



A computer-based interactive game to train persons with cognitive impairments to perform recycling tasks independently



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ABSTRACT

This study assessed the possibility of training three people with cognitive impairments using a computer-based interactive game. A game was designed to provide task prompts in recycling scenarios, identify incorrect task steps on the fly, and help users learn to make corrections. Based on a multiple baseline design, the data showed that the three participants considerably increased their target response, which improved their vocational job skills during the intervention phases and enabled them to maintain the acquired job skills after intervention. The practical and developmental implications of the results are discussed.

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1. Introduction

People with cognitive impairments often use sheltered workplace or supported employment programs to transition to labor markets (Bond, Drake, & Becker, 2008; Bond, Drake, Mueser, & Becker, 1997; Crowther, Marshall, Bond, & Huxley, 2001). An important common future of sheltered workplace or supported employment programs is that they are both community-based rehabilitation (CBR) (Bond et al., 1997; Bond & Liberman, 1992; Goodwin, 1997). With sufficient and appropriate support on the job, people with developmental disabilities and cognitive impairments can often participate in the workplace to various degrees, which provides them with financial support and opportunities for social connections (Chang, Chen, & Chuang, 2011; Chang, Wang, & Chen, 2011; Chang, Wang, Chen, Lee, & Kang, 2012).

The proliferation of compact mobile computing devices, such as palm-sized personal digital assistants (PDAs), offers a novel option for personal prompting and cognitive aides (Carmien et al., 2005; Cihak, Kessler, & Alberto, 2007, 2008; Sohlberg, Fickas, Hung, & Fortier, 2007). PDAs have been used as cognitive aids for participants with cognitive impairments in laboratory settings (Liu et al., 2007), field trials (Carmien et al., 2005), and community-based experiments (Gentry, Wallace, Kvarfordt, & Lynch, 2008). Since its launch in 2007, iPhone and other smart phones have been considered as a new device for a replacement of PDAs to implement task prompting for people with a disability. Smart phones can facilitate video prompting on a friendly user interface to increase vocational independence (Bereznak, Ayres, Mechling, & Alexander, 2012;

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Burke, Andersen, Bowen, Howard, & Allen, 2010; Chang et al., 2011c; Chang, Chen, & Lu, 2011). Furthermore, iPads and other tablet computers have also been adopted in various vocational training studies (Alexander, Ayres, Smith, Shepley, & Mataras, 2013; Bouck, Savage, Meyer, Taber-Doughty, & Hunley, 2014).

Augmented reality (AR) is a technology for a live direct or indirect view of a physical real-world environment, the elements of which are augmented by computer-generated sensory input, such as sound or graphics. The technology functions by enhancing a person's current perception of reality. Chang, Kang, and Huang (2013) leveraged the capabilities of AR using a web camera to add information and meaning to a real object for task-prompting. Using AR, users are not required to match picture cues with reality, which is a prompting strategy used in various studies (Bunning, Kwiatkowska, & Weldin, 2012; Carmien et al., 2005; Cihak et al., 2008; Kagohara et al., 2013).

Games are fun and help motivate people to engage in learning vocational skills (Hamalainen, 2008; Pillay, 2002). We design interactive games for people with cognitive impairments to acquire job skills. Task training in community-based settings is a mainstream trend in vocational rehabilitation (Bond et al., 1997, 2008). However, game-based training is still rarely used in community-based task training programs. It is widely recognized that job coaches play a critical role helping people with a disability to acquire skills in community-based supported employment programs. However, the workload of job coaches can be demanding (Chang, Liao, Wang, & Chang, 2010; Chang, Wang, Chen, & Liao, 2011); therefore, technology can help with task training under the supervision of job coaches. Games provide job coaches options to help orientate people into a new environment without having to place them in real workplaces. This allows for a better transition to workplaces. Therefore, we designed AR-based interactive games in vocational skill-training for people with cognitive impairments. The system uses a personal computer with an external web camera running in-house AR gaming software. Open-source AR toolkits were used to identify AR tags used in community-based rehabilitation environments. Using the system to recognize tags, artificial information on the environment was overlaid on the real world image. The information can be presented in text, sound, pictures, or a combination. This technology can free a job coach or trainer from the requirement of constantly being with users for pre-service vocational training.

Teaching vocational job skills is a crucial area of intervention for people with cognitive impairments to help them develop independent living and community involvement (Chang, Wang, Chen, & Liao, 2011; Chang, Chou, Wang, & Chen, 2013). This study may contribute evidence of effective intervention procedures to teach vocational job skills. Furthermore, the use of novel technologies for task training is a vital area of research because it can help people with cognitive impairments to gain autonomy and control over their environment, which promotes self-determination. This study used a gaming system to provide a simple, time efficient, and effective intervention.

2. Method

2.1. Participants

People with cognitive impairments were nominated by the participating rehabilitation institutes and screened according to degrees of impairments, degrees of self-confidence, the ability to accomplish daily living tasks, and severity of short-term memory loss. The participants were recommended by job coaches who provided pre-service training under community-based supported employment in Taoyuan County, Taiwan. The selection of participants was based on two factors. First, all participants were motivated to become employed, regardless of unsuccessful trials in job interviews. Second, they completed a routine training program under the supervision of job coaches. Therefore, job coaches advised them to search for novel methods of acquiring job skills. Five candidates were included in the participant selection process. However, two candidates found employment and left the study before it started. Consequently, only three participants were enrolled in the study.

Alice, Bill, and Charlie were identified for inclusion in the study. Alice, aged 21 years, had limited oral communication abilities and lived in residential provision. She had difficulties in memorizing routine procedures in her workplace. A psychologist estimated her ID to fall between the severe and profound levels. However, no formal testing or IQ scores were available because test materials were inapplicable to her. In addition to ID, she also had a diagnosis of major depressive disorder. Bill, aged 20 years, was diagnosed with a moderate ID (IQ of 51, Kaufman Assessment Battery for Children: Kaufman & Kaufman, 1983). He was unable to work under the supported employment program in the local district. Charlie, aged 25 years, had mild epilepsy and moderate ID (Adaptive Behavior Composite Score 66, Vineland Adaptive Behavior Scales: Sparrow, Balla, & Cicchetti, 1984). He underwent excellent rehabilitation and has remained employed in a paid part-time job as a recycle worker. Charlie sought a more demanding job with higher pay, such as kitchen assistance, but has been unable to secure such employment. None of the participants had previous experience with computer-based training. The names of participants have been changed in this report to protect their privacy. Informed consent was provided at the levels of the service organization, individual staff members involved in the study, and the main caregivers on behalf of participants with cognitive impairments.

2.2. Setting

The gaming system was deployed in a sheltered workplace that spared non-business hours for recycling skill training of adults with cognitive impairments. The system consisted of an Intel Core i7 personal computer, a 23-in. LCD computer

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