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High functioning children with autism spectrum disorder: A novel test of multitasking

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Abstract

High functioning children with a diagnosis of autism or Asperger's syndrome (HF-ASD) often experience difficulties organising goal-directed actions in their day-to-day lives, requiring support to schedule daily activities. This study aimed to capture these everyday difficulties experimentally using multitasking, a methodology that taps into the cognitive processes necessary for successful goal-directed activities in everyday life. We investigated multitasking in children with HF-ASD using a novel multitask test, the Battersea Multitask Paradigm. Thirty boys participated in the study, 14 with HF-ASD and 16 typically developing controls, matched for age and IQ. Group differences in multitasking were observed. Participants with HF-ASD were less efficient at planning, attempted fewer tasks, switched inflexibly between tasks and broke performance rules more frequently than controls.

Keywords: Multitask; Autism; Asperger's syndrome; Executive function; Prospective memory; BRIEF; Frontal lobe

1. Introduction

"I bet he'll become a rocket scientist, but I'll probably have to dress him and drive him to work."

Mother speaking of her son with high functioning autism, cited in Ozonoff, Dawson, and McPartland (2002, p. 18).

This mother's comment accurately summarizes the paradox faced by many high functioning children with autism spectrum disorder (HF-ASD). By definition, children with *high functioning* autism have normal or above normal intelligence and relatively well developed structural language and cognitive skills (Ozonoff et al., 2002). However, even though some children with HF-ASD achieve milestones such as forming a career or getting a university degree, they continue to have difficulties with the demands of everyday life and may struggle to live independently as adults (Howlin & Goode, 1998). One of the reasons that individuals with HF-ASD find it hard to live independently is because they have difficulties organising and coordinating everyday activities. Children with HF-ASD are commonly reported to have difficulties with time management, organising the materials necessary to perform an activity and sequencing activities; generally reflecting a deficit in the ability to plan ahead (Ozonoff et al., 2002). This impacts upon day-to-day life: at school children can fall behind in class due to poor time management and difficulties organising their workload, homework is all too often left at school instead of being brought home. At home, activities of daily living such as getting dressed or getting ready for bed take longer to perform, often leading to frustration on all sides (Ozonoff, 1998).

The question arises of how to capture these everyday problems experimentally. A number of studies have investigated executive control processes in children with HF-ASD. This research has consistently identified executive function (EF) impairments in individuals with autism

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(Ozonoff, 1998; Pennington & Ozonoff, 1996). The executive profile of children with ASD is one of 'high level' difficulties (Hughes, 2001). Executive deficits in ASD are typically more pronounced than those observed in other developmental disorders (Pennington & Ozonoff, 1996) and may occur across a range of domains of EF (Geurts, Verte, Oosterlaan, Roeyers, & Sergeant, 2004). Planning and cognitive flexibility stand out as areas of EF that present particular difficulties for individuals with ASD. Children with ASD plan poorly on tasks such as the Tower of Hanoi (TOH) relative to both clinical (e.g., children with Attention Deficit Hyperactivity Disorder and children with Tourette's syndrome) and typically developing control groups (Hughes, Russell, & Robbins, 1994; Ozonoff & McEvoy, 1994; Ozonoff, Pennington, & Rogers, 1991). On tests of cognitive flexibility, participants with ASD demonstrate impaired cognitive flexibility (Ozonoff et al., 1991; Ozonoff, Strayer, McMahon, & Filloux, 1994; Prior & Hoffman, 1990; Szatmari, Tuff, Finlayson, & Bartolucci, 1990), engage in highly perseverative and inflexible strategies (Hughes et al., 1994) and show impaired performance when shifting response set (Ozonoff et al., 1994). In comparison, deficits in inhibitory control are less pronounced in ASD, but may depend upon the measure used to assess inhibitory skills. Participants with ASD often perform as well as controls on traditional tests such as the Stroop test (Eskes, Bryson, & McCormick, 1990; Ozonoff & Jensen, 1999; Russell, Jarrold, & Hood, 1999). However, inhibitory dysfunction in ASD has been reported in studies employing different measures such as Go–NoGo paradigms (Geurts et al., 2004; Nyden, Gillberg, Hjelmquist, & Heiman, 1999).

