The power of play: The effects of Portal 2 and Lumosity on cognitive and noncognitive skills

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ABSTRACT

In this study, we tested 77 undergraduates who were randomly assigned to play either a popular video game (Portal 2) or a popular brain training game (Lumosity) for 8 h. Before and after gameplay, participants completed a set of online tests related to problem solving, spatial skill, and persistence. Results revealed that participants who were assigned to play Portal 2 showed a statistically significant advantage over Lumosity on each of the three composite measures—problem solving, spatial skill, and persistence. Portal 2 players also showed significant increases from pretest to posttest on specific small- and large-scale spatial tests while those in the Lumosity condition did not show any pretest to posttest differences on any measure. Results are discussed in terms of the positive impact video games can have on cognitive and noncognitive skills.

1. Introduction

Most children and young adults gravitate toward digital games. The Pew Internet and American Life Project surveyed 1102 youth between the ages of 12 and 17 and found that 97%—both males (99%) and females (94%)—play some type of digital game (Lenhart et al., 2008). Escobar-Chaves and Anderson (2008) further note that the amount of time spent playing digital games continues to increase, and has since the introduction of home computers and gaming consoles in the mid-1980s. The increase in digital game play can be seen in a Kaiser Foundation study (Rideout, Foerh, & Roberts, 2010) that found that 60% of individuals aged 8 to 18 played digital games on a typical day in 2009, compared to 52% in 2004 and 38% in 1999. These young people aren't playing in isolation, either; Ito et al. (2010) found that playing digital games with friends and family is a large and normal part of the daily lives of youth.

Besides being a popular activity across gender, ethnic, and socioeconomic lines, playing digital games has been shown to be positively related to various competencies, attributes, and outcomes such as visual-spatial skills and attention (e.g., Green & Bavelier, 2007, 2012; Ventura, Shute, Wright, & Zhao, 2013), openness to experience (Chory & Goodboy, 2011; Ventura, Shute, & Kim, 2012; Witt, Massman, & Jackson, 2011), college grades (Skoric, Teo, & Neo, 2009; Ventura, Shute, & Zhao, 2012), persistence (Ventura, Shute, & Zhao, 2012), creativity (Jackson et al., 2012), and civic engagement (Ferguson & Garza, 2011). Digital games can also motivate students to learn valuable academic content and skills (e.g., Coller & Scott, 2009; Ventura et al., 2013; for a review, see Tobias & Fletcher, 2011; Wilson et al., 2009; Young et al., 2012). However, others have found a lack of transfer effects between action video game playing and basic cognitive functions and skills (e.g., Boot, Kramer, Simons, Fabiani, & Gratton, 2008) and have raised questions regarding the methodology of studies that observe transfer (Boot, Simons, Stothart, & Stutts, 2013; Kristjánsson, 2013). That is, Boot, Champion, et al. (2013), Boot, Simons, et al. (2013) argue that researchers need to compare any game/treatment condition with a similarly-active control group that has the same expectations of improvement as the experimental group. Only then can we attribute differential improvement to the strength of the treatment. Despite the need to match expectations between treatment and control groups, few psychological interventions do so.

This study seeks to extend the growing body of experimental research examining the relationships between video game play and cognitive and noncognitive skills. We investigate a popular video game called Portal 2, a 3D puzzle game that has received numerous awards

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for its innovative design. In this study we examine the impact of playing Portal 2 for eight hours on two cognitive competencies (problem solving and spatial skills) and on a noncognitive attribute (persistence). As a conservative control condition, we use a popular brain training game called Lumosity — widely advertised as supporting multiple core cognitive processes and skills such as problem solving, memory, attention, speed, and mental flexibility. This control game, with an explicit focus on improving the user's cognition, would generate expectations of improvement more than a simple game like Tetris, which is the game typically used to test game effects against. As such, our choice to use Lumosity as the control condition for the current study addresses and overcomes the main concern (i.e., differential expectations) raised by Boot, Simons, et al. (2013).

