation task. First, a pre-existing aptitude for skills that are employed in a virtual task may increase the likelihood that players will enjoy, and choose to play, video games more often (Boot, Kramer, Simons, Fabiani, & Gratton, 2008). As an individual plays more video games they would have improvement in manipulation of controls and inputs, which would result in better performance (Borecki, Tolstych, & Pokorski, 2013**)**. In addition, previous research has shown that video game players have improvement in cognitive tasks specifically related to video games such as sensory processing, visual attention, and reaction times (Sungur & Boduroglu, 2012). Lastly, video game players may have improvements in their underlying topographical orientation and navigation skills. These reasons are likely interrelated and hard to differentiate. To date, however, no study interrogating the relationship between performance on a navigation task and previous video game play has included detailed information on the amount and type of video games or controlling for improved skill with game controls. These are important issues to resolve to improve understanding of how behavioural measures on virtual tasks generalize to real-life skills.

In collaboration with Ayogo Health, Inc. (ayogo.com; Vancouver, BC, Canada) and the Human Vision and Eye Movements Laboratory (Departments of Medicine, Ophthalmology and Visual Science, University of British Columbia, Vancouver, BC, Canada) we created a video game navigation task specifically developed to assess topographical orientation skills. Within the game there is also a measure of control dexterity. We used this interactive video game and collected detailed participant demographics on aspects that have previously been demonstrated or theorized to have an effect on performance of an orientation task in a virtual environment. This included information on current and past video game usage in order to determine how elements of previous video game experience contribute to performance on topographical orientation and navigation in a virtual environment.

To demonstrate that the virtual navigational task measured navigation and orientation skills that are relevant in the real world, we first hypothesized that performance on our appositely designed navigation video game would correlate with the Santa Barbara Sense of Direction Scale (SBSOD) (**Hegarty, Richardson, Montello, Lovelace, & Subbiah, 2002**), a validated measure of subjective navigation abilities. This would support the navigation video game as a measure of navigation abilities. Because previous experiments demonstrate that previous video game experience increases manual dexterity (Borecki, Tolstych, & Pokorski, 2013), we hypothesized that people with extensive video game experience would be more proficient at game controls, which would have a positive influence on game performance. Previous video game experience has been shown to have a positive influence on sensory processing skills and visual attention (Green & Bavelier, 2006a; Greenfield, deWinstanley, Kilpatrick, & Kaye, 1994), and that improved performance on a virtual reality navigation task has been shown to correlate with video game use (Ventura, Shute, Wright, & Zhao, 2013). We hypothesize that the improvements on navigational tasks in participants with previous video game experience will be most evident in those participants with previous experience playing navigational video games (video games requiring individuals to navigate and orient in the environment), with improved ability performing the game as compared to individuals who do not play navigational video games. This would provide supporting evidence that better performance on the task is due to improved cognitive processes that are involved in navigation.

2. Materials and methods

2.1. Participants

One hundred and twenty three participants (68 females, 55 males) were recruited through the University of Calgary Department of Psychology online Research Participation System, and volunteers received course credits for their contribution. Participants were required to be fluent in English and could not have a history of significant neurological disease or injury. This study was reviewed and approved by the Conjoint Health Research Ethic Board at the University of Calgary and formal consent was collected