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Assisting obese students with intellectual disabilities to actively perform the activity of walking in place using a dance pad to control their preferred environmental stimulation

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ABSTRACT

This study used a standard dance pad with a newly developed foot-pressing position detection program (FPPDP) software program. FPPDP is a new software program which was used to turn a standard dance pad into a foot-pressing position detector to evaluate whether two people with intellectual disabilities would be able to actively perform the activity of walking in place in order to control their preferred environmental stimulation. This study was performed according to a multiple baseline design across participants. The data showed that both participants were more willing to perform the activity of walking activity to activate the environmental stimulation during the intervention phases than in the baseline phase, and retained this effective performance in the maintenance phase. The practical and developmental implications of the findings are discussed.

1. Introduction

Obesity and overweight are common problems with serious implications for people with intellectual disabilities (Emerson, 2005; Marshall, McConkey, & Moore, 2003). Some studies have shown that the incidence of obesity in children with intellectual disabilities is higher than in average children (Rimmer & Yamaki, 2006). The major impact of obesity is that it is linked to many different diseases, such as cardiovascular disease, can give rise to obesity metabolic syndrome and indirectly causes inconvenience in walking or action (Field et al., 2001). Being overweight is associated with pain in the knees and other joints, osteoarthritis and can even affect heart and lung functions (Krebs et al., 2007).

Engaging in physical activity is helpful to reduce an individual's weight and benefit overall health, for instance by reducing the occurrence of cardiovascular disease, improving heart and lung function, increasing body metabolism, preventing osteoporosis, and strengthening bones, muscles, joints, etc. (Poirier et al., 2006).

However, most people with intellectual disabilities lack the awareness and cognitive ability to understand the health issues surrounding obesity and overweight. In addition, they may have limb abnormalities due to congenital conditions, or in terms of their physical and motor development, may have problems such as poor hand-eye coordination or excess muscle tension, all of which can limit their physical activities (De, Small, & Baur, 2008). Compounding this, the majority lack the motivation and willingness to do exercise on their own, and need someone to accompany them or push them to do it.

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Hence, encouraging physical activities for people with intellectual disabilities is an important topic, and discovering *how* to make them actively perform physical activities is the main purpose of this study.

Recently, a few studies have proved that using the response-stimulation strategy to help people with disabilities control their preferred environmental stimulation through simple behaviors can be a highly successful strategy for behavior modification (i.e. to curb unwanted behaviors or habits, or reward desirable behaviors) (Chang & Shih, 2014; Shih, 2011c, 2014; Shih & Chang, 2012a; Shih, Chen, & Shih, 2012b; Shih, Chung, Shih, & Chen, 2011a; Shih & Shih, 2010; Shih, Wang, & Wang, 2014; Shih, Yeh, Shih, & Chang, 2011c). These assigned simple behaviors (i.e., target responses) were designed according to the subjects' conditions and for the purpose of behavior modification; that is to encourage subjects to engage in and maintain their desirable behaviors (such as physical activities, occupational activities, etc.) or to restrain and decrease unwanted behaviors or habits (such as hyperactive behaviors, abnormal head posture, abnormal standing posture, etc.). By using the simple behaviors to control preferred environmental stimulation, people with disabilities can learn to increase positive behaviors and control their inappropriate behaviors, and, furthermore, to improve their interaction with other people and enhance their self-confidence (Gutowski, 1996; Shih, 2011a, 2013b; Shih, Shih, & Shih, 2011b). For example, in terms of curbing unwanted hyperactive behaviors, subjects who controlled their hyperactive behaviors would obtain the preferred environmental stimulation, such as playing their favorite videos/music. The preferred stimulation would be terminated once/if the targeted hyperactive behavior was detected. Another example involved rewarding desirable behavior, whereby subjects who performed the arranged simple occupational activities would obtain the preferred environmental stimulation, which lasted for a while but then stopped. Subjects needed to perform the target activities again in order to re-activate the preferred environmental stimulation.

