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The impact of an exergame-based intervention on children's fundamental motor skills

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ABSTRACT

The purpose of this study was to use the Dynamical Systems Theory as a framework to examine whether there is a difference between an exergame-based and a traditional object control (OC) skills training program, in early elementary school children. In addition the children's enjoyment while playing Xbox Kinect (XbK) games compared to traditional approaches (TA) was also investigated. Sixty-six elementary students were randomly divided into three individual groups of 22 children each, one control group and two experimental groups (TA, XbK). The control group did not receive any structured OC skills training program, while the two experimental groups performed a specific OC skills training program for 8 weeks, two times per week, and 30 min per session. The test of gross motor development 2 was used to assess the OC skills of the participants at the pre-test, post-test and retention test. At the end of each OC training session (XbK and TA) participants completed the modified Physical Activity Enjoyment Scale. Two-way analyses of variance with repeated measures, were conducted to determine effect of training program groups (XbK, TA, Control) and measurements (pre-test, post-test, retention test) across time on OC skills performance. Analysis of the data illustrated that the post-test OC scores and the 1-month retention test OC scores were remarkably greater than pre-test OC scores for both experimental groups and not for the control group. In addition, the XbK approach mean scores on enjoyment were slightly higher than the TA approach. Conclusively, findings suggest that the use of XbK gaming console as an intervention is a valuable, feasible and pleasant approach in order to improve OC skills of elementary school children.

1. Introduction

The importance of encouraging physical activity behavior among children relies on the underlying assumption that the behavior will become part of the person's life and continue into adulthood (Mitchell et al., 2013; Tzetzis, Avgerinos, Vernadakis, & Kioumourtzoglou, 2001). Fundamental motor skills (FMS) have been seen as the “building blocks” for lifetime physical activities (Payne & Isaacs, 2011) and as “the ABCs of movement” (Goodway & Robinson, 2006). Studies in the literature have indicated a positive relationship between the performance of FMS and children's participation in habitual and/or organized physical activity (Fahimi, Aslankhani, Shojaee, Beni, & Gholhaki, 2013; Robinson, 2011; Vandorpe et al., 2012). FMS are common motor activities having specific motor patterns, which are believed to form the foundation for more advanced and specific sport and non-sport motor activities (Gabbard, 2011). FMS are categorized into two groups listed as locomotor skills (e.g., running, jumping, hopping, leaping, galloping, and sliding) and object control skills (e.g., throwing, catching, dribbling, kicking, rolling and striking) (Payne & Isaacs, 2011). It is possible that when children feel confident in their skills, they tend to engage in higher levels of physical activity (Gabbard, 2011). Positive relationships have also been found between FMS performance and weight status (Castetbon & Andreyeva, 2012; Duncan, Stanley, & Wright, 2013) among young children. Further, research has pointed out that children who stay active tend to maintain high levels of physical fitness (Barnett, van Beurden, Morgan, Brooks, & Beard, 2008; Mitchell et al., 2013). The evidence provided by these studies suggests that proficiency in FMS performance during the early primary grades is likely to contribute to increases in habitual and organized physical activity participation, hence preventing unhealthy weight gain among children and adolescents (Gabbard, 2011; Mitchell et al., 2013).

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A general misunderstanding about FMS is that children acquire those skills naturally as a result of growth and maturation (Gallahue, Ozmun, & Goodway, 2012; Goodway & Robinson, 2006; Haywood & Getchell, 2009; Logan, Robinson, Wilson, & Lucas, 2012). However, children need developmentally appropriate practice opportunities and specific skill-related feedback in order to develop FMS (Gabbard, 2011; Logan et al., 2012; Payne & Isaacs, 2011; Robinson & Goodway, 2009). In other words, systematic motor skill instruction should be provided for children to learn and practice FMS during the early elementary school years. Children who do not receive adequate motor skill instructions and practice may demonstrate developmental delays in their gross motor ability (Robinson, 2011; Robinson & Goodway, 2009). As such, early childhood physical activity guidelines, such as the National Association for Sport and Physical Education's Active Start, indicate that the development of movement skills should be a key component of childhood education programs (National Association for Sport and Physical Education, 2009).

