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Amygdala stimulation disrupts emotional perception and emotional memory in humans

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Introduction: Emotional memory refers to the augmenting effect of emotional intensity of stimuli on delayed recall and can be readily identified in everyday human experiences. Human and animal studies suggest that at least two distinct cerebral networks facilitate emotional memory, the bottom up amygdala-hippocampal network and the top-down frontal-hippocampal network. Prior attempts to study the effects of electrical brain stimulation (EBS) on the amygdala have reported both positive and negative emotional experiences in some patients. The effect of amygdala EBS on emotional memory in humans has not been studied. Our central hypothesis was that 50 Hz EBS of human amygdala during perception of visual stimuli would lead to improved recall by augmenting the emotional valence of stimuli.

Methods: 12 patients undergoing intracranial stereo-electroencephalography prior to epilepsy surgery with electrodes reregistered to the left amygdala were recruited. A de novo synchronized system for stimulus presentation and concurrent EBS was assembled using a FDA approved Grass 12X stimulator, SuperLab stimulus presentation, Stim Tracker event marker, and Natus EEG system. A de novo Dartmouth Emotional Memory Task was developed. 48 pictures were chosen from the International Affective Picture System (IAPS) which represented emotionally positive, neutral, and negative valences (scores of 2.5 to 7.5) avoiding extremes and medical themes due to sensitive nature of patients. Pictures were presented for 2 seconds with 50% receiving 3 mA of 50 Hz EBS (both presentation and stimulation were applied in random order) followed by emotional scale. Recall task presented 30 minutes later with 128 recall pictures (48 from encoding task) and 96 new pictures were presented in random order.

Results: 12 patients underwent 2-4 mA stimulation during presentation of stimuli with no discernible reporting of emotional experiences. Amygdala stimulation had no effect on perception of emotionally neutral stimuli (no stimulation average valence 5.05, stimulation valence 5.25, $p=0.95$). Amygdala stimulation reduced emotional intensity of negative stimuli (no stimulation average valence 2.14, stimulation average valence of 3.04, $p<0.001$) and reduced emotional intensity for positive valence stimuli (no stimulation average valence 8.03, stimulation average valence 7.25, $p<0.003$). On delayed recall, neutral stimuli were recalled less well as compared to positively and negatively valence stimuli (delayed recall neutral 5.98, positive 7.45, negative 6.95, $p<0.001$). EBS had small no effect on delayed recall of neutral stimuli (delayed recall stimulated vs. non stimulated 5.95, 5.84, $p=0.86$) and small disruptive effect on positive (delayed recall stimulated vs non stimulated 7.55 vs. 6.04, $p=0.07$) and negative (delayed recall stimulated vs non stimulated 6.95, 5.91, $p=0.09$).

Conclusion: EBS of left amygdala decreases the emotional valence of both positive and negative stimuli and has no effect on perception of neutral stimuli. EBS has small disruptive effect on delayed recall of positive and negative valence stimuli, yet has no effect on neutral stimuli.

Biography

Krzysztof A Bujarski is a Practicing Neurologist in Lebanon. He graduated from Poznan University of Medical Sciences-Center for Medical Education in English in 2000 and has been in practice for 18 years. He completed a Residency at Loyola University Medical Center. He also specializes in Psychiatry. He currently practices at Dartmouth Medical Center and is affiliated with Dartmouth Hitchcock Medical Center.

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