Neural coding of goals in voluntary action

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Aim

The ability to make goal-directed actions is a distinctive feature of human mind (Haggard, 2019). However, how the human brain represents goals and uses such goal representations during the evolving processes of voluntary action generation is largely unknown. The goal might be represented as the set of operations necessary to transit from an initial state to the desired state ("deep coding"), or in terms of perceptual matching, such as visual similarity ("shallow coding").This project analyses how representations of goals are used to generate voluntary actions.
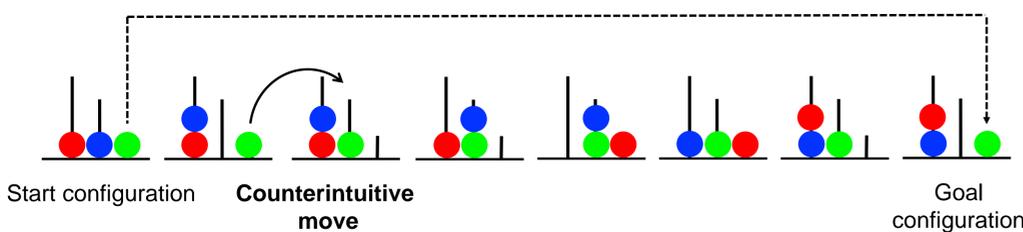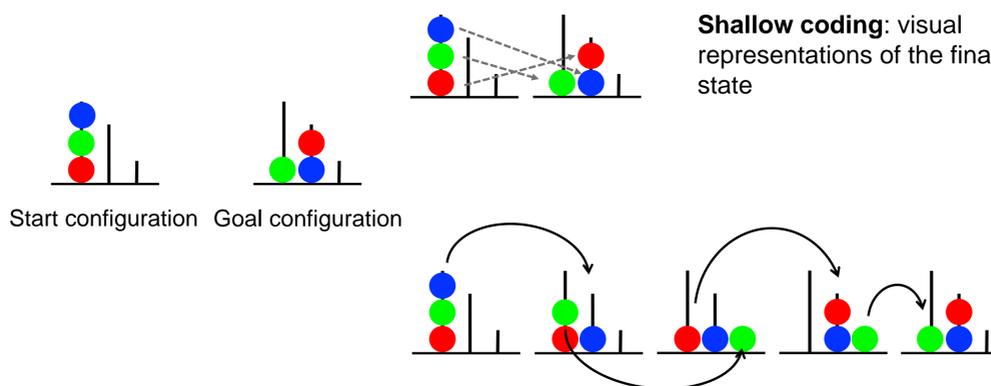
Methods

We will combine the Tower of London task (ToL Shallice 1982), with fMRI methods, including multivariate and representational similarity analysis (RSA).

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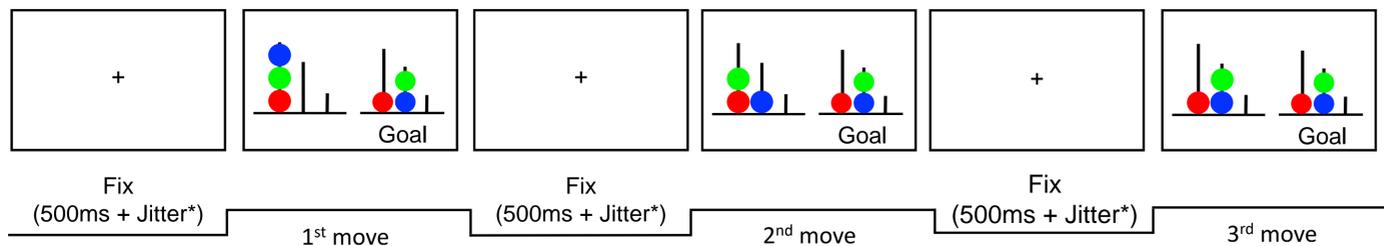
25 participants will participate in a computerised version of the ToL task (demo).

Searchlight RSA will first be used to identify brain areas involved in shallow coding (e.g., showing activations covarying with visual similarity to the goal) and deep coding (e.g., covarying with the number of moves remaining to achieve the goal).

Shallow coding: visual representations of the final state

Deep coding: progressive transition from initial towards final states, achieved by moving coloured balls between pegs

A crucial testbed will come from "counterintuitive moves" within ToL. These involve displacing a ball AWAY from its goal position to get another ball in place first.

Expected results

The main anticipated outcome of this project is a demonstration of which coding scheme(s) (co-)exist in the human brain under different scenarios in voluntary, goal-directed action. This will help to understand the nature of volitional processes and how the brain keeps tracking what we want to achieve.

The second anticipated outcome is a clarification of the interplay of brain regions involved in these processes, and when and why they might change their coding.
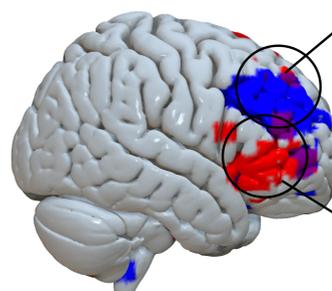
dlPFC (dorso-lateral PFC) pattern of activation correlated with the index of operations necessary to transit from an initial state to the desired state (deep coding - particularly evident for counterintuitive problems).

vlPFC (ventro-lateral PFC): pattern of activation related to the visual similarity between actual and goal states (shallow coding).

References

Haggard, P. (2008). Nature Reviews Neuroscience, 9(12), 934-946.
Shallice, T. (1982). Philosophical Transactions of the Royal Society of London. B, 298(1089), 199-209.

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