We organize this section of the paper as follows. First, we describe Portal 2 and define our focal constructs (problem solving, spatial skill, and persistence) and their associated facets that may be improved by playing the game. Second, we describe Lumosity in relation to the company's stated goals on their website as well as some of the game activities included in their suite of brain games. We then present the hypotheses of our research study.

1.1. Portal 2

Portal 2 is the name of a popular linear first-person puzzle-platform video game developed and published by Valve Corporation. Players take a first-person role of Chell in the game and explore and interact with the environment. The goal of Portal 2 is to get to an exit door by using a series of tools. The primary game mechanic in Portal 2 is the portal gun, which can create two portals. These portals are connected in space, thus entering one portal will exit the player through the other portal. Any forces acting on the player while going through a portal will be applied upon exiting the portal. This allows players to use, for example, gravity and momentum to "fling" themselves far distances through the air. This simple game mechanic is the core basis of Portal 2. Fig. 1 illustrates flinging in Portal 2.

Other tools that may be used to solve puzzles in Portal 2 include Thermal Discouragement Beams (lasers), Excursion Funnels (tractor beams), Hard Light Bridges, and Redirection Cubes (which have prismatic lenses that redirect laser beams).

Redirection Cubes (which have prismatic lenses that redirect laser beams). The player must also disable turrets (which shoot deadly lasers) or avoid their line of sight. All of these game elements can help in the player's quest to open locked doors, and generally help (or hinder) the character from reaching the exit. The initial tutorial levels in Portal 2 guide the player through the general movement controls and illustrate how to interact with the environment. Characters can withstand limited damage but will die after sustained injury. There is no penalty for falling onto a solid surface, but falling into bottomless pits or toxic pools kills the player character immediately.

There are several plausible ways for a person to acquire and hone certain skills as a function of gameplay in Portal 2. These are discussed in the context of our three focal constructs — problem solving, spatial skills, and persistence — in the theoretical review section.

1.2. Lumosity

Lumosity represents a computerized, commercial cognitive training program and claims to improve various core cognitive skills including memory, attention, processing speed, mental flexibility, spatial orientation, logical reasoning, and problem-solving skills. It was selected as the control condition in this study on the basis of assertions the Lumosity group makes relative to its games enhancing cognitive skills. For example, in a self-published paper on the Lumosity website entitled, "The science behind Lumosity" (Hardy, Farzin, & Scanlon, 2013, p. 5), the authors assert, "Taken together, the entire suite of exercises [in Lumosity] represents a comprehensive brain training system — an entire gym for the brain. There are exercises training speed of processing, memory, attention, mental flexibility, and problem solving."

The key component of the Lumosity cognitive training program is a suite of 52 games. Each game is a 2D puzzle-type game, designed to train on one of the aforementioned cognitive skills. Although the major game action involves only pointing and clicking, the games
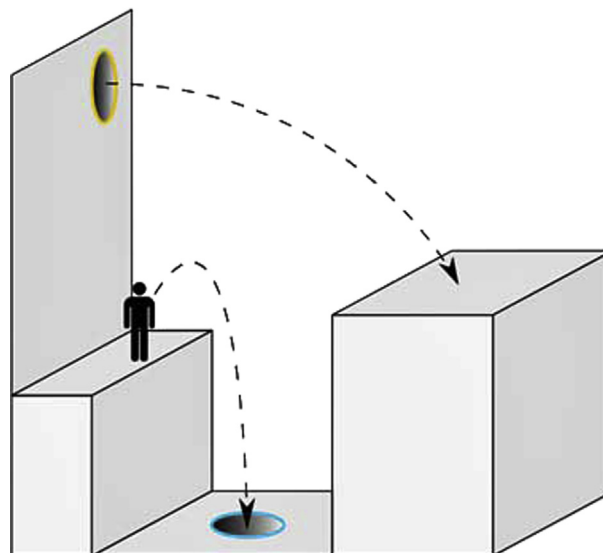

Fig. 1. Flinging in Portal 2.