Chapter 10
Beyond Gaming:
The Utility of Video Games for Sports Performance

Roma P. Patel
UC Davis Eye Center, USA

Jerry Lin
USC, USA

S. Khizer R. Khaderi
University of Utah Moran Eye Center, USA

ABSTRACT

The interest around the utilization of video games as a component of rehabilitative therapy has dramatically increased over the past decade. Research efforts have confirmed the positive effects of repetitive gaming in improving visual outcomes; however, there is limited knowledge on the mechanism of action delivered by repetitive gaming. Utilizing knowledge of the visual system, including targeting specific cells in the retina with visual stimuli, the authors captured the training effects of gaming to augment pre-selected skills. Specifically, the authors embedded a homerun derby style baseball game with a contrast threshold test, to stimulate parvocellular retinal ganglion cells. Parvocellular cells are the first line of the ventral, or "what" pathway of visual processing. Repetitive stimulation of the parvocellular system shows promising preliminary results in improving batting performance.

INTRODUCTION

With the current push to gamify health care, researchers have focused their attention to the role of video games. Emerging data now supports the potential benefits of video games in areas including physical and visual rehabilitation, visual development and vision training. Research over the last 15 years has highlighted direct benefits from video game play in visual processing speed, and the ability to process multiple visual inputs. For example, in 2003, a series of experiments conducted by Green et al. illustrated that one hour a day for 10 days of action video game play by non-gamers improved visual attention

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abilities such as information processing and apprehending more information at a glance, while simultaneously improving the speed of stimulus-response.(Green & Bavelier, 2003). A more recent study showed that playing 5.5 hours of action video games over 9 weeks resulted in a 43% improvement in gray-scale contrast sensitivity versus non-action video gameplay.(Lietal., 2009). Furthermore, action video game play enhances the spatial and temporal resolution of vision, allowing the players to discern the stimulus despite being crowded with distractors both in physical space and in temporal sequence. (Green, Pouget, & Bavelier, 2010). Currently, other health-specific innovative applications of gaming are being explored including its use in the rehabilitation of visual skills after stroke, physical therapy, improved disease self-management, health education, and skills training for clinicians. Video games are currently being studied in the treatment of amblyopia with limited data showing at least a 5-fold faster visual acuity recovery compared to occlusion therapy (Fricker et al., 1981; Li et al., 2011).

Although the benefits of video games are being explored as stated above, the specific mechanisms for how video games enhance certain visual skill sets have not. In this era of developing specialized skills, this type of study is important to isolate methods of improvements and enhancement. We studied the visual mechanisms involved in baseball batting performance. By focusing on a specific visual skill set, the ability to hit a baseball at a high speed, we were able to deconstruct both the visual physiology involved, visual processing patterns and the type of visual stimulus needed to train this skill set. We embedded a home run derby style baseball video game with an algorithm designed to enhance batting performance based on the visual processing pattern noted in baseball players with batting averages above 0.300 (generally considered to be a good to very good batting average).

DEFINING THE RELATIONSHIP BETWEEN VISUAL PROCESSING AND SPORTS PERFORMANCE

To better study the visual function of an athlete, one must first understand the basics of visual processing. The visual processing model described by Ungerleider and Mishkin in 1982 consists of two anatomically and functionally distinct information pathways – a dorsal “where” pathway and a ventral“what” pathway. The dorsal pathway is the Magnocellular (M- cell/Parasol) system consisting of large soma with large dendritic fields and increased axon density in the periphery. Associated neurons have a fast response time with rapid decay, resulting in more transient vision. Although this system has less spatial resolution, it is more sensitive to subtle contrast, movement, location, and onset of stimuli. The ventral pathway is the Parvocellular (P-cell/Midget) system of small soma with small dendritic fields and slow conduction velocity (See Figure 1). This system is sensitive to shape, color, and detail resulting in higher spatial resolution. Thus, the ventral P cell pathway serves for object recognition and form representation while the dorsal M cell pathway provides spatial awareness and action guidance. Jaekl et al. have shown that the visual detection enhancement from multisensory integration (such as auditory input) is mainly articulated by the magnocellular system, which is most sensitive at low spatial frequencies (Jaekl & Soto-Faraco, 2010) Further investigation into the magnocellular pathways in athletes could elicit more knowledge on how their visual processing functions.

One such investigation conducted by Khaderi and colleagues evaluated whether the magnocellular pathway was heightened in athletes compared to the general population.[12] Using Frequency Doubling Technology(FDT), the M cells of the studied baseball players were stimulated to assess their relative sensitivity to the sensitivity of non-athletes. The central 20 degrees of each player’s visual field under-

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