Implementing neuroplasticity principled training paradigms with rhythmic exer-games for all ages and disease processes

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Effective training protocols use principals of motor learning that are characterized by intensive practice, ‘forced use’ of impaired extremities, task specificity, focused attention, saliency, immediate feedback, and delayed knowledge of results. Effective training protocols should also permit individuals at varying levels of skill to begin training at the appropriate level of difficulty and progress at their individual rates of skill acquisition. Practice intensity should be scaled to push the subject to work beyond their self-selected comfortable effort. Training should also be manipulated to increase practice time, rate, accuracy, and complexity of movement. Forced use means challenging sensorimotor awareness and targeting motor output that results in the overtraining of an impaired limb or body area (stroke, Parkinson’s disease, post ankle sprain, ACL injury etc.). Task specificity requires skilled, accurate movements with applicability to multiple tasks. This can include dual tasks, transitions, and quick changes in direction. Focused attention on complex movements adds increasing cognitive and motor loads with longer sequences and intricate patterns. Saliency provides rewarding success and confidence through immediate feedback about improvements in motor output. Exercise video games, or exer-games, enable all of these principles with the added benefit of training in an engaging, social environment. Furthermore, physical training with music at rapid tempos results in increased exertion. Rhythmic exer-games may have the greatest potential to produce both physical and cognitive benefits at any age or disability.

Our research on Dance Dance Revolution (DDR) exer-game-play focused on systematic progression of faster rhythms and song complexity over 30 hrs of training in a wide range of subjects. Pre and post testing demonstrated effective change in healthy young and elderly, Parkinson’s disease, stroke, and obese players in a number of areas. These include improved perceptual processing speed (functional field of view),

visual selective attention (Stroop test), reaction time (single and dual task stepping), and aerobic conditioning with concurrent neuroplasticity on fMRI. Healthy adult subjects were able to play at the ‘Heavy’ level after 30 hrs of training, the equivalent of 14-15 METS! Therefore, rhythmic exer-games have both physical and cognitive benefits. Exit interviews confirm the importance of the social gaming experience with interaction, competition, and encouragement from training peers.

The use of new technology such as functional magnetic resonance imaging (fMRI) allows us to understand how brain structure alters with training due to neural plasticity. The types and modalities of sensory feedback a player utilizes when learning to play a game may ultimately influence more than their game score. Proprioceptive (position and force), auditory, and visual feedback are integrated by players using multiple neural networks in the brain. As players develop the ability to effectively process these multimodal stimuli they may actually be expanding connectivity or promoting plasticity in their brain. Comparisons of brain activity while playing DDR with and without music suggest that rhythmic exer-games tap into common innate neural substrates for music and language processing, enhancing the effectiveness of multimodal training. Pre and post training fMRI scans will be used to discuss these changes in neural activity.