Computers in Human Behavior 66 (2017) 377–387

Contents lists available at ScienceDirect

Computers in Human Behavior

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

Full length article

Number processing ability is connected to longitudinal changes in multiplayer online battle arena skill

Justin W. Bonny*, [1], Lisa M. Castaneda

foundry10, Seattle, WA, USA

ARTICLE INFO

Article history:
Received 7 May 2016
Received in revised form
17 September 2016
Accepted 5 October 2016

Keywords:
Video games
Multiplayer online battle arena
Cognitive skill
Number processing
Working memory
Longitudinal

ABSTRACT

The popularity of multiplayer online battle arena (MOBA) games provides an opportunity to examine how cognitive skills are linked with changes in player performance within a team-based game genre. There is evidence that video game experience in other genres is connected with specific cognitive skills such as visuospatial attention and working memory capacity. Links have also been observed outside of video games such as numerical intelligence being correlated with the performance of chess experts. In the present study, we investigated whether numerical and working memory ability measured at an initial time-point predicted changes in MOBA skill and gameplay frequency measured five months later. We observed that participants who scored higher on a number processing task had greater improvements in MOBA skill and that this link depended on the social context of the gameplay. Specifically, numerical skill was linked to player rankings generated from matches where they were paired with random individuals; no connection was observed with gameplay that took place with a familiar set of teammates. The results of the present study extend previous research indicating video gameplay is linked to specific cognitive skills, in the case of MOBAs being numerical processing. We suggest that the difference in the connection with number ability to gameplay with novel and familiar players is in line with evidence that the importance of individual performance and the sense of achievement can be reduced in team settings. We suggest that future research should examine what types of quantitative abilities are indicative of MOBA skill and the impact of those factors relative to social skills.

1. Introduction

The popularity of competitive video gameplay, specifically eSports, has increased over the past decades to rival traditional sports, such as basketball. With this rapid growth there is increasing interest, both within the gaming and research communities, into what types of skills may increase the likelihood that someone will become an expert gamer. Whereas physical traits such as height and speed are typically used to identify those who could be a good athlete in traditional sports, it is unlikely that a similar observable set of physical traits exist to identify a future expert video game player. Instead, when investigating expert and experienced video game players, research has focused on psychological factors such as cognitive skills. For example, there is evidence that individuals who are skilled at playing first-person shooters tend to score higher on visuospatial tasks (Green & Bavelier, 2003; Powers, Brooks, Aldrich, Palladino, & Alfieri, 2013).

It is likely that links between cognitive factors and changes in gaming performance vary according to the social context in which an individual is playing. In traditional sports, such as badminton, playing as part of a team, versus individually, leads to differences in physical intensity and qualitative differences in style of play (Alcock & Cable, 2009; Liddle, Murphy, & Bleakley, 2010). In video games, the extent to which players can select whether to play as an individual or as part of a team varies by the type of game. An increasingly popular genre, multiplayer online battle arena (MOBA), places heavy emphasis on team play and offers the chance for players to decide whether to be part of a team composed of players they either are or are not familiar with. For games within this genre, two teams of players control individual hero avatars and work together to destroy the other team. Players are provided a choice when they play a MOBA: join a team with their online peers or be randomly assigned to a team with unknown teammates. Given the

* Corresponding author. 100 NE Northlake Way, Seattle, WA, 98105, USA.
E-mail address: justin@foundry10.org (J.W. Bonny).
[1] Present address: Morgan State University; Department of Psychology, 1700 E Cold Spring Ln, Baltimore, MD, 21251 USA. justin.bonny@morgan.edu

http://dx.doi.org/10.1016/j.chb.2016.10.005
0747-5632/

collaborative nature of the game and the varying roles that take place in-game, playing amongst a familiar or a novel group of players could lead to substantially different game experiences and require different skill sets. This makes MOBAs a suitable genre for asking whether cognitive factors play a role in longitudinal changes in gaming skill when playing as part of a familiar or novel team.

When examining the contributions of cognitive skills to video gameplay, most previous research has taken a cross-sectional approach, examining correlations between video game performance and psychological factors at one point in time (Castel, Pratt, & Drummond, 2005; McDermott, Bavelier, & Green, 2014; Unsworth et al., 2015). Studies that have examined longitudinal effects of video game experience have done so by having participants complete a regimented amount of gameplay. This is quite different that the typical experience of gamers who play video games at their leisure. This leaves an open question as to whether cognitive skills are connected to changes in game skill when players determine the frequency and duration of gameplay. In the present study, we investigated whether cognitive performance predicted the degree of change in the duration and skill of gameplay across two time-points when gamers played as an individual amongst familiar and unknown players on a team. To recruit participants with a wide range of gaming experience, the data for the present study was collected onsite at a MOBA tournament.

