Voluntary actions and problem-solving

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Introduction

Volition refers to a capacity to initiate actions through one's autonomous conscious decisions. Voluntary actions are often made for a reason, which is typically a representation of a desirable goal state. However, existing paradigms for studying volition focus on arbitrary, meaningless actions, favouring the stimulus-independency aspect of volition rather than goal-directedness (Haggard, 2019). The aim of this study was to develop a new view of volition as goal-directedness. We investigated the neurocognitive processes of goal-directed actions, their overlap with the brain areas/processes traditionally associated with voluntary actions, and their interaction with other neurocognitive systems during a problem-solving task.

Methods

We used a computerised version of the "Tower of London" (TOL, Shallice 1982) problem-solving task in a series of fMRI and EEG experiments. We compared a condition in which participants solved ToL problems with an instructed condition in which they performed individual actions that constituted the solution as a simple response task without any goal to be achieved.

Results

In the fMRI experiment, the comparison between intention-driven TOL and stimulus-driven TOL problems revealed a significant activation of the medial frontal cortex, which overlapped – although not exclusively – with the areas classically associated with voluntary actions (Seghezzi & Haggard, 2023).
EEG results demonstrated that it was possible to decode intention-driven TOL and stimulus-driven TOL problems within the time window 1s before the action using the spatial SVR (Support Vector Regression approach implemented in DDTBOX, Bode et al. 2019) approach. The same comparison yielded an earlier EEG Readiness Potential associated with ToL intentional actions.
fMRI gPPI revealed a distinctive pattern of connectivity between the pre-SMA and the prefrontal cortex before the first action of the ToL intention sequence, and increased parietal connectivity later in the sequence. EEG WPLI measure of connectivity confirmed the latter, but not the former result.

Discussion

These results provide the first experimental testing of the distinctive goal-directedness aspect of voluntary actions. Defining volition as goal-directedness has clear implications for the conceptualization of its underlying cognitive mechanisms. In particular, these cognitive processes imply a degree of consciousness, since the agent must have a representation of a goal, attribute value to the goal, and must realize that they are not currently in the goal state. Also, by embedding voluntary actions in a goal-directed context, this project goes beyond a conceptualisation of volition as an isolated cognitive function, revealing how volition and its neurocognitive processes are linked to other cognitive areas in a distributed network for problem-solving.

References

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