Research in Developmental Disabilities 35 (2014) 3292–3298

Contents lists available at ScienceDirect

Research in Developmental Disabilities

Encouraging obese students with intellectual disabilities to engage in pedaling an exercise bike by using an air mouse combined with preferred environmental stimulation

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ARTICLE INFO

Article history:
Received 18 June 2014
Received in revised form 6 August 2014
Accepted 12 August 2014
Available online 31 August 2014

Keywords:
Air mouse
PDP
Intellectual disabilities
Pedaling activity
Exercise bike

ABSTRACT

This study extended research into the application of high-tech products in the field of special education, using a standard air mouse with a newly developed pedal detection program (PDP) software. PDP is a new software program used to turn a standard air mouse into a pedal detector in order to evaluate whether two obese students with intellectual disabilities (ID) would be able to actively perform the activity of pedaling an exercise bike in order to control their preferred environmental stimulation. This study was performed according to an ABAB design. The data showed that both participants had more willingness to engage in the pedaling activity to activate the environmental stimulation in the intervention phases than in the baseline phase. The practical and developmental implications of the findings are discussed.

1. Introduction

Obesity is a common problem for people with intellectual disabilities (Alberta, 2014). Some studies have demonstrated that the ratio of obesity in children with ID is higher than in average children (Rimmer & Yamaki, 2006). Obesity is harmful to health, not only in causing general physical decline, but also due to the fact that it can easily lead to hypertension, heart disease, diabetes and other chronic diseases (Cohen, Perales, & Steadman, 2005).

In terms of health, engaging in physical activity is beneficial for controlling weight, reducing the chance of heart disease, reducing the risk of diabetes and some chronic diseases, improving the function of heart, lungs and circulation, and improving bone density, joint flexibility, muscular strength, and balance (Pate et al., 1995).

In addition to cognitive disorders, most people with ID lag behind those without such disabilities in terms of the development of athletic ability, owing to factors such as poor hand–eye coordination, difficulty in muscle tension control, and lack of joint flexibility and balance (Simeonsson, Lollar, Hollowell, & Adams, 2000). Moreover, the level of motivation or willingness for people with ID to engage in physical activity on their own tends to be low, and they usually require others to accompany or push them to do it (Hutzler & Korsensky, 2010).

As mentioned above, regular engagement in physical activity is an important issue for people with ID. Hence, it is essential to effectively encourage and assist them to perform physical activity.

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http://dx.doi.org/10.1016/j.ridd.2014.08.020
0891-4222/

Response-stimulation is a successful strategy of behavior modification which combines the assigned simple behavior and the control of the preferred stimulation (Lancioni, Singh, O'Reilly, & Sigafoos, 2009; Lancioni, Singh, O'Reilly, Sigafoos, et al., 2009; Shih, 2012). Behavior modification can be used to restrain inappropriate behaviors or reward expected behaviors. The assigned simple behavior is designed according to the participant's conditions and the experimental setting, for the purpose of behavior modification (Lancioni et al., 2011; Shih, 2013; Shih, Wang, & Wang, 2014).

For example, for the purpose of restraining an abnormal head posture (i.e., an inappropriate behavior/habit), the participant's head posture can be assigned as a target response (Shih, Shih, & Shih, 2011). If the participant maintains normal (upright) head posture, he/she will obtain the preferred stimulation, for example, the playing of his/her favorite video/music. On the other hand, the preferred stimulation will be interrupted whenever an abnormal head posture is detected. Another example is to reward the performance of an occupational activity (i.e., expected behavior). In this case, the occupational activity is arranged as a target response. If the subject performs the correct target response, he/she will obtain the preferred stimulation, i.e., the playing of his/her favorite video/music for a while, which then will be stopped. The subject is then required to perform the arranged occupational activity again, in order to re-activate the preferred stimulation (Shih, 2013; Shih & Chang, 2012a, 2012b).

