



Effects of self-controlled feedback on learning of a throwing task in children with spastic hemiplegic cerebral palsy



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ABSTRACT

The purpose of this study was to examine the effect of self-controlled feedback on learning a throwing task in children with spastic hemiplegic cerebral palsy (SHCP). In order to achieve the research objectives, using a semi-experimental method, 20 children with SHCP (7–12 years old) were selected from special schools in Tehran, Iran. After showing the participants how to do the throwing task, a pre-test with 10 trials was conducted to homogenize the participants. Then, they were randomly assigned to two groups (self-control group and yoked group) to be examined in acquisition, retention, and transfer phases. Children in self-control group requested feedback when necessary during the acquisition phase. In contrast, participants in yoked-group replicated the feedback schedules of their counterparts in self-control group without any choice. A multivariate analysis of variance (MANOVA) was performed to analyze the data. Based on the results, a significant difference was not found between the self-control and yoked-group in acquisition phase ($F = .538, p < .473$). However, there was a significant difference between the two groups in retention ($F = 11.72, p < .003$) and transfer ($F = 6.74, p < .018$) phases. Thus, based on the better results obtained in the self-control condition, this type of feedback can be used in physiotherapy programs related to children with CP to improve their motor skills and independence movements.

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1. Introduction:

For over a century, researchers and practitioners have been interested in determining ways to improve motor learning (Adams, 1987); relative frequency of augmented feedback is one of the challenges in this field. Research on augmented feedback showed that more feedback frequencies would cause destructive results (Young & Schmidt, 1992). The participants who received feedback after every trial displayed poorer performance in comparison with those who reduced their feedback frequencies regularly (Rice & Hernandez, 2006). The effects of knowledge of result (KR) on motor learning are known as *guidance hypothesis* (Salmoni, Schmidt, & Walter, 1984). Despite its strong effect, feedback frequency has three negative effects including information processing impairment, movement stability reduction, and feedback dependency (Salmoni et al., 1984). Some of the researchers, however, disagreed with the guidance hypothesis believing that higher feedback frequencies were required to learn complex skills due to a high need for control, attention, and memory processes (Wulf, Shea, & Matschiner, 1998). This hypothesis could not also explain the interaction between feedback frequency and type of attention-focus (Wulf, Mc Connel, Gartner, & Schwarz, 2002). On the other hand, many

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studies confirmed this hypothesis (Butki & Hoffman, 2003; Salmoni et al., 1984; Schmidt, Young, Swinnen, & Shapiro, 1989; Wulf & Schmidt, 1996) and introduced several techniques including summary feedback, average feedback, bandwidth feedback, and self-controlled feedback to prevent the negative effects of the feedback frequency mentioned above.

One of the experimental approaches used to provide feedback was *self-controlled feedback* which was used in settings where participants requested it themselves. In this specific type of feedback, participants were allowed to determine exercise features actively (Chiviawosky and Wulf, 2005; Chiviawosky, Wulf, Laroque de Medeiros, Kaefer, & Wally, 2008). Studies related to the self-controlled feedback were conducted in settings in which self-control group was compared with another group called *Yoked-group*. Yoked control was widely used as a control technique that would allow controlling for the possible influence of the temporal relationship between an event and a response. Harnatz and Lapuc (1968) applied yoked-control technique to ensure that the control participants would receive the same number, spacing, and reinforcement as the experimental participants. Since participants in the yoked condition replicated the feedback schedule of their counterparts in self-control condition without any choice in receiving feedback, self-control group could have more learning advantages compared to the other group (Wulf, 2007).

Considering the assumption of this researcher about the effectiveness of reduced feedback frequency, the question arisen here is 'which methods of providing feedback (self-control or yoked control) would be more effective in motor learning'. Recent studies by Chiviawosky and Wulf (2002, 2005, 2007) have been more concerned with self-controlled feedback than other types. Wulf and Toole (1999) suggested that self-controlled feedback would encourage participants to discover more strategies.

Although many studies have examined the effects of feedback on motor learning, these studies have mainly focused on adults, and typically developing (TD) individuals; however, few studies have examined the role of feedback in individuals with physical difficulties such as cerebral palsy (CP). CP is a congenital neurological disorder and the possibility of its occurrence is from conception to two years after birth. Spastic hemiplegic cerebral palsy (SHCP) is one of the most common forms of CP caused by unilateral damage to the motor cortex or pyramidal pathway. Unilateral muscles in the other side of the body (with respect to the damaged brain) are affected by spasms and cramps, and proprioceptions in the affected organs are impaired. As a result of these changes, movements in the affected side become slow, jerky, and alternative (14). The results of studies on the individuals with CP showed that they were able to learn motor skills. For example, Hemayattalab and Rashidi Rostami (2010) studied the learning of a new motor skill in individuals with CP and concluded that they could learn the skill of throwing dart (12). Effects of task context and lack of prediction planning was examined by Mutsaerts, Steenbergen, and Bekkering (2006) in individuals with hemiplegic cerebral palsy (HCP). The results showed that lack of prediction planning in the participants with CP had been caused by the impairment in motor imagery; as an alternative strategy, they used information directly available in the task context. Based on this finding, individuals with CP had deficiency in motion planning of the central nervous system (CNS) as well as dysfunction in the muscular system (Mutsaerts et al., 2006). Therefore, learning a new motor skill might be challenging to them.

Studies on the self-controlled feedback in children have yielded contradictory results. For example, Chiviawosky and Wulf (2008) carried out two studies on children. In the first study, the results related to the older people were generalized to the children; in the second, the effectiveness of self-controlled feedback with more frequencies was shown.

Furthermore, few studies have examined the effects of feedback in individuals with CP. Interesting results, though, have been obtained. For example, Hemayattalab and Rashidi Rostami (2010) concluded that principles related to the feedback frequency in individuals with CP were similar to TD people; higher feedback frequencies had more feedback dependency. In another study by Harbourne (2001), the effects of KR on the upper limbs ability were examined in two groups including 10 healthy adults and 10 adults with CP to detect target speed and identify the possible error. The effects of KR on individuals with CP were found to be the same for TD people in this study. However, there was not enough evidence and further research is required.

Based on the literature, no study has yet compared self-control and yoked feedbacks in individuals with CP. Accordingly, in the present study there was an attempt to address this issue. For this purpose, two methods of providing feedback were considered in which the participants in self-control group could request feedback when they wanted to, while participants in yoked-group replicated the feedback schedules of their counterparts in self-control group without any choice. Thus, it was expected that by comparing two feedback conditions in children with SHCP, the researchers would be able to answer this question: which method of providing feedback (self-controlled feedback and yoked feedback) would be more effective?

2. Materials and methods

2.1. Participants

The study population consisted of 20 children with cerebral palsy (CP) who were recruited from a special school for the disabled children in Tehran, Iran. The inclusion criteria were being male and diagnosed with spastic hemiplegic cerebral palsy (SHCP), without intellectual disabilities and aged between 7 and 12 ($M = 11.6$ years, $SD = 1.5$). Hand dominance was determined by asking participants which hand they used for writing; participants were asked to use their non-dominant arm to throw the bean bags toward the target. Participants with right-hand dominance were 12 (60%), and those with left-hand 8 (40%). The exclusion criteria were sufferance from neurodegenerative diseases, psychiatric illness, traumatic head injury, epilepsy, hearing and visual impairment, and moderate to profound mental retardation that would interfere with their

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