

ORIGINAL ARTICLE

Insula Connections With the Parieto-Frontal Circuit for Generating Arm Actions in Humans and Macaque Monkeys

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Abstract

It has been recently found that the human dorso-central insular cortex contributes to the execution and recognition of the affective component of hand actions, most likely through modulation of the activity of the parieto-frontal circuits. While the anatomical connections between the hand representation of the insula and, the parietal and frontal regions controlling reaching/grasping actions is well assessed in the monkey, it is unknown the existence of a homolog circuit in humans. In the present study, we performed a multifiber tractography investigation to trace the tracts possibly connecting the insula to the parieto-frontal circuits by locating seeds in the parietal, premotor, and prefrontal nodes of the reaching/grasping network, in both humans and monkeys. Results showed that, in both species, the insula is connected with the cortical action execution/recognition circuit by similar white matter tracts, running in parallel to the third branch of the superior longitudinal fasciculus and the anterior segment of the arcuate fasciculus.

Key words: dorso-central insular cortex, grasping circuit, MRI tractography

Introduction

In primates, the execution of goal-directed hand actions relies on a parieto-frontal circuit primarily constituted by inferior parietal and ventral premotor areas (PMv; Jeannerod et al. 1995). This circuit is crucial not only for controlling the action goal but also for recognizing the actions of others (Rizzolatti and Craighero 2004; Grosbras et al. 2012; Molenberghs et al. 2012; Rizzolatti and Sinigaglia 2016). It has been recently shown that this circuit is controlled by the ventro-lateral prefrontal

areas that constitute a third node of the classical parieto-frontal circuit (Borra et al. 2017; Gerbella et al. 2017).

More recently, increasing attention has been paid to the neural basis of an additional aspect of the executed action, that is, its affective component, specified by dynamic and kinetic terms, and originally dubbed “vitality forms” by Stern (1985, 2010). These action components allow, on one side, the agent to communicate his/her own mood/attitude and, on the other, the observer to understand the mood/attitude of the agent.

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