

The Interaction of Sleep Deprivation and Pain Perception: Literature Review

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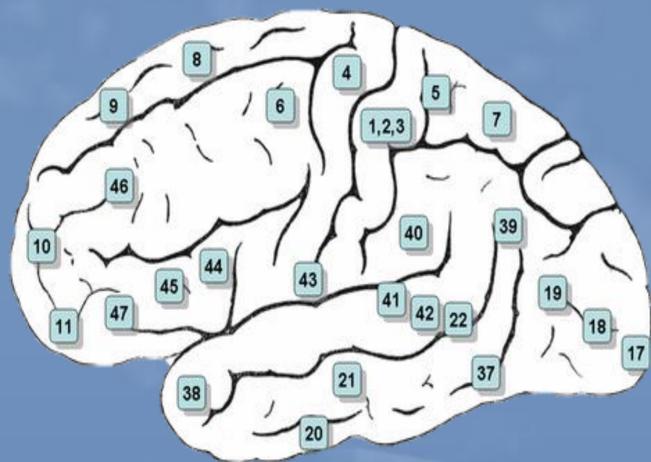
Significance

There is sufficient evidence that patients with pain will experience sleep disturbance and that patients with sleep disturbance report lower tolerance to pain. This study was undertaken to explore the neural basis of the relationship between sleep and pain.

Methods

A literature review was done to establish brain regions affected by sleep disturbance and brain regions responsible for the the development of pain. Regions were then assessed for overlap in function. Once regions were identified, an experiment was performed to verify overlapping neural regions.

Brodmann's Regions (wikipedia)



Acknowledgments

Funding and support provided by UB School of Nursing, Dent Neurologic Institute, Garman Endowment, Michael Dwyer (BNAC).

Review of Literature Results

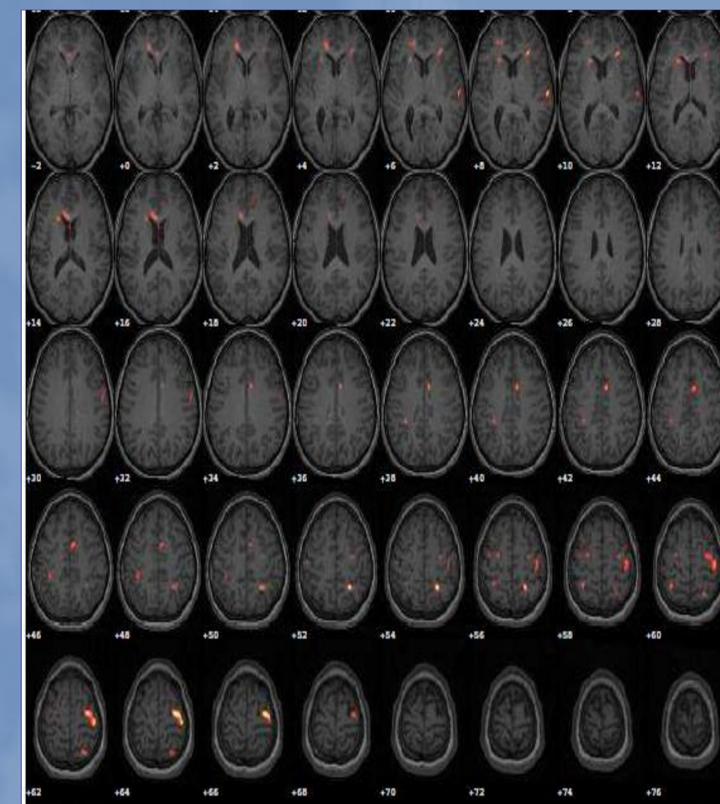
Brodmann's Regions	Function	Inhibitory for Pain Transmission? (Y/N)	Connectivity
6	Motor planning and execution. Inhibit response, language production, moral reasoning.	Y	Connections with the insula, orbital cortex, frontal operculum, premotor cortex.
7	Spatial orientation, logical reasoning, spelling/handwriting, auditory attention	N	Connection with the lateroposterior, laterodorsal, and rostral intralaminar centrolateral thalamic nuclei.
8	Control of eye movements, muscle control, generating sentences, working memory, pain anticipation, processing uncertainty.	Y	Found in the frontal cortex, anterior to the premotor cortex. Connection with Brodmann area 6. In the dorsolateral prefrontal cortex. Activation of this region occurs when uncertainty increases.
10	Control executive functions, pain, logical inference, risk vs benefit, recognize emotions	Y	Linked to anterior, posterior cingulate cortex, retrosplinal cortex, amygdala, and temporal gyrus.
13	Expectation of painful stimulus. Pain processing, heat, touch, express fear or disgust, error awareness	Y	Posterior insular cortex. Forms a bridge between the lateral and medial layers of the brain.
17	Process visual information, colors, motion	Y	Connections with the cuneus and lingual gyrus. It is bound to Brodmann area 18.
24	Multitasking, worry, mood swings, decrease aggression, memory retrieval	Y	Connectivity with amygdala and periaqueductal gray, projects into autonomic brainstem motor. Connectivity is implicated in schizophrenia.
31	Judge emotional states of others, self-reflection, self evaluation	Y	Connections with posterior cingulate gyrus and parietal lobe. Bound by Brodmann area 24 and 23.
32	Reward-based decision making. Mood regulation, evaluate emotional words, identify pain	Y	In the cingulate region of the cerebral cortex Cingulate sulcus found in its inner boundary. Connected to Brodmann area 24, 6, 8, 9, 10, and 11.

Conclusions and Clinical Application

There is a significant relationship between sleep and pain. The ROL revealed overlapping brain regions possibly responsible for the relationship. The fMRI experiment confirmed the brain regions.

There is a significant relationship between sleep disturbance and the development of the perception of pain. Clinicians should address sleep disturbance when treating pain.

MRI Results



Sleep deprivation is associated with increased perception of pain. The anterior cingulate cortex (ACC) which plays a role in cognitive functions such as decision-making, emotion, and impulse regulation was hypo-activated in the experimental group. Hypo-activation of the parietal lobe was also seen. The parietal lobe receive sensory inputs from touch, temperature, and pain receptors.

Experimental Setup

