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Discomfort-Induced Approach in Physical Therapy and Rehabilitation

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Main goals of rehabilitation are to help patients to reach the fullest physical, physiological, social, vocational and avocational potential consistent with their level of impairment, desires and life plans [1]. Rehabilitation involves medical, social, educational, and vocational measures used to optimize neurologic recovery, teach compensatory strategies for residual deficits, and teach Activities of Daily Living (ADLs) and skills required for community living [2].

The majority of rehabilitation approaches that involve physical therapy are based on providing a patient with a positive re-enforcement of the patient's performance by the physical therapist who conducts the treatment or a by a computerized device used in rehabilitation. Thus, positive feedback is used in gait re-education of individuals with Parkinson Disease [3], in improving of pointing movements in individuals with stroke [4], in enhancement of postural control in individuals with traumatic brain injury and cerebrovascular accident [5]. Such positive re-enforcement helps a patient to focus on the quality of the produced movement, ambulation, or the body posture.

While the positive re-enforcement approach is extensively used in rehabilitation one can ask a question of whether rehabilitation based on using a positive feedback is the most efficient (and the only) way of restoring the lost ability to perform daily tasks or learning new movements and skills.

We contend that the rehabilitation of patients could also be efficient when they are subjected to a discomfort leading to a need to overcome it. The support for the above statement comes from a number of studies that use a negative feedback to improve the patient's body posture, gait pattern, or use of his/her affected extremity.

Among them is the Constraint-Induced Movement Therapy (CI) therapy that involves constraining movements of the less-affected arm with a sling while intensively training use of the more-affected arm [6]. While the literature reports the common therapeutic factor in all CI Therapy techniques as inducing concentrated, repetitive practice of use of the more-affected limb, we argue that CI therapy also creates a discomfort due to inability of a patient to use the less affected arm. Such a discomfort could also serve as a negative feedback that promotes the use of the affected upper extremity.

The CI Therapy approach has been applied successfully to treatment of the upper extremities in patients with chronic and subacute CVA [6], patients with chronic traumatic brain injury [7], for the lower limb of patients with multiple sclerosis [8], and individuals with incomplete spinal cord injury and fractured hip [9]. The approach has recently been extended to focal hand dystonia of musicians and phantom limb pain [10].

Negative feedback has been used in enhancement of ambulation in individuals with stroke who demonstrated narrow base of support during stance and gait. The feedback was provided in the form of an auditory signal (a beep) accompanying each step performed with a narrow distance between the feet [11]. Such a feedback was annoying to the patients so they tried to avoid receiving a beep and as a result improved their step width to a larger degree as compared to the group of patients that were not provided with such a negative feedback [12].

Weakness of abdominal muscles is one of the factors leading to low back pain [13] and specific stabilization exercises have been recommended [14]. A method and device for exercising the abdominal muscles was developed, based on alleviating the induced discomfort [15]. The device includes a miniature vibrator and an electrical switch attached to the belt and is positioned facing the abdominal wall. When the stomach is flat the switch activates a vibration of the abdominal muscles. To avoid the discomfort associated with vibration, the user periodically flexes abdominal muscles thus exercising them.

Weight bearing asymmetry and impaired balance are common in individuals with stroke-related hemi paresis [16-19]. Symmetrical stance and weight bearing has been recognized as a predictor of the ability to ambulate [20,21], and it was shown that achieving symmetry of weight bearing is an important goal of rehabilitation and fall prevention [22]. Compelled Body-Weight Shift (CBWS) therapy, which involves lifting the non-affected lower extremity through the use of a shoe insert on the healthy side over a period of several weeks, can also be considered as a discomfort-induced therapy. Indeed, the lift forces loading the affected limb during treatment and daily activities (and as such creates discomfort that the patient wants to avoid). A series of studies showed that the CBWS therapy improves the symmetry of weight bearing and the velocity of gait in individuals with acute and chronic stroke [23-25].

Recent studies in individuals post-stroke have shown that walking on a split-belt treadmill led to short-term improvements in step length asymmetry [26,27]. Walking on the split-belt treadmill (with the belts moving at two different speeds) exaggerates the participants' step length asymmetry thus augmenting their "error". This error augmentation is critical because it provides the nervous system with a cue to correct the asymmetry [28]. It is quite possible that walking on the split-belt treadmill may also be associated with a discomfort that contributes to the improvement in the symmetry of gait. While the improvements in asymmetry are brief, and the individual with stroke returns to the baseline asymmetry after several minutes of over ground or treadmill walking [26,27], these studies demonstrate the capacity of individuals with stroke to produce a more symmetric walking pattern.

The available information suggests that negative feedback and discomfort-induced approaches could be effective tools in physical therapy and rehabilitation. Future studies focused on development of new rehabilitation techniques that are based on using a discomfort-induced approach are needed.

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