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Using virtual reality environment to improve joint attention associated with pervasive developmental disorder

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ABSTRACT

The focus of this study is using data glove to practice Joint attention skill in virtual reality environment for people with pervasive developmental disorder (PDD). The virtual reality environment provides a safe environment for PDD people. Especially, when they made errors during practice in virtual reality environment, there is no suffering or dangerous consequences to deal with. Joint attention is a critical skill in the disorder characteristics of children with PDD. The absence of joint attention is a deficit frequently affects their social relationship in daily life. Therefore, this study designed the Joint Attention Skills Learning (JASL) systems with data glove tool to help children with PDD to practice joint attention behavior skills. The JASL specifically focus the skills of pointing, showing, sharing things and behavior interaction with other children with PDD. The system is designed in playroom-scene and presented in the first-person perspectives for users. The functions contain pointing and showing, moving virtual objects, 3D animation, text, speaking sounds, and feedback. The method was employed single subject multiple-probe design across subjects' designs, and analysis of visual inspection in this study. It took 3 months to finish the experimental section. Surprisingly, the experiment results reveal that the participants have further extension in improving the joint attention skills in their daily life after using the JASL system. The significant potential in this particular treatment of joint attention for each participant will be discussed in details in this paper.

1. Introduction

Joint attention is a core skill and an important social skill that can promote the learning in social contexts (Warreyn, Roeyers, Van-Wetswinkel, & De Groote, 2007). Individuals with pervasive development disorder (PDD) are known to suffer from deficient joint attention skills. Lack of joint attention skills leaves PDD unable to interact socially with others (Presmanes, Walden, Stone, & Yoder, 2007). Kasari, Freeman, and Paparella (2006) also mentioned that individuals with PDD have limited joint attention skills negatively impacting their ability to interact with others. However, joint attention skills describe the coordination of attention in relation to objects and events (Mundy, 2003), and mean that describe the situation where two or more people simultaneously focus on or share an interesting thing or experience in social situations (Adamson & McArthur, 1995; Baldwin, 1995; Mundy, 2003). Additionally, joint attention skills also describe as a triadic relation among the self, others and objects (Leekam, Lopez, & Moore, 2000).

Joint attention is widely divided into two classes: responding and initiating joint attention skills (Charman et al., 1997, 1998; Mundy & Gomes, 1998), and mainly involves using eye contact, pointing, showing or verbal orders to attract attention to an object (Bruinsma, Koegel, & Koegel, 2004; Jones, Carr, & Feeley, 2006; Meindl & Cannella-Malone, 2011). Responding

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joint attention (RJA) skills refer to response by pointing or showing to enhance social interaction with others (Brooks & Meltzoff, 2005; Leekam, Hunnisett, & Moore, 1998; Sigman & Ruskin, 1999). Initiating joint attention (IJA) skills is defined as the use of eye contact, gaze shifting, and pointing to initiate coordinated attention with another individual (Franco & Butterworth, 1996; Mundy & Crowson, 1997; Seibert et al., 1982). More specifically, some studies indicated that children typically develop the ability to participate in joint attention at between 6- and 12-months of age (Butterworth & Jarrett, 1991; Leekam et al., 1998; Mundy & Gomes, 1998; Povinelli & Eddy, 1997). Initiating and responding joint attention skills are related to expressive and receptive language acquisition, and even associated with general cognition (Morales et al., 2000). Furthermore, initiating and responding joint attention skills reflect behavior and mental processes and promote human learning and development of social cognition, interaction and communication (Mundy & Newell, 2007). Additionally, the RJA and IJA are also characterized by affective development of symbolic play and imitative behavior for children with PDD, which are essential in social language development. Therefore, initiating and responding joint attention skills is closely correlated in the development of social skills for PDD.