Although it is probable that this profile of executive dysfunction has a significant impact upon the everyday lives of children with HF-ASD and their families, few studies have sought to measure this effect. Executive dysfunction in children and adults with HF-ASD has been shown to correlate significantly with measures of adaptive behaviour (Ozonoff et al., 2004). Performance on the Tower of London task relates to communication symptoms in school age children with autism (Joseph & Tager-Flusberg, 2004). Poor cognitive flexibility may be related to the everyday repetitive behaviours that characterize ASD (Hughes, 2001), however this relationship has not consistently been reported (Joseph & Tager-Flusberg, 2004).

It is possible that so little evidence exists to support relationships between EF and everyday difficulties in ASD because many tests of EF involve planning or solving a single problem within highly structured, clearly defined limits. In contrast, multitask tests assess an individual's ability to organise and coordinate the performance of *multiple* activities in a more fluid environment which is more representative of everyday life (Burgess, Veitch, Costello, & Shallice, 2000; Shallice & Burgess, 1991).

In a multitask test, the participant is required to perform a number of tasks within a given time period. The tasks are interleaved, meaning that they cannot be performed sequentially. Success is constrained by a set of rules which typically restrict the order in which tasks can be performed. These time and rule-based constraints emulate practical restrictions placed upon the organisation of multiple activities in everyday life, such as performing an activity at or within a certain time or performing one activity in advance of another. Indeed, multitask tests have a high 'ecological validity' as test performance reflects real life difficulties (Alderman, Burgess, Knight, & Henman, 2003; Burgess, Alderman, Evans, Emslie, & Wilson, 1998).

Adult neurological patients with frontal lobe damage can demonstrate significant impairments organising activities in their day-to-day lives. For example, Shallice and Burgess (1991) report a patient who shopped for food sequentially, returning to his car after purchasing each individual item, because coordinating buying multiple items at one time was too challenging. Such patients perform poorly on multitask tests, demonstrating poor time management (i.e., spending too long on one task), failing to attempt all tasks assigned (despite being aware of the requirement to do so), breaking the rules and carrying out subtasks incorrectly (Burgess & Shallice, 1996; Burgess et al., 2000; Shallice & Burgess, 1991).

The key difficulty of these patients is an impaired ability to create and activate delayed intentions (Burgess et al., 2000). In a multitask test, multiple intentions (to perform multiple tasks) are created, but the execution of the majority of these intentions must be delayed, as it is not possible to perform all the tasks simultaneously. Moreover, during this delay, attention is focused on another activity (the current task) rather than the 'to-be-performed' (delayed) tasks. When an intention is delayed, an 'intention marker' must be created. When this marker is subsequently activated, it 'brings to mind' the intended action and switches the focus of attention to performing the intended task. These processes of marker formation, activation, and intention execution are believed to be impaired in adult frontal lobe patients who perform poorly on multitask tests and in their everyday lives (Burgess, 2000; Burgess et al., 2000).

Recent investigations into the cognitive processes involved in multitasking have placed the organisation of prospective actions firmly within the context of the executive control of behaviour (Burgess et al., 2000; Kliegel, Martin, McDaniel, & Einstein, 2002). The ability to create and activate delayed intentions has been defined as prospective memory, PM (Burgess et al., 2000; Einstein & McDaniel, 1996; Ellis, 1996). Successful prospective remembering is influenced by retrospective mnemonic processes and various executive functions (Burgess et al., 2000; Kliegel et al., 2002; Shallice & Burgess, 1996). Retrospective memory is important for storing the content of an intended action. We not only need to remember that we intend to do something, we must also remember what it was that we intended to do. Planning is the EF most involved in the creation of delayed intentions, and the success with which an intention is executed is influenced by the quality of the plan through which it was set up (Gollwitzer, 1999). Switching attention from a current task to the intended task requires