Insula functions

The insula serves as an integration cortex for multimodal convergence of distributed neural networks such as the somesthetic-limbic, insulo-limbic, insulo-orbito-temporal and the prefrontal-striato-pallidal-basal forebrain [1].

Histologically, the insula is a part of the paralimbic cortex, as it bears in its antero-inferior part an allo and mesocortical area. The insula is functionally involved in cardiac rhythm and arterial blood pressure control, as well as in viscero-motor control and in viscero-sensitive functions. There is considerable evidence for the involvement of the insula as a somesthetic area, including a major role in the processing of nociceptive inputs.

The combined findings of many sleep-related studies have confirmed a close link between the insula and insomnia, sleep deprivation, sleep disorders, and more. Although these results do not directly confirm that the insula is involved in sleep, an overall analysis of the results indicates that the insula may be a potential key brain region involved in sleep [2].

The insular lobe is involved in the gustatory, olfactory, auditory, and vestibular senses, motor integration, and motor planning of speech [3] [4].

Its possible role in some epilepsies may explain some failures of temporal lobectomy [5].

The insulae are believed to be involved in consciousness and play a role in diverse functions usually linked to emotion or the regulation of the body's homeostasis. These functions include perception, motor control, self-awareness, cognitive functioning, and interpersonal experience. In relation to these, it is involved in psychopathology.

Recent neuroimaging studies have demonstrated that anterior insular cortex activation is associated with accessing interoceptive information and underpinning the subjective experience of emotional state. Only a small number of studies have focused on the influence of insular damage on emotion processing and interoceptive awareness. Moreover, disparate hypotheses have been proposed for the alteration of emotion processing by insular lesions. Some studies show that insular lesions yield an inability for understanding and representing disgust exclusively, but other studies suggest that such lesions modulate arousal and valence judgments for both positive and negative emotions.

In a study, Terasawa et al. examined the alteration in emotion recognition in three right insular and adjacent area damaged cases with well-preserved higher cognitive function. Participants performed an experimental task using morphed photos that ranged between neutral and emotional facial expressions (i.e., anger, sadness, disgust, and happiness). Recognition rates of particular emotions were calculated to measure emotional sensitivity. In addition, they performed heartbeat perception task for measuring interoceptive accuracy. The cases identified emotions that have high arousal level (e.g., anger) as less aroused emotions (e.g., sadness) and a case showed remarkably low interoceptive accuracy. The current results show that insular lesions lead to attenuated emotional sensitivity across emotions, rather than category-specific impairments such as to disgust. Despite the small number of cases, our findings suggest that the insular cortex modulates recognition of emotional saliency and mediates interoceptive and emotional awareness [6].

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