NEUROGYMTECH

Video Game Technology: From Recreational Activity to Clinical Tool

The popularity of video, computer and virtual reality games continues to grow, and systems like the Nintendo Wii are rapidly making the transition from home to therapeutic and institutional use. Such systems are now commonly seen in both neurorehabilitation and longterm care settings[1, 2]. In clinical settings, systems like the Nintendo Wii are, for the most part, used to augment recreational and therapeutic activity programs because they are motivational and they encourage participation and movement that might otherwise be difficult to solicit. For example, it was recently published in the Edmonton Journal that the Glenrose Rehabilitation Hospital in Alberta is now using the Wii technology to treat patients with movement and balance issues[3] . There, virtual boxing with Nintendo's popular Wii video game is helping a boxer who had sustained a brain-injury re-develop his right jab and footwork.

The use of the video game and virtual reality technology as an important rehabilitation aid is, in fact, increasingly supported by evidence[4, 5]. It has been clear for some time now that for training or re-training of motor control and coordination to be effective, it must be intensive, speed-sensitive and preferably a problem solving process (i.e. using patient-initiated, not passive movement). The 'gaming' environment generally satisfies these key ingredients for motor functional recovery; it is conducive to intense training that is speed-sensitive and it requires the patient's active involvement. Not surprisingly, techniques that utilize these principles, for example, intensive electromyography (EMG) or virtual reality, have been shown to improve patients balance and motor skills[6].

CLINICAL CONSIDERATIONS

While there is obvious motivational benefit for clients using video and virtual reality games during motor rehabilitation, what are the limitations from a clinical perspective? The Nintendo Wii game, for example, employs a sensor that allows the user to play virtual games of tennis, golf, or boxing by swinging the arm while holding a movement-sensor. This type of activity encourages the training individuals to engage in intensive, speed-sensitive, and variable training.While this has benefits from a general movement perspective, the therapist has no control over the actual movement that a patient makes, the musculature and joints involved (e.g. arm versus shoulder) or the numerous other parameters that might be important to control (e.g.weight shift, posture). This has been a major limiting factor in the effectiveness of this type of biofeedback activity in the clinical setting.

If the therapist were able to control actual movement parameters in a much more specific manner, video game technology would be more useful as a clinical tool. In essence, the clinician needs Wii-like motivational training but with total control over the type of movement elicited, including the interaction between the desirable and undesirable moving elements (e.g. agonist/antagonist activity). The patented NeuroGym® Trainer, a powerful,multi-faceted biofeedback rehabilitation device, was specifically designed to address these issues in order to more effectively help clients regain motor control and coordination. It uses input from various sensors to control the action of computer games, to provide real-time, speed-sensitive feedback. This allows highly intensive goal-oriented and motivational rehabilitation. Unlike traditional biofeedback devices, the NeuroGym® Trainer provides exceptional versatility through the use of a variety of input sensors that the therapist may choose to use individually or in combination. These include one or more channels of muscle activity (EMG), pressure, proximity, stretch, joint angle alarm goniometer, horizontal angle, and tilt. An incontinence vaginal probe is also available for urinary incontinence training.

Figure 1: A patient can play a computer game to practice ankle flexion and extension using the NeuroGym® Trainer biofeedback with position sensors.

The NeuroGym® Trainer was designed by a physiotherapist as a clinical tool. Unlike general gaming systems, it uses clinically relevant computer algorithms that therapists can choose from to design treatment paradigms ranging from simple one-channel options to multi-channel training set-ups using a combination of inputs from multiple sensors. Thus, therapists can select to target individual muscles for relaxation or activation, or use multiple sensors and algorithms to train more complex multijoint movements.

BENEFITS AND CLINICAL APPLICATIONS

The versatility of sensor inputs and program options means that therapists can set up ideal training situations for isolating specific muscles while simultaneously monitoring extraneous muscle activity. A rehabilitation session, for example, could focus on wrist extension, by having the patient play a computer game of Pong with the muscle activity generated by the wrist extensors. In order to help train the relaxation of the antagonist muscles, in this case the wrist flexors, the therapist can choose a game option that will activate the game paddle only when the extensors are activated without the flexors. Of course the therapist can control the level of difficulty of the game by adjusting the threshold of 'clean' muscle activity necessary to play the game. This way, even those with considerable co-contraction early in the rehabilitation process can participate and effectively learn to improve joint control in a much more motivational and intensive manner.

In neurorehabilitation, therapists often have patients who might traditionally have been unable to participate in virtual reality or video games because of severely limited muscle control and joint movement. The NeuroGym® Trainer's hardware and software has addressed these limitations by providing powerful sensors and program options that can magnify even minute amounts of muscle activity. This means that even if a patient has no overt movement at a joint, but the therapist is able to detect even minute muscle activity with the EMG sensor, a game of Pong or Maze can be played. With the increased practice that motivational computer games allow and the specificity of training that the therapist can set up, improved muscle targeting and control result. Game parameters can then be gradually adjusted to increase the difficulty of the task, challenging the patient to improve further.

The versatility of the NeuroGym® Trainer sensors gives therapists numerous treatment options. For example, the pressure sensors can be used for balance biofeedback in standing or in sitting. Tilt and position sensors can be useful for adjusting postural control. For more complex rehabilitation configurations, multiple sensors can be used to control computer game parameters.

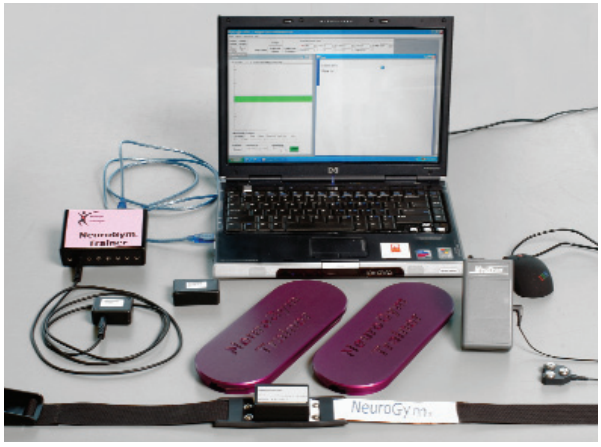

Figure 2: The NeuroGym® Trainer and sensors.

VIDEO GAME TECHNOLGY AS A CLINICAL TOOL

The NeuroGym® Trainer with it's powerful software and sensor technology provides therapists with a clinical tool that incorporates the motivational aspects of video and virtual reality games with the practical clinical needs of today's rehabilitation settings. Applicable to the treatment of the full range of motor deficits associated with neurological injuries or conditions, it can be used to:

- Increase active range of joint movement
  Increase weight-bearing ability and balance (static &
- dynamic)
- Decrease muscle tension
  Improve coordination between agonist/antagonist
- muscle pairs
- Improve coordination of functional synergies
  Discourage unwanted muscle activity in a particular
- movement
  Improve coordination of multi-joint movements

With the NeuroGym® Trainer, video game technology has ceased to be simply a recreational tool; it has become an effective means for therapists to help their patients develop improved motor control, balance, and stability.

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NEUROGYMTECH

Neurogym Technologies Inc.
100 - 1050 Morrison Drive
Ottawa, Ontario, Canada K2H 8K7

T 613-523-4148
TF 1-877-523-4148 (Canada & US)
F 613-523-4148
E sales@neurogymtech.com

www.neurogymtech.com