Control over brain activation and pain learned by using real-time functional MRI

deCharms et al., 2005

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Plan

- What is biofeedback and neurofeedback
- Potential use of rtfMRI as an alternative to neurofeedback
- Hypothesis
- Methods/rtfMRI training
- Results
- Discussion/Conclusion
- Limitations of Study and Future study

Biofeedback

- A subject's ability to measure quantifiable bodily functions, i.e., Blood pressure, heart rate, muscle tension, conveying the information in real-time
- Objective: to provide a greater awareness and voluntary control over physiological processes
- Mechanism: Subjects search voluntarily for an appropriate strategy to self-regulate subjective sensations, psychomotor and imaginative activities

Neurofeedback

- Special type of biofeedback
- Uses EEG – measurement of the electrical brain activity (delta (<4 Hz), theta (4-8 Hz), alpha (8-13 Hz), beta (13-30 Hz), and sensorimotor rhythm) generated by the fluctuating sum of excitatory, and inhibitory postsynaptic potentials in the brain
- Application: Has been demonstrated to alleviate symptoms of ADD, epilepsy, PTSD, and to enhance healing processes (Fregni et al., 2007)

GET JACKED QUICKLY

Role of rtfMRI

- Potential utility of fMRI (3.0 Tesla General Electric Signa Scanner) as an alternative neurofeedback as described by (Cox et al., 1995)
- Labelled rtfMRI
- Advantage – provides measurement of localized processes within the brain as they take place
- Application?
- Rostral anterior cingulate cortex (rACC) involved in mediating pain perception
Hypothesis
• To investigate whether learned, deliberate manipulations of (rACC) activation through rtfMRI leads to predicted effects of pain perception

Methods
• Subjects were recruited from in and around Stanford University
• 36 healthy and 12 patients with chronic pain (mean age 30.1 yrs.) were tested
• Healthy subjects were presented with a noxious thermal stimulus to induce pain
• Statistical analysis was done utilizing paired t-tests.

rtfMRI Training
• Experimental Group – 8 healthy and 8 unhealthy (chronic pain) subjects were given cognitive strategy guidelines along with rtfMRI to gain control over their Rostral anterior cingulate cortex (rACC)
• Pre-test Training: 3 x 13min scans with pain stimulus applied once at end of each scan
• Post-test training: pain stimulus was applied during each increase and decrease block
  • Pain stimulus was rated immediately after it was presented

Controls
• Group 1: Identical cognitive instructions to the experimental group, but no rtfMRI training
• Group 2: Same as group 1 except longer cognitive training and focusing on only diverting attention away from the pain
• Group 3: Identical to experimental group except rtfMRI info was derived from a different brain region
• Group 4: Identical to experimental group except rtfMRI corresponded to activation from a previously tested subject
• Group 5: Chronic pain subjects received autonomic biofeedback info rather than rtfMRI

Results
• All Experimental subjects learned to control the FMRI signal in the rACC
• Other areas were also activated ie. Cerebellum, superior temporal cortex
• rACC showed most significant activation of any forebrain region p<0.001

Results
• Control over pain increased significantly through training p<0.05
• Control over pain intensity by exp. group was significantly larger than all 4 control groups.
• Chronic pain patients reported substantial decreases in average baseline pain level.
• The control group with autonomic biofeedback info reported no change in baseline pain level.
Discussion and Conclusions

• **FIRST** full group control study where individuals learned how to gain control over a localized brain area (ie. rACC) which resulted in an impact on physiological functions (ie. Pain)
• Suggests a possible protocol for rtfMRI
• Potential for further research application
• **HOPE** for long-term pain treatment and other clinical applications

Limitations and Future Study

• Difficult learning conditions making it difficult for transfer training (ie. Training without fMRI for long-term solutions)
  • Very loud in the fMRI
  • rtfMRI response info is delayed (8 s) relative to cognitive and brain events
  • fMRI machine is very expensive
• Limitation of control groups: should have compared against EEG neurofeedback training
  • lower amplitudes of slower wave (delta, theta, and alpha) activity and relatively higher amplitudes of faster wave (beta) activity decreases pain experience (Fregni et al., 2007)
• Future Study: Study similar to this one except decrease delayed response of rtfMRI and substitute EEG neurofeedback instead of autonomic biofeedback

QUESTIONS