



Muscle reaction function of individuals with intellectual disabilities may be improved through therapeutic use of a horse



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ABSTRACT

Reaction time and muscle activation deficits might limit the individual's autonomy in activities of daily living and in participating in recreational activities. The aim of the present study was to assess the effects of a 14-week hippotherapy exercise program on movement reaction time and muscle activation in adolescents with intellectual disability (ID). Nineteen adolescents with moderate ID were assigned either to an experimental group ($n = 10$) or a control group ($n = 9$). The experimental group attended a hippotherapy exercise program, consisting of two 30-min sessions per week for 14 weeks. Reaction time, time of maximum muscle activity and electromyographic activity (EMG) of rectus femoris and biceps femoris when standing up from a chair under three conditions: in response to audio, visual and audio with closed eyes stimuli were measured. Analysis of variance designs showed that hippotherapy intervention program resulted in significant improvements in reaction time and a reduction in time to maximum muscle activity of the intervention group comparing to the control group in all 3 three conditions that were examined ($p < 0.05$). The present findings suggest that the muscle reaction function of individuals with ID can be improved through hippotherapy training. Hippotherapy probably creates a changing environment with a variety of stimuli that enhance deep proprioception as well as other sensory inputs. In conclusion, this study provides evidence that hippotherapy can improve functional task performance by enhancing reaction time.

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1. Introduction

Individuals with intellectual disabilities (ID) are characterized by a lower ability to understand new or complex information and to learn and apply new cognitive, social and motor skills. Successful performance of motor skills is dependent on the individual's ability to establish and maintain stability throughout a sequence of controlled movements (Smail & Horvat, 2005). A common characteristic observed during voluntary movements among individuals with ID is that they need more time to initiate and respond to movements (Latash, 2000). Reaction time is an index of sensori-motor performance in sports (Nakamoto & Mori, 2008) and reflects the time between application of a stimulus (e.g., sound or flash of light) and response to the stimulus (Welford, 1980). The shorter the reaction time people have, the sooner they will be able to react to the actions around them. Thus, in the case of an unexpected sudden situation or danger they will protect themselves in a very short time.

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Previous studies have reported longer reaction times in individuals with ID (Horvat, Ramsey, Amestoy, & Croce, 2003; Zafeiridis et al., 2010). Nevertheless, the underlying mechanisms for these differences have not been extensively studied (Inui, Yamanishi, & Tada, 1995; LeClair & Elliott, 1995; Un & Erbahçeci, 2001). Davis (1987) suggested that muscle activation and EMG variability could be the reason for the movement delays observed in this population. However, Horvat et al. (2003) did not confirm these findings as they observed similar patterns of consistency across trials in motor unit recruitment and muscle activation for individuals with and without ID. However, it has been suggested that visual and vestibular information are not used effectively by individuals with ID, since movements are often delayed or inefficient (Horvat, Croce, & Zagrodnik, 2010). Thus, it is essential to offer variable practice activities to provide sensory information which is used to control movements in space and to produce feedback for movement adaptations (Horvat et al., 2010). These adaptations could be achieved in various ways such as by changing the order in which the agonist muscles are recruited, by modifying the size of the muscle contraction, which is reflected in EMG amplitude, or by altering the degree of antagonist activation (van der Heide & Hadders-Algra, 2005).

Hippotherapy is a therapeutic method which is based on equine movement. It provides such stimulation that is very difficult to reproduce in any other traditional therapy setting and creates a valuable environment for learning new motor strategies that could be used by the child in daily functional activities (McGibbon, Benda, Duncan, & Silkwood-Sherer, 2009). The rationale for hippotherapy is that the horse's gait provides a precise, smooth, rhythmic, and repetitive pattern of movement to the rider that is similar to the mechanics of human gait (Bertoti, 1988; Uchiyama, Ohtani, & Ohta, 2011). This rhythmical movement, combined with the warmth of the horse's body provides deep proprioception as well as other sensory input (Bertoti, 1988). Adjusting to the horse's movements also involves alterations in muscle utilization and joint movements which, over time, may lead to increased muscle activity (McGibbon et al., 2009).

Therefore, the movement of the horse provides a variety of inputs to the rider, which may be used to facilitate improved muscle activation and movement responses. Better movement responses to auditory or visual stimuli may help individuals with ID to react quicker in the case of any unexpected sudden daily situation like a car horn or an obstacle on their walking way. Thus, the improved process of sensory information would result in appropriate movement responses and consequently to safer daily lives.

To our knowledge, no previous study has investigated the effects of a hippotherapy intervention program in muscle activation and movement responses in individuals with ID. Although many previous studies recommended hippotherapy as a treatment effort to address impairments and improve functional outcomes for individuals with disabilities (for a review see, Zadnikar & Kastrin, 2011), there is only one recent study provided evidence that hippotherapy can be an effective intervention for improving functional outcomes and can be recommended as an alternative mode of therapy for improving balance and strength in individuals with ID (Giagazoglou, Arabatzi, Dipla, Liga, & Kellis, 2012). This study, however, examined postural balance responses while reaction time adaptations were not addressed. Although individuals with ID show longer reaction time responses compared with individuals with typical development (Davis, 1987; Horvat et al., 2003), changes in these variables after hippotherapy intervention programs have not been previously investigated. A deficit in these variables might limit the person's autonomy in activities of daily living and in participating in recreational activities.

Children with ID react to the environmental stimulus more slowly and unpredictably than those with typical development while movement performance is often delayed or inefficient (Horvat et al., 2010). These impairments are possibly related to the confirmation of stimuli and the lateness in preparing the proper movement by individuals with ID (Horvat et al., 2003). Since the target movement is hard to perform, children with ID need longer reaction and performance time (Un & Erbahçeci, 2001). Therefore, it is essential to establish whether movement responses in persons with ID can be improved by proper training. Therefore, the aim of the present study was to assess the effects of a hippotherapy intervention program on movement and reaction time to visual and auditory stimuli and on muscle activation adaptations in adolescents with ID.

2. Method

2.1. Experimental design

A randomized group pre–post test design was applied. Participants with ID were assigned either to an experimental or a control group. The experimental group followed a 14-week hippotherapy intervention program. The participants were tested prior to the start and after the end of the 14-week period by performing a rising from a chair task in response to audio and visual stimuli. The dependent variables included movement reaction time and time to maximal EMG activation of the knee muscle.

2.2. Participants

Nineteen healthy male adolescents (age = 15.3 ± 2.1 years) with ID participated in the study. The sample included only males since the specific school from which the sample was chosen has only three female students who did not express their willingness to participate in the program. Participants were equally divided into groups based on five criteria: age, height, weight, school placement (residential school for children with disabilities) and moderate IQ level. The evaluation phase included information derived from the files of the official developmental team assigned by the Greek State regarding the IQ of each individual as it was

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