Understanding Attention Deficit Hyperactivity Disorder: Does it affect proactive or reactive brain processes?

Successful planning and goal-directed behaviour is an integral part of everyday life. Activating and remembering goals, and then putting intended goal plans into action at the appropriate moment requires is essential for successful task performance, but requires mental effort. In this study we compared these processes in adults with and without Attention Deficit Hyperactivity Disorder, and investigated whether task performance and brain activity were associated with people's self-reported levels of impulsivity.

Sixteen adults with ADHD and 20 adults without ADHD took part in a cued version of the colour-word Stroop task, where they were presented with colour names printed in specific colours and were instructed *either* to read the word presented *or* to name the ink colour. Sometimes the colour matched the word (requiring little mental effort to select a response), and sometimes it conflicted with the word (requiring a lot of mental effort to select a response). While completing the task, participants' brain activity was measured using electroencephalograms (EEGs) recorded. We were particularly interested in the brain activity that occurred after receiving the instruction for the trial, but before the colour-word was presented, as this should indicate the proactive processes that people engage in activating and maintaining a goal. Participants also filled in a questionnaire reporting on three aspects of their impulsivity – tendency to act impulsively, difficulty maintaining attention, and tendency not to plan ahead.

As expected, all participants performed better on the Stroop task when the colour matched the word than when they did not match. Participants with ADHD showed an

even greater discrepancy between their performance on easy and hard trials. They also reported more problems with acting impulsively than the control participants. Interestingly, they did not report greater problems with inattention – possibly because many of the participants with ADHD usually took medication to control this. Nevertheless, we found that individuals (both with and without ADHD) who reported more problems with inattention slowed down more when the Stroop trials demanded attentional control. In contrast, people with a diagnosis of ADHD and people reporting a tendency to act impulsively made the most errors on the task. Although we expected that proactive brain activity (occurring between the instruction and the cue to respond) would be associated with better performance on the Stroop task, instead we found the opposite – proactive brain processes were strongest among participants who had most difficulty with the Stroop task. This may be because people with inherent problems controlling their attention may have compensated by putting in more mental effort.

This study demonstrates that different aspects of self-rated impulsivity are associated with different kinds of task behavior – inattention is associated with slower behavioural responses, while impulsive action is associated with committing errors. Our results suggest that medication for ADHD may effectively treat inattention problems, but may be less effective at helping people to control their impulsive actions. We also conclude that proactive brain processes, which have been little studied to date, are highly relevant to how well people can control their attention, and may be a useful focus for future research into assisting people to manage attentional difficulties.