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Editorial Open Access

Virtual Reality in Neurorehabilitation

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Editorial

Virtual Reality or Virtual Realities (VR), which can be referred to as immersive multimedia or **computer-simulated** realities, replicates an environment that simulates physical presence in places in the real world or imagined worlds and lets the user interact in that world. Virtual realities artificially create sensory experiences, which can include sight, hearing, touch, and smell (concept cited from Wikipedia). Unlike other visual imaging technologies commonly related to “imagine”, Immersion and interactivity are the two major features of VR technology [1]. VR can be defined as a special human-computer interaction technique effectively combining sensory control technology and computer graphics technology. User can receive signals from the PC-created virtual environment with the help of various sensors. In the same time, user's performance can be accurately recorded by computer, and the virtual environment will be accordingly adjusted to realize the human-computer interaction [2]. Despite some disputation, more and more studies have showed the beneficial effect of rich environment on post-stroke recovery [3]. In VR technology, various rich environments can be simulated for patients with software. Also, a real and safe training environment will provide subjects task-specific training and accurate sensory feedback, in which key elements such as repetitive practice feedback and motivation maintaining should be included [4]. Rehabilitation physician should develop individualized rehabilitation program based on different dysfunctions to keep patients’ interest and active participation and such program can go far beyond traditional therapies [5]. In Schuster’s [6] research, stroke patients with over 6 months course receive VR training or conventional rehabilitation. In VR group, patients wearing special data glove with sensors could conduct a real-time interaction with various simulated rich environments presented on a screen to practice their hands. The motor function was evaluated at half month, one month and two months after recruit and the result indicated a significant progress of hand function in VR group than the control group. In Merians’ study [7], twelve subjects (over 6 months from attack) with wrist extension ⊠ 10°, finger extension ≥ 10° received 8-day training. VR training emphasized on upper arm movement as well as wrist and hand movement through four VR game-Plasma Pong, Hummingbird Hunt, Hammer Task and Virtual Piano-combined with the robotic technique. The kinematic measures demonstrated improvement of motion stability, smoothness of motion trail and motion velocity in joints such as shoulder, elbow, forearm, wrist and finger. In addition, the selective movement of the affected hand was also improved significantly. Considering the different impairments of upper extremities in stroke patients, Monica [8] used VR-based interactive rehabilitation training games connected with multimodal interface systems such as motion capture system, force-feedback robotics system and anti-gravity exoskeleton support training system, which provided patients task-specific rehabilitation training games in different patterns. The final results showed that the patients had significant improvement in gross motion of shoulder, elbow and wrist as well as fine motor skills of hand. Judith [9] applied VR technology in rehabilitation of hand motor function, the operating system of which comprises data gloves [10], Rutgers control gloves [11] and a computer simulating virtual environment. To improve the range of motion, velocity, and enhance muscle strength and facilitate the emergence of discrete movements, the training was conducted with the games such as capture butterflies, play the piano, power gloves, aircraft, and pilot boat. In this process, various signals produced by the software system based on the training results provided a feedback for patients. After training, the final experimental data showed that the VR system significantly improved the range of motion, flexibility and grip strength of hand in stroke patients. In addition, the patients’ interest and active participation was enhanced greatly in training games.

With VR rehabilitation technology patients can interact with the objects in virtual world simulated by computer to observe, imagine, imitate and learn a variety of movements, and the mechanism might be associated with the activation of mirror neuron system [12,13]. A mirror neuron is a neuron that fires both when an animal acts and when the animal observes the same action performed by another. Thus, the neuron "mirrors" the behavior of the other, as though the observer were itself acting [14]. All mirror neurons distributed in different brain regions constitute the mirror neuron system which unifies the perception and execution of actions through a "percept - execute matching mechanism" [15]. The mechanism is similar to that of virtual reality rehabilitation training. In most elaborate studies in literature, VR technology were used to improve gross motor functions of the upper extremity, but few researches were conducted for fine motor skills of hand. Though all these studies have confirmed the effectiveness of VR therapy with experimental data, its best indication is still unclear. The subjects were not described in detail in many studies, and the inclusion and exclusion criteria varied. In addition, the subjects recruited in the studies were stroke patient’s ≥ 6 months from onset, a “slack-water” stage for the functional recovery. VR technology provides new ideas in develop individualized rehabilitation program for stroke patients with fine motor dysfunction in upper extremities.

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