Cortico-striatal white-matter connectivity underlies the ability to exert goal-directed control

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Abstract

The balance between goal-directed and habitual control has been proposed to determine the flexibility of instrumental behavior, in both humans and animals. This view is supported by neuroscientific studies that have implicated dissociable neural pathways in the ability to flexibly adjust behavior when outcome values change. A previous Diffusion Tensor Imaging study provided preliminary evidence that flexible instrumental performance depends on the strength of parallel corticostriatal white-matter pathways previously implicated in goal-directed and habitual control. Specifically, estimated white-matter strength between caudate and ventromedial prefrontal cortex correlated positively with behavioral flexibility, and posterior putamen – premotor cortex connectivity correlated negatively, in line with the notion that these pathways compete for control. However, the sample size of the original study was limited and so far, there have been no attempts to replicate these findings. In the present study, we aimed to conceptually replicate these findings by testing a large sample of 205 young, healthy adults to relate cortico-striatal connectivity to performance on the slips-of-action task. In short, we found only positive neural correlates of goal-directed performance, including striatal connectivity (caudate and anterior putamen) with the dorsolateral prefrontal cortex. However, we failed to provide converging evidence for the existence of a neural habit system that puts limits on the capacity for flexible, goal-directed action. We discuss the implications of our findings for dual-process theories of instrumental action.

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