The Effects of Methylphenidate on the Neural Signatures of Sustained Attention

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Abstract

Background
Although it is well established that methylphenidate (MPH) enhances sustained attention, the neural mechanisms underpinning this improvement remain unclear. We examined how MPH influenced known electrophysiological (EEG) precursors of lapsing attention over different time-scales.

Methods
We measured the impact of MPH, compared with placebo, on behavioural and electrocortical markers while healthy adults (n=40) performed a continuous monitoring paradigm designed to elicit attentional lapses.

Results
MPH led to increased rates of target detection and electrophysiological analyses were conducted to identify the mechanisms underlying these improvements. Lapses of attention were reliably preceded by progressive increases in α-activity that emerged over periods of several seconds. MPH led to an overall suppression of α-activity across the entire task but also diminished the frequency of these maladaptive pre-target increases through a reduction of α-variability. A drug-related linear increase in the amplitude of the frontal P3 event-related component was also observed in the pre-target timeframe (3–4 s). Further, during immediate target processing there was a significant increase in the parietal P3 amplitude with MPH, indicative of enhanced perceptual evidence accumulation underpinning target detection. MPH-related enhancements occurred without significant changes to early visual processing (visual P1 and 25Hz steady-state visual evoked potential).

Conclusions
MPH serves to reduce maladaptive electrophysiological precursors of lapsing attention by acting selectively on top-down endogenous mechanisms that support sustained attention and target detection with no significant effect on bottom-up sensory excitability. These findings offer candidate markers to monitor the therapeutic efficacy of psychostimulants or to predict therapeutic responses.