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Stimulus-reward association and reversal learning in individuals with Asperger Syndrome

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ABSTRACT

In the present study, performance of a group of adults with Asperger Syndrome (AS) on two series of object reversal and extinction was compared with that of a group of adults with typical development. Participants were requested to learn a stimulus-reward association rule and monitor changes in reward value of stimuli in order to gain as many points as possible. In order to assess whether difficulties with stimulus-reward association learning and with reversal and/or extinction might be related to social and behavioural impairments, we performed correlation analyses between test measures and scores measuring the severity of clinical symptoms in the areas of repetitive behaviours and social interaction as assessed by the Autism Diagnostic Interview-Revised (ADI-R) [Lord, C., Rutter, M., & Le Couteur, A. (1994). Autism diagnostic interview-revised: A recise version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders, 24*, 659–685]. Individuals with AS showed difficulties in establishing rapid stimulus-reward associations, whereas no severe impairment was observed in reversal and extinction learning. In addition, the present findings show that these difficulties correlate with scores in social reciprocal interaction, suggesting that the diminished ability in the assignment of reinforcement value to incoming stimuli might be related to disturbances in social behaviour often reported in autism spectrum disorders.

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1. Introduction

Autism spectrum disorders (ASDs) are pervasive developmental disorders characterized by abnormal social interaction, communication problems, restricted interests and disruptive stereotypic movements. Within the domain of ASD, *high functioning autism* (HFA) commonly refers to individuals meeting criteria for autism with normal intellectual functioning and a history of speech and language delay. Those at the higher functioning end, diagnosed with *Asperger Syndrome* (AS, DSM-IV, American Psychiatry Association, 2000; ICD-10, World Health Organization, 1992), show no evidence of impaired language function and their intellectual abilities fall within the normal range. As individuals within the ASD, clinical features of HFA and AS include poor communication, inappropriate social interactions, restricted interests and stereotypic behaviour. Although cognitive abnormalities are generally more severe in HFA than in AS, it is widely accepted that both conditions are part of the same spectrum of syndromes. Therefore, in the present work, we did not intend to draw any distinction between HFA and AS.

As shown by several works, using advanced Theory of Mind tasks, difficulties in social reasoning and understanding of others' mental states have also been reported in HFA or AS (Abell, Happe, & Frith, 2000; Happé, 1994; Jolliffe & Baron-Cohen, 1999; Stone, Baron-Cohen, & Knight, 1998; Zalla, Sav, Stopin, Ahade, & Leboyer, 2009). Along with a well-documented literature on mindreading disturbances, several studies have provided evidence in favor of executive dysfunctions in ASD. The executive functions refer to a whole range of adaptive abilities necessary to planning, working memory, inhibition and mental flexibility, as well as to initiation and monitoring of action (Ozonoff, Pennington, & Rogers, 1991; Russell, Saltmarsh, & Hill, 1999). Two executive components are thought to be crucially involved in successful social cognition and mindreading: (1) the ability to hold in mind multiple perspectives (i.e., working memory) and (2) the ability to suppress dominant but irrelevant perspectives (i.e., inhibitory control).

Impairments in executive functions (EFs) in people with HFA have been reported by using tests, such as the Tower of Hanoi task (Ozonoff et al., 1991), the Tower of London task (Hughes, Russel, & Robbins, 1994) and the Wisconsin Card Sorting Test (WCST) (Ozonoff et al., 1991). However, evidence in favor of a specific impairment in inhibitory control in people with HFA or AS remains controversial. Individuals with HFA might encounter difficulties in inhibiting the prepotent response in tests, such as the Windows task (Russell, Mauthner, Sharpe, & Tidswell, 1991), the oculomotor antisaccade task (Luna, Doll, Hegedus, Minshew, & Sweeney, 2007) and the Detour reaching task (Hughes & Russell, 1993). Conversely, they do not exhibit difficulties in inhibition on the Stroop paradigm (Ozonoff & Jensen, 1999), on the stop signal paradigm (Ozonoff & Strayer, 1997) and on the Go-NoGo task (Ozonoff & McEvoy, 1994). A recent study using more ecological tests, such as the Six Elements multitask and the Hayling test has also reported inhibitory and executive dysfunctions in individuals with AS suggesting specific impairments when inhibitory control is required in conjunction with increased attentional resources (Hill & Bird, 2006).

Dias, Robbins, and Roberts (1996) have provided evidence that two dissociable forms of inhibitory control, cognitive and affective, are mediated by different regions of the prefrontal cortex. Animal research has led to the suggestions that damage to the lateral prefrontal cortex causes a loss of inhibitory control in higher order shifting between supra-ordinate features of visual stimuli and attentional selection, whereas damage to orbitofrontal cortex (OFC), because of its close connections with the limbic system, causes a loss of inhibitory control in affective processing, thus disrupting the ability to adapt behaviour to changes in the emotional and social significance of stimuli (Rolls, 2004; Schultz, Tremblay, & Hollerman, 2000). Inhibitory control over inadaptive responses is crucial in the context of a complex interactive social environment, in which one has to respond and adapt one's own behaviour to rapidly and constantly changing situations and affective valued stimuli, such as gestures, face and voice expressions (Loveland, 2001).

The reinforcement effects of behavioural outcomes are mediated by a wide neural circuit also including subcortical neural structures, such as striatum, the amygdala and the thalamus (Komura et al., 2001; Schultz et al., 2000; Tremblay & Schultz, 2000; Zalla, Koechlin, Pietrini, Basso, Aquino, & Grafman, 2000). This response-reinforcer learning mechanism depending on the basal ganglia and the amygdala presumably plays a crucial role in the formation of instrumental behaviour underlying goal-directed actions (Sander, Grafman, & Zalla, 2003). Recently, Pasupathy and Miller (2005)