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# Effect of trait anxiety on pain-related brain activity

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*Abstract*— **Although differences in trait anxiety are known to cause different pain sensitivities, the effects of trait anxiety on brain activity in response to pain is unknown. The present study examined the difference in brain activity in response to pain between individuals with particularly high and low trait anxiety. We found that participants with high trait anxiety exhibited significantly higher activity in the Orbitofrontal Cortex during moderate intensity stimulus compared to that in the low trait anxiety participants.**

## I. INTRODUCTION

In recent years, an increasing number of studies have attempted to quantitatively evaluate pain using brain activity. To properly evaluate pain, it is necessary to clarify the brain mechanisms underlying pain perception. A previous study [1] reported that differences in trait anxiety cause different pain sensitivities. However, to our knowledge, the effect of trait anxiety on the cerebral processing of pain has not been clarified. In this study, to examine the effect of trait anxiety on the brain mechanisms of pain perception, we screened and enrolled people with particularly high and low trait anxiety and conducted a pain stimulation experiment while measuring their electroencephalogram (EEG). We then examined EEG source activity to investigate the brain regions that influence pain perception due to the high level of trait anxiety.

## II. METHODS

*Participants*: A preliminary survey was conducted on the Internet. The State-Trait Anxiety Inventory (STAI) was used to investigate trait anxiety scores. The target was limited to healthy right-handed men in their 20s and 30s. We classified participants with a score of 55 or higher as those with particularly high trait anxiety (HTA) and a score of 40 or lower as those with low trait anxiety (LTA). Ten HTA and nine LTA individuals participated in the experiment (age 22.8±2.5 years). The experimental procedure was approved by the Research Ethics Committee of the University of Tokyo (approval number: KE20-79). Written informed consent was obtained from each participant.

*Equipment*: EEG was measured during pain stimulation and recorded using a 32-channel EEG device (BrainAmp DC, BrainProducts, Germany) at a sampling rate of 500 Hz; all heat stimuli were applied to the dorsum of the left hand using a thermode (TSA-II, Medoc, Romat Yishai, Israel).

*Procedure*: First, the pain threshold of the participants was determined using the binary search method. A pain stimulus was then applied. Stimulus intensity was defined as low, middle, and high stim by adding 0.5, 0.8, or 1.1 °C to the pain threshold temperature. Each stimulus lasted for 40, 50, or 60 s. The duration of stimulation was similar for all participants. This sequence is based on the method described by Nickel et al. (2017)[2]. Figure 1 shows the stimulus sequence.

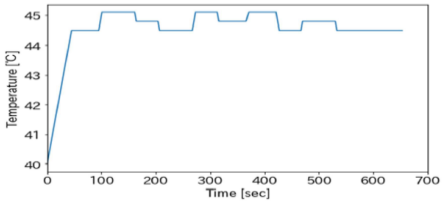


Figure 1. Stimulus sequence (when the pain threshold is 44℃)

*Analysis :* Artifacts were removed from the EEG signals using automatic subspace reconstruction. Source analysis was conducted using low-resolution brain electromagnetic tomography (LORETA, LORETA Key software version 20200414, Pascual-Marqui et al., 1994). To test the effects of trait anxiety (HTA vs. LTA) on brain activity, two-sided independent t-tests were conducted with an alpha level of 0.05.

## III. RESULTS

In the first middle stim, HTA individuals exhibited significantly higher 16–30 Hz activity in the orbitofrontal cortex (OFC) ($t$ = 5.62, $p$ < 0.05, MNI: -15 40 -25 (MNI-coordinates in mm)] than LTA individuals (Fig. 2).

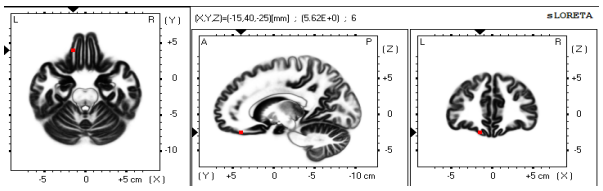


Figure.2. Significant differences in the orbitofrontal cortex (HTA VS LTA)

## IV. DISCUSSION & CONCLUSION

This result reflects the difference in brain activity between HTA and LTA. Previous studies have suggested that the OFC is involved in the evaluation of negative information [3]; hence, the degree of negative evaluation of pain may be stronger in individuals with HTA.

## REFERENCES

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