Voluntary action and problem solving

Silvia Seghezzi & Patrick Haggard

Introduction

Volition refers to the mental capacity to initiate actions through one's autonomous decisions. Scholars disagree over definitions of volition (1). Further, existing experimental paradigms for studying volitional action focus on arbitrary, meaningless actions and on their neural precursors. In contrast, this project develops a new view of volition as means-ends problem solving. We study how volition contributes to the organisation and execution of complex goal-directed action sequences, thus linking volition to classical neuropsychology of executive functions and problem-solving. The project considers volition as a 'smart' cognitive function, providing an alternative to current views of volition as either randomness, or subjective preference in evaluative decision- making. Here, a structured series of three experiments used "Tower of London" tasks (2) to identify distinct cognitive processes related to volition, such as planning, choice, and inhibitory control.

Methods

Participants (N=31) performed ToL problems on a computer. They moved coloured balls between pegs, transforming a start configuration into a goal configuration. Each trial thus involves planning and then executing a path through a problem-space, by a series of voluntary actions. Each action is assumed to follow from a prior plan, barring planning or execution errors, to approach the goal. We selected problem configurations, so that contrasts between specific configurations provided an operational definition of a cognitive process previously identified as fundamental to voluntary action. These were processes of pre-planning, of choice between alternatives, and of inhibition of a prepotent but suboptimal action. The timing ((RT: reaction time) of each action was recorded.

Results

We distinguished three main parameters of the problem that modulated the timing of voluntary actions.
1. Plan capacity: longer action sequences were associated with increased RTs for the ***FIRST*** keypress of the sequence.
2. Counterintuitive moves involve displacing a ball AWAY from its goal position to get another ball in place first. These were associated with increased RTs compared to the other moves within the sequence.
3. Turning point moves commit a participant to one of two alternative paths that have equal value. These were associated with increased RTs compared to the other moves within the sequence.

Discussion

Our results showed that three key cognitive processes that underpin many voluntary actions can be identified within the ToL task, from their effects on movement timing. These are the capacity of an internal action plan, the inhibition of a suboptimal move, and picking between alternative action possibilities. Thus, ToL fulfils many of the criteria that cognitive neuroscience expects of a definition of volition[1], namely: internally-generation, goal-directedness, and spontaneity. This study shows that the cognitive psychology of means-ends problem-solving can provide insightful and valuable tools for investigating the neuropsychological processes of voluntary action, paving the way for the use of ToL type problems for the investigation of the neural precursors of voluntary action.

References

1 Haggard, P. Annu Rev Psychol 70, 9-28, (2019).
2 Shallice, T. Philos Trans R Soc Lond B Biol Sci 298, 199-209, (1982).