NEUROFEEDBACK IN THE CLASSROOM

Krell, Jason; Todd, Anderson; and Dolecki, Patrick K.

Issue Explored

> The opportunity for Neurofeedback Training (NT, Figure 1) in the classroom as a prospective teaching tool for building attention

Figure 1: Neurofeedback Training set-up. The portable headset sends EEG data via Bluetooth® to the computer, which performs a Fourier transform and provides feedback directly to the student via game play.

Keywords

> Attention, Biofeedback, Disruptive Innovation, Neurofeedback Training

Background

> Education is undergoing global reform. Despite a circuitous path, several key features have emerged:
- Increasingly personalized learning[15]
- Targeting greater accessibility[6]
- New desired learning outcomes, centred on adaptive competences[5]

Recent developments have largely resulted from sustaining innovations (e.g. increased computer access in the classroom[3]). They do not address new expected learning outcomes, including higher-order thinking skills, real-life problem solving, and collaboration.[8] Building these adaptive skills requires the development of several cognitive, affective, and motivational components:[5]
- Well-organized and flexibly accessible knowledge
- Heuristic methods
- Meta-knowledge
- Self-regulation
- Self-efficacy

The authors of this presentation theorize that attention exists as one of several root capacities that support these critical components and that developing greater attention will contribute to better outcome scores in adaptive competences.

Disruptive Innovation

> Christensen (2008) pioneered the Disruptive Innovation framework to provide a more complete understanding of building and development. Disruptive innovations differ from sustained innovations in that they do not target further development of incumbent technologies – they explicitly target new areas with new metrics of quality (Figure 2). In the context of education, the sea-change occurring will require disruptive innovation – this means investigating pedagogical frameworks to cultivate skills in areas previously deemed inaccessible or static (Figure 3).

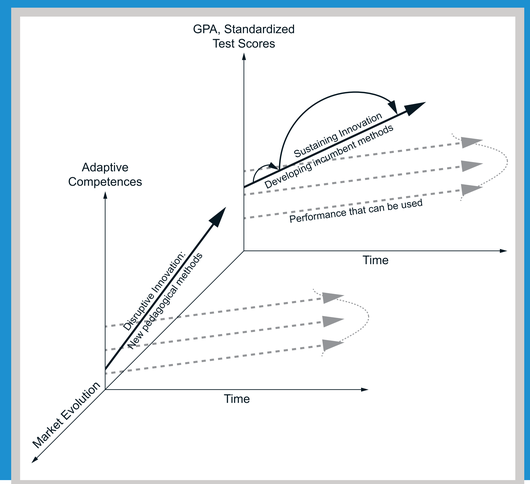

Figure 2: Schematic representation of Disruptive Innovation, as derived from Christensen (2008). As illustrated, Disruptive Innovations form an integral component of the evolution of learning, responding to new learning outcomes and replacing dated frameworks.

Attention

Centrality of Attention

> Bruce McCandliss (2011) explicitly identified one of the necessary bridges between Science and Education as selective attention. Attention is relevant to Cognitive Science as a driver of cognitive development and to Education as a requisite for learning. A survey of research literature[2, 7] and educator anecdote shows the centrality of attention to the learning process. In order to build adaptive competences attention is required. Studies of Attention Deficit Hyperactive Disorder have further reinforced this core understanding by focussing on pharmacological solutions to assist the learning process.

