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Chapter 13

Serious Games and Motor Learning: Concepts, Evidence, Technology

Josef Wiemeyer
Technische Unversität Darmstadt, Germany

Sandro Hardy
Technische Unversität Darmstadt, Germany

ABSTRACT

Digital games in general require fine motor skills, i.e., operating the computer mouse, the keyboard, the touch-screen, or a joystick. With the development of new gaming interfaces, the performance of whole-body movements became possible to control a game. This opens up new lines of application, e.g. improving motor skills and motor abilities. The most important question is whether and how virtual game-based perceptual-motor training transfers to real motor tasks. Theory distinguishes between specific motor skill learning and generic motor ability improvement. Existing evidence shows that the improvement of motor abilities (e.g., balance) is possible by particular exergames while the improvement of motor skills (e.g., basketball throw) depends on several moderators like accuracy of the interface and correspondence of virtual and real tasks. The authors conclude that there are two mechanisms of transfer, located at the elementary and fundamental perceptual-motor level and at the cognitive level. Current issues for technology comprise adaptivity, personalization, game mastering, accuracy of interfaces and sensors, activity recognition, and error detection.

INTRODUCTION

Digital games, i.e., games that are played on electronic devices including microprocessors, have become a widely spread leisure activity attracting not only children and youth but also younger and older adults (e.g., ESA, 2012). When playing digital games, players normally improve their performance, i.e. game score. As a 'secondary effect', players enhance their competencies demanded by the game. For example, Green and Bavelier (2007) showed that playing an ego-shooter game, i.e., a

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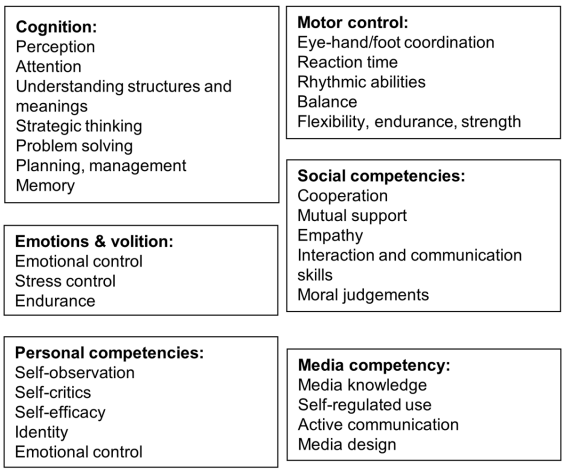
game where the player acts from a first-person perspective and has to fight against other players by using a gun, improved spatial resolution of visual perception. This was not the case for participants playing Tetris.

In Figure 1 competency areas relevant to digital games are illustrated. Gaming can affect five dimensions of competencies:

- Cognitive competencies.
- Motivational, emotional and volitional competencies.
- Perceptual-motor competencies.
- Social competencies.
- Media competencies.

Considering these game-specific effects on competencies the idea seems likely to develop and construct digital games that do not only elicit fun and entertainment but are intentionally and systematically designed to improve selected competencies. Therefore, Serious Games (SG) can be defined as digital games explicitly serving additional purposes beyond mere fun and entertainment. Beginning in the 1980s, SG have been developed for and applied to numerous fields like vocational training, academic and school education, health and rehabilitation, solving scientific issues, and sports (e.g., Ratan & Ritterfeld, 2009). SG promise to offer unique options for learning meeting the requirements posed by theories of learning: "Modern theories of effective learning suggest that learning is most effective when it is active, experiential, situated, problem-based and provides immediate feedback" (Connolly, Boyle, McArthur, Hainey, & Boyle, 2012, p. 661).

Figure 1. Competencies potentially enhanced by playing digital games (adapted with modifications from Wiemeyer & Kliem, 2012, p. 42)



In this chapter, we focus on the application of SG to motor learning.

The objective of this chapter is to address the following questions: Can motor learning be enhanced by SG? If so, which mechanisms are responsible for the learning effects? For further applications, which are the prerequisites for establishing strong and sustainable motor learning effects?

As a first step, theories of motor learning and transfer are discussed in order to deal with the possible mechanisms relevant to the impact of SG on motor competencies. Then existing evidence is analyzed testing the influence of SG on motor learning. Finally, the chances and limits of applying SG to motor learning are discussed.

SERIOUS GAMES FOR MOTOR LEARNING: THEORY

Motor learning can be defined as the more or less permanent change of the capability to show observable behavior (i.e., movements) as a consequence of experience (i.e., mental or physical practice).

In principle motor learning can take two forms (See Figure 2): On the one hand *specific motor skills* like operating a surgical instrument or throwing a javelin can be acquired or improved. On the other hand *domain-specific general motor abilities* can be improved. General abilities are differentiated into conditional and coordinative abilities.

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