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Heart–Brain Connections: Neuroanatomy Underlies Effective Neurofeedback plus Biofeedback Interventions

Michael Thompson, M.D. & Lynda Thompson, Ph.D.
Andrea Reid, MA., James Thompson, Ph.D., David Hagedorn, Ph.D.

Abstract

Clinical experience has shown that patients with a range of conditions, including traumatic brain injuries (TBI), depression, anxiety, and panic disorder, could decrease symptoms and better manage their response to stress through either neurofeedback (NFB) or biofeedback (BFB) treatment. Indeed, it seemed logical in our clinical setting to combine these two approaches, whenever this was possible, in order to maximize the benefits and possibly shorten the training time for clients. Wanting to go beyond saying that combining NFB and BFB is common sense, we began to investigate and develop a rationale for combining EEG feedback with heart rate variability training (HRV training) that was based on functional neuroanatomy. This paper summarizes those neauroanatomical underpinnings, as we currently understand them, with an emphasis on connections between central midline structures and brain-stem nuclei. It will emphasize how HRV should be combined with NFB, both single channel and 19 channel LORETA z-score NFB.

Heart rate variability will decrease with concussion and other heart variables will change. The right insula is often involved in these changes. This is discussed with references in this paper.

Heart Rate Variability Training Does Affect the Brain

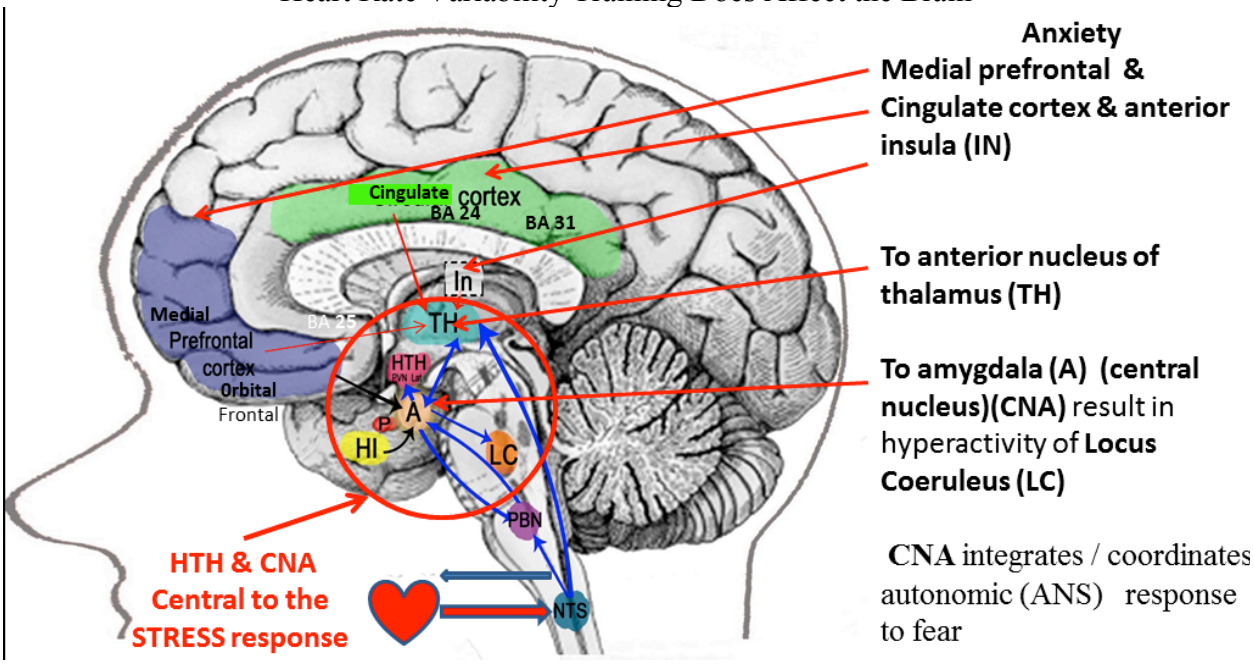

Diagram by Maya Berenkey from *The Companion to The Neurofeedback Book* (in press)

TH = Thalamus	CNA = Central Nucleus Amygdala	HI = Hippocampus
IN = Insula	A = Amygdala	PBN = Parabrachial Nucleus
HTH = Hypothalamus	ANS = Autonomic Nervous System	NTS = Nucleus Tractus Solitarius
P = Pituitary	PVN = Paraventricular Nuc.	

Figure 12. **Central Pathways for Response to Stress**
Hypothalamic – Pituitary – Adrenal & Autonomic Responses

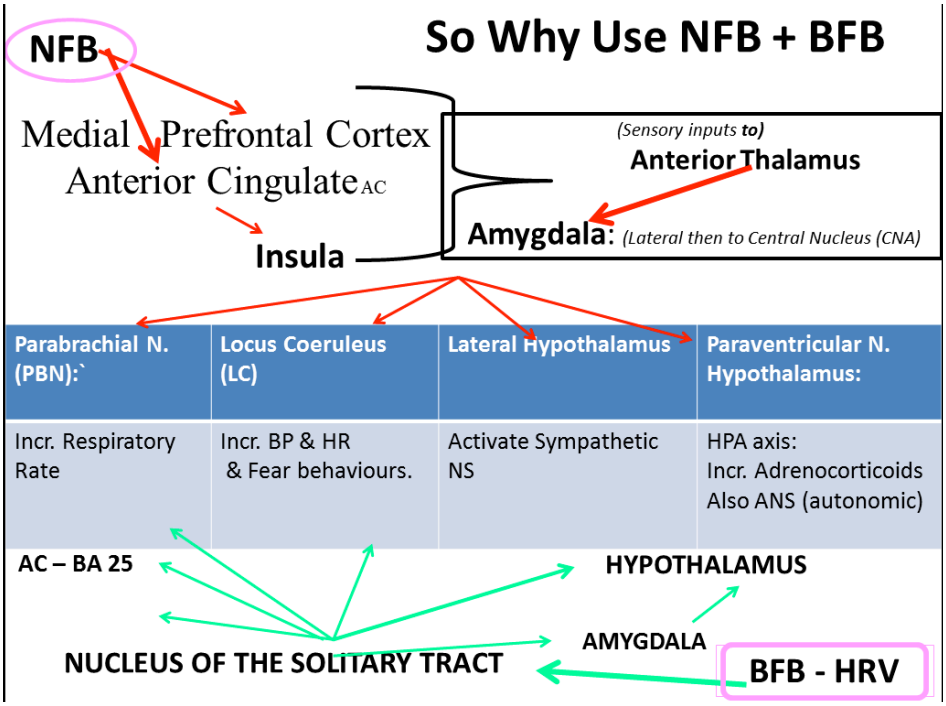

Figure 13. This figure illustrates how NFB as 'top-down' training and HRV as 'bottom-up' training can both affect the same central structures.