However, the children with PDD always distract difficulty in understanding the intentions and inferring the mental states of others (Tomasello, Carpenter, Call, Behne, & Moll, 2005), and consequently preventing them from using RJA and IJA skills for social interaction, such as pointing and showing (Carpenter, Call, & Tomasello, 2002; Mundy, Sigman, Ungerer, & Sherman, 1986). Kasari et al. (2006) suggested that significant joint attention deficits exist for children with PDD, rendering them unable to establish joint attention skills to interact with others. Thus, such children were unable to participate in or respond to joint attention associated with others (Corkum & Moore, 1998; Presmanes et al., 2007). Furthermore, Whalen, Schreibman, and Ingersoll (2006) tried to develop a treatment for responding and initiating joint attention skills, and taught children with PDD appropriately implement responding and initiating joint attention skills their results indicating that children with PDD were exhibited a positive change in joint attention skills. MacDuff, Ledo, McClannahan and Krantz (2007) used the verbal bids including the script prompts, the no script prompts, and pointing to teach three children with PDD joint attention skills. Their study of indicated that three participants could use promote bids of joint attention skills to interact with others. But, some uncontrollable situations were happened (e.g. unstable emotions) for children with PDD.

Recently, some studies have found that children with PDD were attracted to computer-based tasks (Chen & Bernard-Optiz, 1993), and that computer technology provides an opportunity to practice skills with repetitive function. The virtual reality environment also has navigation features based on user of perspective view, and can enable children with PDD to experience situations similar to real life (Parsons et al., 2000). Further, the virtual reality environment provided an virtual character (avatar) to represent user participation in social activities (Cheng & Ye, 2010), and social cognitions and skills learning (Cheng, Moore, McGrath, & Fan, 2005; Parsons & Mitchell, 2002).

Studies have shown that individuals with PDD can use virtual reality to learn simple social interaction skills, and computers can provide them with more opportunities for involvement in learning activities (Parsons, Mitchell, & Leonard, 2004). Mengue-Topio, Courbois, Farran and Sockeel (2010) built a virtual route map environment and requested that people with PDD identify the shortest path from a specific station to a store for subjects with PDD and furthermore compared with 18 members of a control group. The results indicated that participants with PDD memorize the landmarks and then find the shortest path through learning the virtual map environment. Cheng, Chiang, Ye and Cheng (2010) proposed using the collaborative virtual learning environment intervention-system to improve social empathy for three children with PDD, and showed that three participants improved their empathic skills and understanding of social empathy. Furthermore, Cheng and Chen (2010) investigated using the 3D virtual character expression system to help three children with PDD understand the expression of others, and the results demonstrated that three participants exhibited significantly improved understanding of social emotions. Therefore, the virtual reality environment provided an interesting and stimulated motivation for learning social skills (Brown, Neale, Cobb, & Reynolds, 1999), and provided users potential benefits by allowing them to simulate their real life human social interaction (Churchill, Snowdon, & Munro, 2001; Parsons, Mitchell, & Leonard, 2005; Passerino & Santarosa, 2008).

Additionally, data gloves motivate children with PDD to interact in virtual environment. Bruno and Muzzupappa (2010) designed 3D virtual microwave applied data glove to assess effects of virtual microwave for PDD with children, their study demonstrated that the usefulness of the virtual reality was helpful for children with PDD. Pabon et al. (2007) proposed designing a virtual kitchen scene using data gloves and vibration tactile stimulus to help with social interaction and physical rehabilitation, and the results demonstrated that the data glove stimulates capture of hand motion in rehabilitation and also help their social skills. Thus, the results indicated that using computer technology in education for children with PDD is a trend, and such children have the potential ability to learn social skills through individualized learning (Bell & Potter, 2001).

Therefore, this study developed the Joint Attention Skills Learning system (JASL system) and applied data glove to practice joint attention skills, and learned the fundamental concepts of the joint attention skills of pointing, showing, sharing, and interaction for children with PDD.

2. The development of JASL system

2.1. JASL system

This study creates a simulated environment to promote joint attention skills for children with PDD, and the JASL system was developed using 3Ds Max and Virtools. Virtools Scripting Language (VSL) was selected as the programming language (VSL) owing to its functions.