

Chapter 50

A Study on Whether Digital Games can Effect Spatial Reasoning Skills

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ABSTRACT

This chapter explores the use of a set of 2D recreational puzzle games for training basic spatial skills such as tilting, rotating and flipping. An experiment was carried out with twenty-four human subjects. Initially, the subjects' spatial capabilities were assessed by having them play two games which require spatial manipulations and reasoning. Following this initial assessment, subjects were split into three groups. The members of group 1 acted as the control group and were not required to practice on any spatial tasks. The individuals in group 2 and 3 were instead invited to take part in a training phase where they had to play with a set of math puzzle games of varying difficulties. Members of group 2 played the games by carrying out spatial instructions as imparted by a research assistant. Members of group 3 played the games individually and without any restrictions. The subjects of group 2 and 3 are referred to as trained subjects and executor subjects, respectively. By the end of training, all subjects were asked to repeat the initial assessment procedure in a control session. The comparison of the data collected during the control session with that collected during the initial assessment, indicates that both trained players and executors performed much better in terms of spatial capabilities than the subjects in the control group. Specifically, trained players and executors made fewer spatial manipulative errors and successfully completed spatial tasks faster than their peers in the control group.

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INTRODUCTION

Computers are becoming more and more an essential component in training and education. Several new technologies and computing applications require the user to analyze, encode and transform information from visual displays. As such, these technologies are relying on and implicitly placing an increasing emphasis on the user's visual and spatial skills (Kirby and Boulter, 1999). Thus, it is not surprising that such technologies have been directly exploited to train cognitive capabilities of certain groups of people such as e.g. the elderly or people with impairments. Special training has proven a viable method to boost, reverse or at least stop missing or declining certain perceptual abilities. However, this has a practical limitation because the equipment required is usually very expensive and it is often only available in a laboratory or clinical setting. Given the importance of proper cognitive skills and the simultaneous lack of widely available approaches to hone them, less expensive training alternatives have been investigated. Within this context, it was found that for instance flight performances could be trained using simulators and game like applications (Gopher et al., 1994).

Despite digital games have sometimes been subtly misrepresented in the popular press, a growing number of scholars have begun to explore the favorable sides of electronic games. As a result, video games are used more and more within new domains and especially in the world of learning and education. They are a potential alternative option to expensive dedicated hardware and instrumentation. An extensive body of previous work highlights the benefits of computer-based activities and digital playing. Video games have been used effectively to improve e.g. visual attention performance (Da Cunha Belchior, 2007; Greenfiel et al., 1994), spatial visualization (McGlurg, 1992), working memory capacity (Green & Bavalier; 2003), problem-solving skills (Betz, 1996) and performance in response selection tasks

(Clark et al.; 1987). Other studies analyzed the positive effect of digital games on visual-motor coordination (Griffith et al., 1983), reaction time (Yuji, 1996), spatial cognition (Gagnon, 1985; Dorval, & Pepin, 1986), creative thinking (Rieber et al., 1998), eye-hand coordination and verbal knowledge (Drew & Waters, 1986), and mathematical reasoning (Ensley & Crawley, 2006). In general, these studies proved that cognitive training can successfully be accomplished. At the same time, there is a clear indication that these approaches are targeted and specific to the ability being trained and do not have a general validity for all perceptual skills.

In our study, we explore whether and to what extent spatial reasoning capabilities can be trained and improved by playing a set of 2D recreational math puzzle games that rely on the spatial manipulation of pentominoes (Golomb, 1994). Similarly to other math or strategy games, these puzzle games couple leisure activity and excitement with intellectual reasoning and cognitive capabilities. The simplest game configuration that we considered consists of twelve different pieces that are built as arrangements of five square units joint along their edges. By manipulating the pieces and combining them with each other, one can form hundreds of combinations that can sharpen geometry, problem solving and visual skills. An early study on human-human communication while playing with pentominoes in a collaborative way (Fernández et al.; 2007) shows that subjects resort extensively to localization expressions when they play together towards the resolution of a puzzle thus making this kind of game an excellent prototyping arena for both situated natural language understanding and spatial reasoning analysis. We specifically concentrate on the second issue by presenting the results of an experiment carried out with twenty-four human subjects resolving a diversity of tasks within the realm of the pentominoes.

Our approach has three main phases. First, we run a test to assess the spatial capabilities of

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