タイトル

１．Insular activity reflects the volatility of pain prediction under uncertain environment.

２．Insular activity reflects the volatility in pain learning task.

著者

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抄録

People learn behaviors that maximize reward probability in reinforcement tasks. However, in more realistic situations, the reward probability itself may change. Such changes in reward probability are referred to as volatility. Previous studies have revealed a relationship between volatility and anterior cingulate cortex (ACC) activity in reinforcement learning tasks. On the other hand, studies of pain avoidance learning tasks have reported activity in the anterior insular cortex (AIC) during pain anticipation, suggesting that the AIC is an important region for pain perception and pain anticipation. In the present study, we added volatility changes to a pain avoidance learning task to determine whether the ACC or the AIC is related to the volatility of pain probability.

Participants performed a pain prediction task in which they learned the relationship between cues and thermal pain probability in MRI. In the volatile environment condition, the relationship between cue and pain probability switched every 10 trials. In contrast, in the stable environment condition, the relationship between cue and pain probability remained constant over 20 trials. Participants predicted pain or no pain by two alternative forced choice after cue presentation. Participants' behavior was modeled as a Bayesian learning agent, and parameters were estimated from participants' pain prediction responses. The model included estimates of trial-by-trial pain probability and volatility.

The results showed that the activity of the right AIC during the anticipation period (the time just before the pain stimulus) was positively correlated with the volatility value estimated from the model. Activity in the AIC and parahippocampal gyrus during cue observation was also found to be correlated with volatility, although statistically weaker. These results indicate that activity in the AIC, but not the ACC, is associated with volatility in pain learning. Furthermore, the results suggest that AIC is even related to higher-order abstract concepts such as environmental variability.

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