Many theories of motor development have emerged over the years, but few have considered the interaction of contextual and learner variables as the dynamical systems theory (DST). A DST perspective emphasizes the importance of all systems in contributing to a particular behavior or pattern of behaviors rather than the reliance on a single subsystem (Thelen & Ulrich, 1991). Each subsystem has its own path and rate of development, and subsystems are free to assemble, producing many possibilities of movement and many degrees of freedom. Subsystems may include factors such as the difficulty of the task, the playground environment and the child's skill level. Among the factors that play an important role in increasing training opportunities for motor skills and movement concepts are physical activities and games. The important role of physical activities and games on physical, motor, cognitive and emotional development indicates that games that incorporate physical activity can be considered as an effective component of training programs (Fahimi et al., 2013). However, it is difficult for many young children -with their busy and erratic urban lifestyles-to engage in such training programs frequently given that such activities take place at a strict designated time and place. Furthermore, considering the difficulties of FMS development in school settings, such as the limited time devoted to physical education and the large numbers of students classes, new training strategies are needed to maintain young children motivated.

One potential new training strategy to improve FMS may be through physically interactive video games (i.e. exergames). Exergames utilize innovative technologies that provide an interactive environment requiring gestures and body movements in order to simulate on-screen game play. The advent of the Nintendo Wii video game console in 2006 was a landmark for the incorporation of physical activity in video game play (Murphy, 2009). A player could interact with the various Wii exergames using a wireless controller (Wii Remote) which detected the player's movement in three dimensions through accelerometer and optical sensor technology (Wii Remote, n.d.). Microsoft launched the Kinect sensor for the Xbox game console in 2010, inaugurating a new series of exergames with an even more natural interface, given that the player was not required to carry any controller. In fact, Kinect is a webcam-style motion sensing device that detects movement in three dimensions through a camera and depth sensor (Microsoft Kinect, n.d.). According to Papastergiou (2009), exergames are appealing to children and could be effective in helping them improve their motor skill acquisition and develop motivation for physical activity. Vernadakis, Derri, Tsitskari, and Antoniou (2014) reported that exergames such as Xbox Kinect Adventures may be motivating for children and may enhance skill-specific self-efficacy, which might aid skill acquisition. Furthermore, Barnett, Hinkley, Okely, Hesketh, and Salmon (2012) suggested that the active bodily involvement required by exergames increases children's learning and incorporation of play. In this sense, children playing such games experience reinforcement of positive feedback from emotional enjoyment and successful achievement, which may strengthen children's openness to new experiences (Barnett et al., 2012).

The paucity of research on the utilization of exergames in FMS development and, in particular, the lack of studies on the utilization of the newer generation exergames of Xbox Kinect (XbK) in FMS development (lack which is documented in subsections 2.2. and 2.3.) led the authors of this paper to design and implement a study that addressed the impact of XbK exergames on children's object control skills, as compared to traditional approaches for the development of such skills. The dynamic systems theory (which is described below) was applied as the theoretical framework by providing good practices that were incorporated in the prescription of the FMS training regimes followed in the study.

2. Review of literature

2.1. Dynamical systems theory

According to the DST theoretical framework, movement develops through a complex and multifaceted interaction among the individual, the task, and the environment (Newell, 1984; Thelen & Ulrich, 1991). Unique variables within each of these subsystems may combine to produce effective or ineffective movements leading to task success or failure (Newell, 1984). DST explains the basis of new behavior patterns and the role of interactions of many subsystems in the emergence of completely new behaviors from old behaviors (Thelen & Ulrich, 1991). Based on DST, a child is seen as a self-organizing system and the complex interactions of many subsystems shape this system (Gallahue et al., 2012). DST identifies many concepts in order to explain the motor development of children. Behavioral attractors, phase shift, control parameters, rate limiters and the constraints model are the main concepts of DST (Gallahue et al., 2012).

From a DST perspective, new skills may be a product of the interactions of cognitive instructions, perceptions, motivation, physical fitness, and practice, all within a particular context (Newell, 1984; Thelen & Ulrich, 1991). Within this complex system, one or more variables may be acting as a rate limiter. For example, if every variable within the subsystems acting upon the system is in place except for the practice variable, the desired behavior will not be evidenced until the system has received sufficient practice in the given context. Additionally, other individual differences among children may facilitate or inhibit the desired performance (Langendorfer & Roberton, 2002).

For physical educators, it is often difficult to identify, describe, control, and understand the most influential variables and interactions affecting movement behavior. Using a DST approach, a physical educator should consider the influence of learner constraints on motor performance and manipulate the task and the environmental factors in order to promote motor skill development. System self-organization in the production of movement responses within the DST perspective results from cooperation of many subsystems. DST emphasizes the importance of context and individual differences, explains the systems' contribution to children's development in many ways and provides an interesting framework for early intervention programs which are crucial in influencing children's life in positive ways. In this study, considering the essential of FMS supported by DST, the researchers were inspired to design a specific program for promoting FMS and encourage future physical activity participation by manipulating constrains in children environment.