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Investigating differences in neurotransmitter profiles to explain differences in pain perception

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The aim of this dissertation was to investigate differences in neurotransmitter profiles as a potential neurobiological mechanism to explain differences in pain perception. As a difference in pain perception between patients with a borderline personality disorder and healthy subjects has been well established, as well as the brain regions and neurotransmitters associated with pain perception, the focus of the dissertation was a comparison of glutamate- and γ-amino butyric acid levels in the right posterior insula, the right insula, the bilateral anterior cingulate cortex, the bilateral medial cingulate cortex, the right thalamus and the right dorso-lateral prefrontal cortex between groups.
We used a device called pinprick, which allows for the application of predefined amounts of pressure on an area of the skin, as a measure of pain sensitivity. The concentrations of glutamate and γ-amino-butyric acid in the right posterior insula were measured with a technique called single voxel magnetic resonance spectroscopy. The concentration of glutamate was measured in the aforementioned brain regions using a technique called whole brain Magnetic Resonance Spectroscopic Imaging. Both these measures make use of the fact that differences in the molecular structure of neurotransmitters lead to a unique signal profile when a static magnetic field is combined with a sophisticated combination of dynamic gradients over time, called a sequence. Based on this background we formulated the following hypotheses:

1. Patients with a borderline personality disorder perceive less pinprick pain than healthy subjects.
2. The glutamate/γ-aminobutyric acid ratio in the right posterior insula correlates positively with pinprick pain intensity ratings in the overall group.
3. The glutamate/γ-aminobutyric acid ratio in the right posterior insula correlates positively with pinprick pain intensity ratings in the healthy control group.
4. The glutamate/γ-aminobutyric acid ratio in the right posterior insula correlates positively with pinprick pain intensity ratings in the borderline patient group.
5. Patients with a borderline personality disorder have a lower glutamate/γ-aminobutyric acid ratio in the right posterior insula than the healthy control group.
6. Patients with a borderline personality disorder perceive less pinprick pain than healthy control subjects in the subsample with whole brain spectroscopic imaging measures.
7. The combined Glutamate plus Glutamine / total Creatine ratio measures of the right insula, the bilateral anterior cingulate cortex, the bilateral medial cingulate cortex, the right thalamus and the right dorsolateral prefrontal cortex correlate positively with the pinprick pain intensity ratings controlling for depressive symptoms and patient status.
8. Borderline personality disorder patients have a lower Glutamate plus Glutamine / total Creatine ratio in the combined Glutamate plus Glutamine / total Creatine ratio measures of the right insula, the bilateral anterior cingulate cortex, the bilateral medial cingulate cortex, the right thalamus and the right dorsolateral prefrontal cortex than healthy control subjects.

We could confirm hypothesis 1, hypothesis 2 and hypothesis 2a, while the other hypotheses could not be confirmed. We could thus add evidence to the established finding that patients with a borderline personality disorder, on average, perceive the same mechanical stimulus as less painful than healthy control subjects. We could also add evidence to the established link between the ratio of the glutamate to γ-aminobutyric acid ratio concentration in the right posterior insula and pain perception. The differences in neurotransmitter profile in the brain regions associated with the processing of painful stimuli as a neurobiological explanation for the differences in pain perception between patients with a borderline personality disorder and healthy control subjects could not be established.