Cognitive Rehabilitation
Computer Brain Solutions: Prevention Powerhouse or a Warm Fuzzy Wannabe? A Perspective in Neuroplasticity and Practicality

Amy Price, University of Oxford, UK

ABSTRACT

Mild traumatic brain injury (MTBI) survivors claim advantage in retraining their brains with neuroplasticity based cognitive training after trauma. Significant growth in computer based cognitive rehabilitation is spurred on by positive research findings on neuroplasticity and advances in accessible computer technology. Drawbacks include limitations on the part of both patient and therapist in regards to time expenditure, cost of therapy, ease of use/learning curve, and the availability of long-term studies in regards to near and far transfer of training. MTBI patients may have sustained motor, visual, auditory, and chronic pain difficulties that complicate computer use. Benefits and barriers as perceived by patients and psychologists who are using the interventions for patient rehabilitation are critical. MTBI patient and therapist feedback concerning efficacy, usability accessibility, and satisfaction are needed to realize this form of rehabilitation.

Keywords: Cognitive Rehab, Cognitive Training, Computer Brain Training, Mild Traumatic Brain Injury (MTBI), Neuroplasticity

INTRODUCTION

William James 1890 (as cited in Green, 2010) conceptualized neuroplasticity but lacked the tools to validate the theory. Neuroplasticity, also referred to as cortical re-mapping or brain plasticity, was first seen in rodent studies used by Kornsksi (as cited in LeDoux, 2002). Neuroplasticity was explored further by Merzenich (1987) who speculated that sensory representation would be modified in the brain by neuronal inputs synchronization forming selective patterns/maps. Experience strengthens the map much like treading a repetitive path deepens the imprint on surface terrain. This is similar to Hebbian theory where synapses are shown to strengthen learning and provide dynamic response to stimuli (Hebb, 1949). Merzenich demonstrated overlapping sensory receptive fields by fusing the 3rd and 4th digit on one hand of owl monkey subjects so they would use the fused fingers as one. He then did cortical mapping before and some months after fusing it was found the nervous system adapted to the
changing needs using temporal correlation to classify experience by using the fused fingers as a single unit (Jenkin, Merzenich, & Ochs, 1987). Merzenich then demonstrated neuroplasticity in auditory function and through his work with cortical mapping, he contributed to the development of cochlear implants (Syka, Merzenich, 2003; Rosen, Fourcin, Abberton et al., 1985).

**Neural Plasticity.** The implications for cognitive recovery show brain response is not fixed but changes dynamically in response to stimuli and interactive computer technology was considered a medium for delivering neuroplasticity based interventions. Merzenich (2008), Gordon (2008), and Posner (2007) have developed new computer based cognitive solutions to this end.

Ramachandran (2005) explored the reality of neuroplasticity with phantom limbs. He proposed that the phantom pain of amputees was in the brain rather than the peripheral nerves and that the representation was mapped in the somatosensory cortex Ramachandran used MEG to demonstrate amputated limbs flood the vacated cortical area with neurons that normally branch from that area. The neurons swarm like ants that have had their hill crushed and then with training, they reorganize. Ramachandran noted movement attempts by amputees produced sensory feedback via vision and proprioception channels to established, intact sensory limb maps. For patients to enjoy relief, new patterns needed to be formed through these channels. He used mirror visual feedback and mental imaging to change the brain patterns not only with phantom limbs but with those who had sustained strokes, agnosias and other cognitive impairments (Ramachandran & Altschuler, 2009).

**The Heterogeneity of Neural Networks.** Each brain is a unique combination of genetics, environment and lived experiences (Kandel, 2005). Delivering positive brain results without a working knowledge of where and how that brain will benefit is a little like building a freeway with no blueprint. Optimal benefits require continuous assessment with a dynamic program that will adjust for changes in function. Likewise compliance is made possible by accessibility.

It is not always possible to reconstruct the core by considering only the surface. For an example we will consider working memory. Training working memory alone produces marginal results even in undamaged brains and this training seldom transfers to other memory tasks. Personalizing solutions is a critical key in achieving good benefit for effort ratios. A closer look at individual MTBI survivors will show for some individuals the key to memory is attention as people seldom remember what they failed to attend to. In this case, training attention networks will increase memory capacity (Posner & Rothbart, 2007). Another group may have slowed processing skills which reduces the amount they can attend to. When information processing skills are trained for speed and accuracy benefits in working memory are also realized (Willis, Tennstedt, Marsiske, 2006; Jaeggi, Buschkuehl Jonides, & Perrig, 2008). Other individuals may remember what they see but not what they hear. In this instance, training auditory attention and processing skills will yield results for working memory (ABT Conference, 2007).

**Computer Assisted Therapy.** “Accessibility is a research and practice field that focuses on making a system usable by a number of persons as diverse as possible” (Baravalle, 2009). Working models and computer strategies can bring dramatic changes in cognitive strength. Men exposed to spatial attention choices show minor changes in mathematical or spatial ability after practicing action computer games whereas women not exposed to this area of learning show improvement on mapping and math skills after only five weeks of training spatial abilities (Feng Spence and Prat, 2009). Working memory capacity is compromised...
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