To apply this response-stimulation strategy, it is mandatory to (a) identify and specify the target responses, such as curbing unwanted behaviors or rewarding desirable behaviors; (b) adopt or develop suitable detectors or sensors to detect those behaviors (Shih & Chang, 2012a; Shih & Chang, 2012b; Shih, Chang, & Mohua, 2012a; Shih et al., 2014); and (c) develop matched assistive programs to connect the target responses with environmental stimulation, i.e., using the target responses to control/produce environmental stimulation (Shih, 2011a, 2011c; Shih et al., 2011a, 2011c, 2012b; Shih, Shih, & Luo, 2013).

Some recent studies demonstrate the possibility of applying commercial high-tech products which are embedded with special sensors to be the precise detectors of the aforementioned target responses (Shih, 2011a, 2011b, 2012, 2013a, 2013b; Shih et al., 2011a; Shih & Shih, 2010; Shih et al., 2014). This approach involves using software technology to reset the default functions of commercial high-technology products in order to turn these commercial products into high performance/precise detectors that are able to detect individuals' target responses. The common feature of these studies is that the adopted high-tech devices were all standard devices which were accessible, cheap and possessed powerful functions. By adopting software technology, standard commercial products were transformed into high performance assistive technology (AT) devices, with impressive results. For example, a mouse has been turned into a precise hand motion detector (Shih & Shih, 2009). A trackball was modified into a precise thumb/finger poke detector (Shih & Shih, 2010). A Nintendo Wii Remote Controller has been used as a precise limb action detector (Shih, Chang, & Shih, 2010a; Shih et al., 2011c), head position/angle detector (Shih et al., 2011c), and 3D object orientation detector (Shih et al., 2012a). A Wii Balance Board has been applied as a high performance change of standing posture detector (Shih, Chang, & Shih, 2010) and standing location detector (Shih, 2011c; Shih et al., 2011a, 2012b). A gyration air mouse was used as a precise limb action detector (Shih, 2011a; Shih, Chang, & Shih, 2010b; Shih et al., 2013).

The dance pad is a commercial device developed for application in dance games (Wikipedia, 2014), as shown in Fig. 1. Most dance pads are divided into nine square blocks, with 8 direction/action panels in the main stepping area, 2 function panels – "select" and "start", and each panel having its own switch sensor. When the user steps on a block, the switch sensor transmits the signal to the control system for playing dance games.

Very few studies have been conducted into the application of dance pads, and in the research that does exist, the dance pad was only applied without modification as a musical action game in exercise training.

Each sensor panel of a dance pad can detect foot-pressing when a subject steps on it and transmits a signal to the control system. With the application of software technology, the original function of the dance pad can be extended to allow it to be used as an AT device in the form of a foot-pressing detector that can be applied in the fields of education and rehabilitation, instead of just for the purpose of dance games.

This study adopted software technology to use a standard dance pad combined with preferred environmental stimuli to investigate whether children with intellectual disabilities who were obese could be encouraged to perform the activity of walking in place.

In this study, the panels "X" and "Up" were the two assigned positions used for the purpose of measuring walking activity. As shown in Fig. 2(a) the subject stepped on the dance pad with his/her left foot on "X" and right foot on "Up", meaning that the switch sensors of the panels "X" and "Up" would be turned on (denoted as "X_{on}" and "Up_{on}") at the same time. When the subject started to walk in place, by stepping on the "X" and "Up" panels in sequence, as shown in Fig. 2(b) and (c), the switch sensors of the panels "X" and "Up" would be turned on in sequence ("X_{on}" → "Up_{on}" → "X_{on}" → "Up_{on}"→. . .). This signal could be used to determine whether the subject was in standing ("X_{on}" and "Up_{on}" at the same time) or walking ("X_{on}" → "Up_{on}" → "X_{on}" → "Up_{on}"→. . .).

Whenever walking activity was detected, the control system would trigger the video playback (environmental stimulation). Conversely, if the subject stopped walking, the control system would terminate the video, and playback of the interrupted video would commence again only when the control system detected new walking activity.