With the use of assigned simple behaviors to control the preferred stimulation, disabled people can learn to restrain and decrease inappropriate behaviors (e.g., hyperactive behaviors, abnormal head or standing postures). On the other hand, people with disabilities can also learn to increase and maintain positive behaviors (e.g., correct postures, physical activities, occupational activities). Moreover, behavior modification can enhance individuals' self-confidence, increase their interaction with others, and meet the goal of improving individuals' daily life (Gutowski, 1996; Lancioni, Singh, O'Reilly, Sigafoos, et al., 2009; Shih, 2013; Shih, Chiang, Wang, & Chen, 2014).

Using this response-stimulation strategy, it is necessary to adopt suitable motion sensors to detect the arranged target responses (Chang & Shih, 2014; Shih & Chiu, 2014), and to develop apposite software programs to connect the arranged target responses with the preferred environmental stimulation (Shih, Wang, Chang, & Shih, 2012; Shih, Wang, et al., 2014).

Recent studies have proposed using high-tech products to detect the aforementioned target responses (Chang & Shih, 2014; Shih & Chiu, 2014; Shih, Shih, & Luo, 2013). Software technology is used in this approach to modify the default functions of the high-tech products, in order to turn them into precise motion detectors that are able to detect individuals' target behaviors. The high-tech products used in these studies are all standard products without hardware modification, and are easily accessible, inexpensive, and contain powerful functions, such as motion-sensors. For instance, a mouse was used as a thumb/finger poke detector (Shih, Shih, Lin, & Chiang, 2009); a gyration air mouse was converted for use as a precise limb action detector (Logitech, 2010; Shih, 2011; Shih, Chang, & Shih, 2010b); a Nintendo Wii Balance Board was used to detect a change in standing posture (Shih, Shih, & Chiang, 2010; Shih, Shih, & Chu, 2010) and a wireless object location detector (Shih & Chang, 2012b); a Nintendo Wii Remote Controller was applied as a limb action detector (Shih, Chang, & Shih, 2010a; Shih, Yeh, Shih, & Chang, 2011), head position/angle detector (Shih, Shih, et al., 2011), and 3D object orientation detector (Shih, Chang, & Mohua, 2012).

Similar to a general bike, an upright exercise bike is a common piece of indoor sports equipment, consisting of a stationary bicycle with a saddle, pedals and handlebars, but without true wheels (Wikipedia, 2013), as shown in Fig. 1. When pedaled, an exercise bike can reduce the weight load on the knees of obese people, with the activity able to be carried out in a fitness room at any time and under any weather conditions (Houtz & Fischer, 1959). In addition, pedaling an exercise bike is safe and easy to do, and this activity can improve the function of the heart, lungs and circulation, enhance muscular endurance, help control weight, etc. Hence, pedaling an exercise bike is a suitable physical activity for obese people with ID to engage in.

This study extended the research into the application of high-tech products in the field of special education. By adopting software technology and using a standard air mouse combined with the preferred environmental stimulation, the research aim is to investigate whether two obese students with ID can be encouraged to actively perform the activity of pedaling an exercise bike.

An air mouse (Gyration, 2010; Logitech, 2010), as shown in Fig. 2, is a remote point-and-click device that allows users to operate a computer, tablet, set-top box, Web TV, etc. It uses gyroscope technology (Wikipedia, 2010) to detect the operating motions, with the motion-sensing module able to accurately position the cursor on any pixel on the screen, through detecting a user's hand movements in the air to control the mouse cursor. With the application of software technology, the original function of the air mouse can be extended so that the air mouse can be used as a pedal detector that relies on its motion sensor. No additional hardware modifications are required.

In this study, an air mouse was fixed on one pedal of an upright exercise bike for the purpose of measuring pedaling activity. When a subject started to pedal, the air mouse would detect the continuous pedaling signal and transmit the signal to the control system. This signal could be used to determine whether the subject was engaging in the pedaling activity or not.

A minicomputer (ASUS, 2013) was used as the control system in this study. The control system would trigger the video playback (environmental stimulation) once the continuous pedaling activity was detected, whereas if the subject stopped pedaling, the video would be interrupted by the control system. The interrupted video would be started again only when the control system detected new pedaling activity. The subject's pedaling activity was thus linked to his/her preferred video stimulation. As long as the chosen video was attractive to the subject, it was expected that this could form a strong motivation for the subject to perform the pedaling activity.