Development of rehabilitation training system for spatial recognition and upper limb movement

T. Iwasaki, K. Ishihara, S. Ishihara, K. Matsuura

Purpose The person who uses a wheelchair has limitations in the reachable and manipulative areas—these physical limitations outturn lack of visual cognition ability. Wang (2011) denoted impaired vision, attention deficits in the person who uses a wheelchair with mild cognitive impairments or dementia, and cognitive problems in adults with cerebral palsy or post-polio syndrome. Safety problems (i.e., lack of obstacle attention) on powered wheelchair manipulations are common in these people. People with trunk disorders often have very similar restrictions. Limited range of motion and movement was applied due to wearing orthotics during their developmental years. In addition to movement restrictions, they also have narrowed spatial perception. This research aims to measure the behavioral and cognitive restrictions of a challenged person who uses a wheelchair, then build a training system for spatial cognition and upper limb movement. **Method** Participant A is a 20-years old female university student. She has a "physical disability certificate," as restricted mobility and lower-limbs functional disability by schistorrhachis (spina bifida = separated spine) existing at birth. Indoor and outdoor, her mobility is mainly on a wheelchair. Crutches are used for an in-house and short walk. On the independence of daily living activities, toileting and bathing could be done by herself. Lower-limb difficulties are slowly increased over the years, mainly on clubfoot and swollen limbs. Muscle strength of upper limbs has enough since she uses a manually-propulsion wheelchair. Although of upper limb muscle strength, limb movement is slower in the above directions from her. Non-disabled participants are 2 male and 2 female students of the same age. All the participants are right-handed. Reaction times and hit rates in spatial locations were measured. Our original stimuli and reaction measuring device, "Iki Iki Pong" (Ishihara et al.2010) (Figure 1), was placed in 6 different places from a sitting subject. This time, simple reaction times for randomly flashed buttons were measured for 50 trials x 6 settings. **Discussion** Participant A showed delayed reaction time (+41%,45%) and decreased correct hit rate (-10%) at middle upper and left upper positions than non-disabled participants. Figure 2 shows the result. Thus, training in these directions would be suitable for participant A. **Expansion of the Training Game** A rehabilitation game system is developed with the Unity game engine and a projector. MIDI device was connected to the game program. In the latest developing version, keyboards to be hit are shown by projection mapping. The target flashes and the player hits the corresponding key. Then, reactive sounds and visual feedback are given (Figure 3). Reaction time and the error rate are recorded. **Results** Within 3 one-minute trials, reaction time was significantly improved in participant A's weak positions, upper left and right (Kruskal-Wallis test, p<0.001). After 3 days of exercise (each day has 3 trials), reaction times improved in her weak positions and showed no difference as good positions (Mann-Whitney U test, p=0.77) (Figure 4).

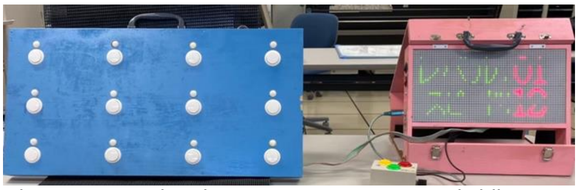


Figure 1. Reaction time measurement game (Ishihara,2010)

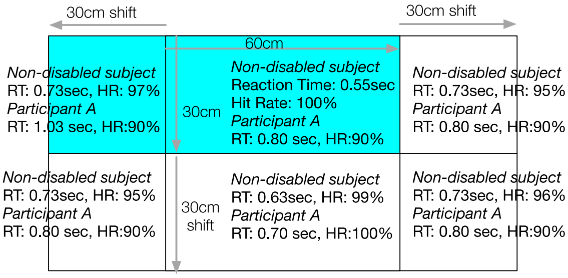
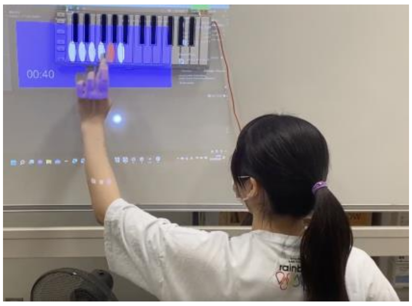


Figure 2. Reaction Time and Hit Rate



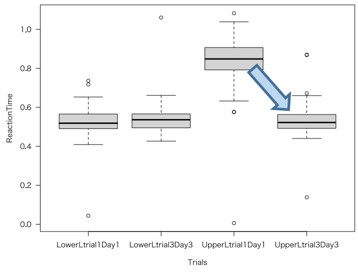


Figure 3. Developed system (projected MIDI device). Figure 4. Reaction Time: Lower left and upper left positions at day 1 and 3.

References

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Address: Faculty of Rehabilitation, Hiroshima International University
Email: i-shige@hirokoku-u.ac.jp