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Assisting people with multiple disabilities and minimal motor behavior to improve computer pointing efficiency through a mouse wheel

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ABSTRACT

This study evaluated whether two people with multiple disabilities and minimal motor behavior would be able to improve their pointing performance using finger poke ability with a mouse wheel through a Dynamic Pointing Assistive Program (DPAP) and a newly developed mouse driver (i.e., a new mouse driver replaces standard mouse driver, changes a mouse wheel into a thumb/finger poke detector, and intercepts mouse action). Initially, both participants had their baseline sessions. Then intervention started with the first participant. When his performance was consolidated, new baseline and intervention occurred with the second participant. Finally, both participants were exposed to maintenance phase, in which their pointing performance improved significantly. Both participants improved their pointing efficiency with the use of DPAP and remained highly successful through maintenance phase. Implications of the findings are discussed.

Nowadays, computer technologies play a very important role. As an integral component in our daily life, they have been widely used in education, academic study, daily life, communication training, entertainment and pre-job training (Schellens & Valcke, 2005). For persons with disabilities, this is a great opportunity to broaden their lives, to increase their independence and capacity to engage fully in daily activities and academic or vocational options, with the assistance of computer

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technologies (Bache & Derwent, 2008; Bernard-Opitz, Sriram, & Nakhoda-Sapuan, 2001; Hoppestad, 2006). The benefits would be clear if persons with disabilities are given the opportunity to improve their level of competency in using computer interfaces (Davies, Stock, & Wehmeyer, 2002a,b; Ritchie & Blanck, 2003).

Pointing devices, such as mice, are replacing traditional keyboards for many computer input tasks because of the extensive use of windows and graphical user interfaces (GUI) in computer operation systems (OS). The mouse, as an important input device, could be used to indicate position on a display screen, and is easy for most individuals to operate. Even young children can use a mouse (Donker & Reitsma, 2007a; Donker & Reitsma, 2007b). Some studies have indicated that children with developmental disabilities can learn pointing (Durfee & Billingsley, 1999; Shimizu & McDonough, 2006).

However, people with severe disabilities generally encounter mouse operation problems (Brodwin, Star, & Cardoso, 2004; Rao, Seliktar, & Rahman, 2000). Targeted at the mainstream population, most commercial computer input devices are targeted at the mainstream population and have been designed without taking into account that the technology might be used by people with disabilities (Abascal & Nicolle, 2005). For disabled persons, it is difficult or impossible for the disabled to operate computers that rely on a mouse, or similar pointing devices (Brodwin et al., 2004).

Based on this, various specialized computer pointing devices have been proposed to comply with the needs of people with multiple physical disabilities (Brodwin et al., 2004). For example, devices designed for people with severe hand disabilities include infrared- or ultrasonic-based head-controlled interfaces (Chen et al., 1999; Evans, Drew, & Blenkhorn, 2000), optically controlled interfaces (Lin et al., 2007; Park & Lee, 1996), and several other interfaces such as footmice and camera mice (Betke, Gips, & Fleming, 2002; Chen, Chen, Kuo, & Lai, 2003; Springer & Siebes, 1996; Tu, Tao, & Huang, 2007). However, all these available computer pointing devices are normally very costly, and are often more difficult to obtain or maintain than ordinary commercial devices, limiting their long-term use by people with disabilities.

Software support was also proposed to meet the needs of the disabled by few researches besides these specialized hardware support technologies. Shih and Shih (2009c) adopted software technology to redesign the mouse driver, in order to enable physically disabled people to export the remaining ability of each limb to complete the mouse operation. For example, the right hand could control a mouse left-to-right movement, while the left hand controls the up-to-down movement, and the mouse button is pressed by the left toe (Shih & Shih, 2009a). Through the above-mentioned multi-mice configuration, the complete mouse operations can be distributed among limbs with remaining ability. The function of each mouse is adjusted individually by Shih's mouse drive to achieve the above requested functions. Therefore, in addition to the exclusive use of specialized alternative input, disabled people would also benefit from being trained to use very common, cheap and powerful commercial mice.

Pointing is the most commonly adopted basic mouse operation for most computer programs and CAI software, and is achieved by moving the mouse in order to move a cursor on the computer screen. When the cursor is pointed at a specific item such as an icon, picture, or text, the user presses and releases the mouse button to send functional commands to the computer (Akamatsu & MacKenzie, 2002; Bohan, Chaparro, & Scarlett, 1998; Shimizu & McDonough, 2006). Other mouse operations include double-clicking, dragging and scrolling, while pointing is easier than dragging for both children (Donker & Reitsma, 2007a,b; Joiner, Messer, Light, & Littleton, 1998) and adults (MacKenzie, 1992).

Users can gain from being provided useful functions in pointing (i.e., cursor-capturing, which helps the user to move the cursor to the target centre automatically) to position the target quickly, easily, and accurately. The advantages of the cursor-capturing function may be greater for older users, children, or users with motion-impairments who are either unfamiliar or have difficulty in positioning a mouse (Grossman & Balakrishnan, 2005; Park, Han, & Yang, 2006).

Many researchers have proposed methods to facilitate the quality of target positioning operation (Ahlstrom, 2005; Ahlstrom, Hitz, & Leitner, 2006; Akamatsu & MacKenzie, 2002; Cockburn & Brewster, 2005; Cockburn & Firth, 2003; Dennerlein & Yang, 2001; Grossman & Balakrishnan, 2005; Park et al., 2006), but new problems are also raised. The latest research adopted software technology to redesign