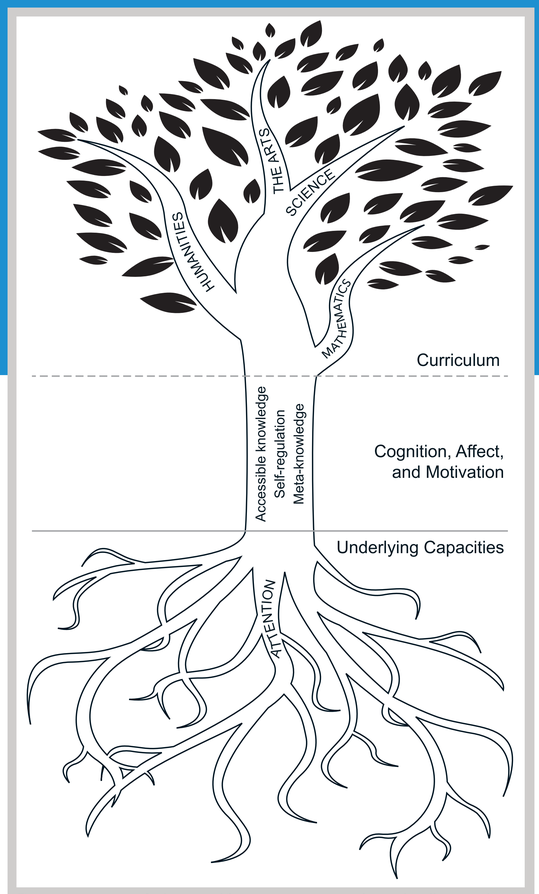

Figure 3: Depiction of educational/learning components layered to illustrate the hierarchical relationship. Before widespread acceptance of the Neuroplastic model of the brain, underlying capacities were assumed to be fixed hardware components and limiting factors in educational outcomes.

Can Attention be Learnt?

> Although what it means to "pay attention" is common knowledge, few seem able to describe how to attend or know what attention feels like. This inability to delineate such an important autonomous process is central to the challenge of teaching attention and is (at least) partly responsible for attention's extraneous nature to teaching models. Compounding this difficulty, a growing proportion of the population grapples with neurologically-based learning disabilities that involve deficits in attention.[10] Given the importance of attention in acquiring knowledge and cognitive development, it follows that the treatments and training regimes prescribed for attention would best succeed by directly addressing its neurological basis.

Neurofeedback Training

> NT teaches individuals to self-regulate by providing direct feedback on temporal and spatial patterns in brain activity. Using EEG measurement, NT rewards individuals for attending effectively, causing them to further attend. This form of learning (operant conditioning) is intrinsic to human growth and development. Repetitive training of particular brain activity patterns remodels the structure of the brain to accommodate the new function. Existing research on attention training has focused on simultaneously maximizing Mu activity and minimizing Theta activity (Table 1).

Table 1: Commonly used brain wave activity patterns for NT

Brain Wave	Frequency Range [Hz]*	Region of Origin	Associated Activity	Used in NT
Delta	0.5-3.0	Anterior (adults), Posterior (children)	Deep sleep	No
Theta	3.5-7.0	Thalamus, Hippocampus	Drowsiness, deep meditation	**Yes**
Alpha	8.0-12.0	Occipital	Calm, daydreaming	No
Mu	8.0-13.0	Sensorimotor Cortex	Attentive concentration	**Yes**
Beta	13.0-30.0	Symmetrically Frontal	High stimulation including anxiety	No

* Frequency ranges differ from source to source and should be considered guidelines.

Empirical evidence has shown that NT is efficacious in building greater attention in both ADHD diagnosed[11] and non-diagnosed individuals[12]. Further, the observed effect sizes compare to those of pharmacological treatments.[1] Despite a history of success and that NT is not a fledgling science (early records date to work on rabbits in 1875 by Caton[9]), it is not widely prescribed as a treatment and further, has had very little Educational research investigation. The first published work using NT in the classroom appeared in Pediatrics (March, 2014) by Steiner's research group at Tufts. The research was well-designed (n value, experimental design) and yielded benchmark results, supporting that NT holds potential as an effective tool in the classroom in building and sustaining student attention in the classroom.

Discussion

> The authors of this presentation view NT as a viable candidate for extensive empirical testing in the classroom. It is not seen as a panacea, but as a potential Disruptive Innovation and curricular supplement for the next generation classroom. Given the accessibility of the technology and the vast potential it holds in teaching students to become more effective at learning, it follows that MBE provides an ideal space to develop and critically review methodological/ethical considerations for implementation.

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