NeuroGym® for Hand Therapy

Hand therapy is a vital area of physical and occupational therapy following central and/or peripheral neurological damage. In fact, with the increased incidence of stroke survivors worldwide, there is growing pressure to provide effective, evidence-based rehabilitation. As a result, optimizing recovery of hand function has been the focus of considerable research in recent years.

Therapeutic practices in rehabilitation have begun to be significantly influenced by research in neuroplasticity, motor control and motor learning. For example, there are now robust findings indicating that functionally relevant adaptive changes can occur in the human brain during recovery from a stroke or other brain insult (1-4,5). Clinical therapists are, therefore, eager to consider new methods of training and therapeutic techniques based on the neurobiological principles of neuroplasticity. As a result, studies of such techniques as Constraint Induced Movement Therapy (6) or Virtual Reality training (7) continue to be investigated as alternatives to conventional physical therapy treatment. For example the potential of biofeedback practice in a virtual environment was studied for the rehabilitation of the hand (7; 8) and arm (9).

Another technique that is based on motor learning principles is the use of biofeedback interfaced with real-time computer games. The NeuroGym® Trainer is a multi-sensor device with physiotherapist-designed software. It uses information from sensors (eg. EMG, pressure, tilt, proximity etc.) in a number of therapist-set paradigms to drive motivational computer games such as intercepting a ball with a paddle (Pong) or steering a car down a track. This obviously creates an environment in which patients can sustain the motivation to practice for extended periods of time.

Recently, two new sensors for hand training have been added to the NeuroGym® Trainer to further increase the efficacy of rehabilitation. The first, a glove-like sensor, allows the clinician to program precise finger movements. The second is a pinch/pressure detector. Both enable the patient to play speed-sensitive computer games with the information provided by the sensors.

The hand training sensors add to the NeuroGym® Trainer's already large list of applications including facial training, balance and coordination, and incontinence training. The two hand-specific sensors, one detecting light pressure and one detecting finger joint movement, could be combined with EMG sensors to comprise a comprehensive and intensive hand training paradigm. The information from the finger movement, whether flexion-extension or press-release motion, feeds into the software of the NeuroGym® Trainer. This multi-sensor biofeedback device can then be set to intensively train advantageous motions while simultaneously discouraging movements that are not advantageous to the overall synergy. For example, a therapist may set up a video game where two game pieces are controlled by extension of digits two and four. Digit three may then be assigned a desired extension range while the thumb may be assigned a desired pressure range to maintain thumb extension. If either digit deviates from the desired range, the user would lose control over the game piece.

