

Theme: Imaging Research in Basic and Clinical Science: Neuroscience, Cardiology and Oncology

Opposing “actor-critic” hypo- and hyper-activation in autism and obsessive-compulsive disorder

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Abstract:

Repetitive behaviour, a hallmark of dysfunctional inhibition, is a transdiagnostic trait across diverse neuropsychiatric disorders. However, what are the precise validators that differentiate between these nosological entities? We took the paradigms of two disorders characterized by repetitive behaviours – autism spectrum disorder (ASD) and obsessive-compulsive disorder (OCD) – and applied a novel “actor-critic” approach, based on reinforcement learning theories, to capture inhibition as an ecological construct, involving error monitoring. We evaluated 21 healthy controls (HC), 18 adults with ASD, and 19 adults with OCD (age and sex-matched) while performing an fMRI-adapted stop-signal task. ROIs, from which we extracted beta-values of brain activation, were defined based on the intersection between task-related whole-brain activity maps and the anatomical boundaries of the striatum (the “actor”/action-based module) and dopaminergic midbrain (“the critic”/value-based module). Three-group comparison revealed a significant group \times inhibition phase \times ROI interaction ($Z(2,55) = 2.197$, $p = 0.013$). HCs exhibited a remarkably consistent sequence across all the “actor-critic” regions with activation during successful inhibition, further activity increases during failed inhibition, and a sharp decline during error processing. The ASD group displayed an inverse pattern in the ventral tegmental area with hypoactivation during failed inhibition, compared with HCs ($t(37) = 3.472$, $p = 0.001$) and OCD subjects ($t(35) = 2.302$, $p = 0.028$). The OCD group showed caudate hyperactivation regarding error monitoring phases ($t(38) = 2.951$, $p = 0.005$). These findings suggest two disorder-specific signatures: difficulties in error recognition in ASD and error-hypervaluation in OCD. We also advocate for the research utility of the actor-critic model in effectively incorporating central aspects of neuropsychiatric disorders: timing dynamics, domain-specificity, and construct inter-relatedness.

Keywords: autism, obsessive-compulsive disorder, actor-critic, disorder-specific, midbrain, striatum