1.1. Cognitive skill and gameplay experience as indicators of player expertise

Accumulating evidence suggests that cognitive skills are linked to skilled performance within a particular domain. Traditionally it has been argued that the amount of deliberate practice, where an individual uses focused practice to improve their skill, is the direct contributor to expert performance and primary indicator of expertise in a variety of domains including chess, musical performance, and athletics (Ericsson & Lehmann, 1996; Ericsson & Williams, 2007). However, research examining the extent to which levels of deliberate practice relative to other factors can account for performance across novices and experts has questioned its importance (Campitelli & Gobet, 2011; Grabner, 2014; Hambrick et al., 2014). Recent studies have found that although deliberate practice accounts for a substantial amount of variance in expert performance, the majority of variance in performance cannot be accounted for by it alone (Macnamara, Hambrick, & Oswald, 2014). It has been found that cognitive factors, when included in addition to hours of deliberate practice, are significantly correlated with expert performance. For example, greater working memory capacity has been linked with more skilled performance by poker players (Meinz et al., 2012) and sight-reading pianists (Meinz & Hambrick, 2010), and highly-ranked chess players score higher on tests of numerical intelligence (Grabner, Stern, & Neubauer, 2007). This suggests that cognitive skills likely play a role in skilled performance within a range of activities.

There is evidence that connections between experience and cognitive skills extend to video gameplay. Specifically, individuals who frequently play video games have been found to have higher performance on select visuospatial tasks (e.g., visual attention) compared to those who have very little if any video game experience (Appelbaum, Cain, Darling, & Mitroff, 2013; Green & Bavelier, 2003, 2012). A meta-analysis by Powers and colleagues (2013) provided additional evidence of a modest difference between video game players and non-video game players for visual and spatial skills and that the extent of differences varies according to video game genre (e.g., first-person shooters vs. puzzle) and cognitive process (e.g., executive function, visuospatial attention). Training studies focusing specifically on the link between visual attention ability and first-person shooter experience have sought to address the causal direction of these correlations. Individuals with no previous history of first-person shooter gameplay were found to have improved performance on visual attention tasks after completing a set of training sessions suggesting video game experience led to these changes (Green & Bavelier, 2003 but see; Boot, Blakely, & Simons, 2011). There is also evidence that training with real-time strategy games can also improve executive function ability (Basak, Boot, Voss, & Kramer, 2008; Boot, Kramer, Simons, Fabiani, & Gratton, 2008). However, the type of video gameplay captured in correlational and training research differ; participants in the correlational research played at their leisure whereas those in the training study had regimented gameplay (i.e. told to play a game for a set amount of time). This raises questions as to whether improvements observed in regimented gameplay would be observed to a similar extent if individuals freely selected to play video games over a period of time. While most correlational and training studies have focused on the impact of video game experience on cognitive skills, other gaming expertise research has focused on the reverse direction, whether the development of skilled video gameplay may be connected to cognitive ability. Drawing from expertise research in more traditional games, it has been found that working memory skill is predictive of poker player performance and linked to chess player rankings, along with numerical intelligence (Grabner et al., 2007; Meinz et al., 2012). As such, it remains to be seen if a similar link is observed in video gaming, specifically whether players that are high in select cognitive skills are more likely to improve their video gameplay over an extended period of time.

Given that many video games are multiplayer, an open question is whether links between video game play and cognitive skills differ when individuals play as part of a group versus individually. Although many individuals choose to play alone, video games are often used as a socializing activity, similar to playing board games or traditional sports (Whitbourne, Ellenberg, & Akimoto, 2013; Yee, 2006). Individual versus group gameplay could rely on a different set of cognitive skills or reduce the impact of cognitive, relative to other, skills (e.g., communication) with regard to game performance. For example, when a group of participants completed a set of team-based tasks (e.g., solving a puzzle) a collective intelligence factor that incorporated the abilities of all team members was a stronger predictor of team performance than individual abilities (Engel, Woolley, Jing, Chabris, & Malone, 2014; Woolley, Chabris, Pentland, Hashmi, & Malone, 2010). This suggests that the social context in which individuals play a video game could impact the extent to which the cognitive abilities of an individual are linked to game performance. The motivations for individuals to play video games could also impact performance and differ according to social context. When students were presented with an instructional math video game, those who played collaboratively reported being more motivated to continue playing the game compared to students who competed against each other, although students in the competition condition had higher in-game performance (Ke & Grabowski, 2007; Plass et al., 2013). This suggests that, when part of a familiar team, there is greater interest in continuing to play and less emphasis on personal achievement. It remains to be seen whether the extent to which cognitive skills affect individual performance varies when playing video games as part of a familiar versus unknown group.

1.2. Factors that predict extent and frequency of playing a video game

It is likely that cognitive ability also plays a role in how frequently individuals play video games. If an individual is not proficient at an important skill relied heavily upon by an activity,