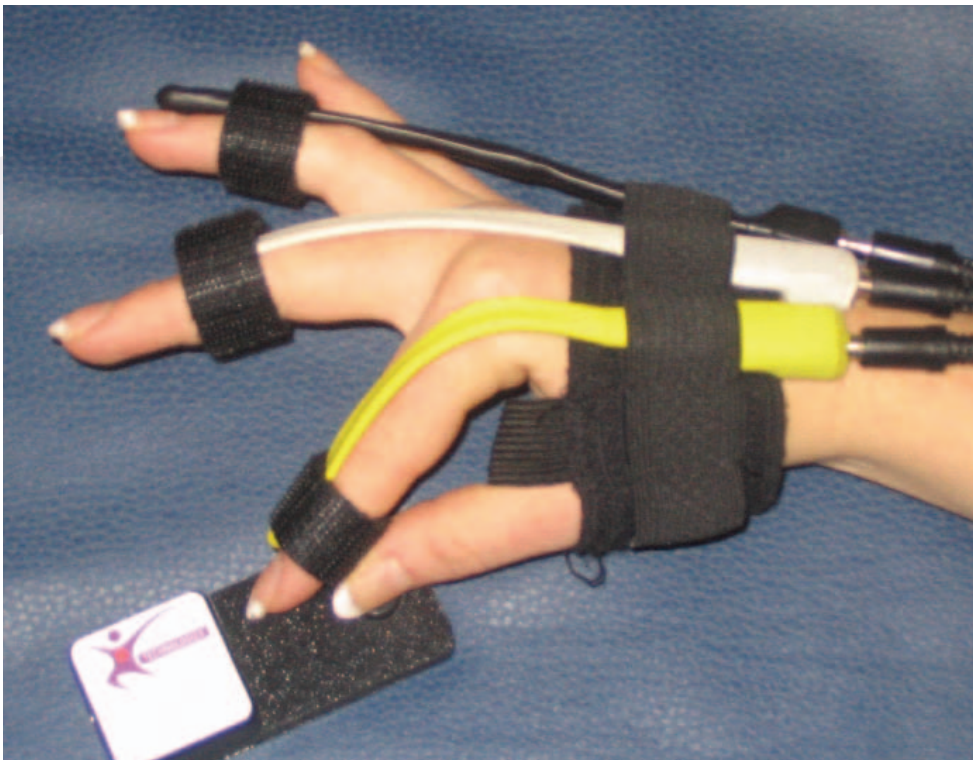

Figure 1. Three finger movement sensors and one fine pressure sensor.

An experienced hand therapist could easily design many different training paradigms, in each case allowing for intensive, speed-sensitive training of the desired finger/hand synergy. In line with recent evidence of brain plasticity, such training should optimize the re-learning of coordinated movement and improve the active range in the trained extremities.

A combination of sensors can also be used to create powerful multi-faceted upper extremity training. For example, patients with limited reaching and grasping ability could effectively train such movements by combining the information from a proximity sensor (reaching) with that of a joint goniometer set to encourage wrist extension. Pinch or finger joint sensors could then be added to create the desired combination of arm and hand training.

The goals of hand therapy may include improving finger dexterity, increasing hand grip strength, improving arm and hand steadiness or the ability to perform aimed reaching. Whether deficits in these abilities are the result of a brain insult or due to central or peripheral nerve or tendon damage, the NeuroGym® Trainer gives the therapist the necessary tools to provide intensive, motivational and varied practice.

Figure 2. The NeuroGym Trainer.

REFERENCES

1. Hlustic P, Mayer m. Paretic hand in stroke: from motor cortical plasticity research to rehabilitation. *Cogn Behav Neurol.* 2006 Mar; 19(1):34-40.

2. Nudo RJ Adaptive plasticity in motor cortex: implications for rehabilitation after brain injury. *J Rehabil Med* 2003. May; (41 Suppl): 7-10.

3. Nelles G. Cortical reorganization - effects of intensive therapy. *Restor Neurol Neurosci* 2004; 22(3-5): 239-44.

4. Liepert J, Bauder H, Wolfgang HR, Miltner WH, Taub E, Weiller C. Treatment-induced cortical reorganization after stroke in humans. *Stroke* 2000 Jun; 31(6): 1210-6.

5. Fregni F, Pascual-Leone A. Hand motor recovery after stroke: tuning the orchestra to improve hand motor function. *Cogn Behav Neurol.* 2006 Mar; 19(1): 21-33.

6. Mark VW, Taub E. Constraint-induced movement therapy for chronic stroke hemiparesis and other disabilities. *Restor Neurol Neurosci* 2004; 22:317-336.

7. Deutsch JE, Merians AS, Adamovich S et al.) Development and application of virtual reality technology to improve hand use and gait of individuals post-stroke. *Restor Neurol Neurosci* 2004; 22:371-386.)

8. Holden MK, Todorov E, Callahan J. Virtual environment training improves motor performance in two patients with stroke: case report. *Neurology Report* 1999; 23:57-67.

9. Adamovich SV, Merians AS, Boian R, et al. A virtual reality-based exercise system for hand rehabilitation post-stroke. *2nd International Workshop on Virtual Rehabilitation*; September 2003; Piscataway, NJ.

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