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## Investigating distinct and related contributions of Weak Central Coherence, Executive Dysfunction, and Systemizing theories to the cognitive profiles of children with Autism Spectrum Disorders and typically developing children



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### ABSTRACT

Many attempts have been made to explain the cognitive profiles of children and adults with Autism Spectrum Disorders (ASD). The current study investigated three prominent theories of cognitive processing – Weak Central Coherence, Executive Dysfunction, and Systemizing – to determine how they could define the cognitive patterns of performance in children with ASD. Utilizing tasks that tapped into visuospatial and linguistic domains, and both parent-report and child performance, the present research found support for the Weak Central Coherence and Executive Dysfunction theories in accounting for distinct cognitive profiles in children with ASD. No differences were observed between children with ASD and TD children on Systemizing abilities or preferences. The results also indicate that cognitive profiles in ASD may manifest in different ways in children historically considered High-Functioning Autism and Asperger's Syndrome. Additionally, the present research demonstrated the importance of using comprehensive measures to assess cognition and behavior in children with ASD. These results provide support for the consideration of individual differences in cognitive profiles of children with HFA and children with AS when developing educational and therapeutic programming.

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### 1. Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that presents a pattern of impairments across social communication and restricted/repetitive behaviors and interests (American Psychiatric Association [APA], 2013). The current overall prevalence rate of ASD diagnoses is 1 in 68 children (Center for Disease Control, 2014) and as low as 1 in 50 among school-aged children (Blumberg et al., 2013). As more children are diagnosed with ASD, empirical investigations into the cognitive mechanisms underlying ASD are increasingly vital. Current proposals have suggested that consideration of multiple theories may provide a more thorough understanding of the mechanisms underlying cognitive processing in ASD (e.g., Brundson & Happé, 2014; Happé & Ronald, 2008). In addition to utilizing a multifold theoretical approach to studying cognitive processes in individuals with ASD, it is well established that individual characteristics are also just as important considering the heterogeneity of abilities observed in ASD (e.g., López & Leekam, 2003; Loth, Gomez, & Happé, 2008).

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Consistent with that thought, the present research uses multiple methods to assess three current and prominent cognitive theories of ASD, Weak Central Coherence (Frith, 1989), Executive Dysfunction (Pennington & Ozonoff, 1996), and Systemizing (Baron-Cohen, 2002), with the main objective being to examine the extent to which these theories, together and alone, provide a viable explanation for the cognitive profiles of individuals with ASD. Through the use of comprehensive measures to capture each cognitive theory and exploring individual differences across historical diagnostic classifications, the present study will investigate the unique contributions, as well as the relations between Weak Central Coherence, Executive Dysfunction, and Systemizing theories in children with ASD and typically developing (TD) children.

### 1.1. Weak Central Coherence theory

Weak Central Coherence theory was first proposed by Frith (1989) and rests on two basic principles: (1) individuals with ASD possess a natural bias to focus on the local properties of information and (2) individuals with ASD exhibit difficulties integrating the local properties of information into meaningful representations. Support for the Weak Central Coherence theory has been found across visuospatial and linguistic tasks in children with ASD. Superior performance has been observed in children with ASD on the Children's Embedded Figures Test (CEFT; Witkin, Oltman, Raskin, & Karp, 1971), a task that requires disengaging from a larger, meaningful picture in order to locate a hidden figure. Multiple studies have found that children with ASD as young as three years of age were able to complete this task faster than TD children (e.g., Jarrold, Gilchrist, & Bender, 2005; Keehn et al., 2009). In linguistic tasks, children with ASD have also shown difficulties in global processing and a preference for local processing. Children with ASD commit more errors on tasks that require the use of context in pronouncing words and completing sentences (e.g., Booth & Happé, 2010; Burnette et al., 2005; López & Leekam, 2003). These studies indicate that Weak Central Coherence theory has viability in accounting for the cognitive profile across domains in children with ASD.

Several recent findings, however, suggest that not all paradigms demonstrate context insensitivity or weak global processing in ASD across visuospatial and linguistic tasks (e.g., Henderson, Clarke, & Snowling, 2011; López & Leekam, 2003). Some studies have found that global or contextual processing depends primarily on individual characteristics, such as language (e.g., Brock, Norbury, Einav, & Nation, 2008) or task instructions (e.g., López, Hadwin, Donnelly, & Leekam, 2004; Plaisted, Swettenham, & Rees, 1999). Furthermore, others have found that Weak Central Coherence profiles may vary across visuospatial and linguistic tasks, with some individuals with ASD exhibiting greater local processing and weaker global processing across both domains, and others displaying this pattern in only the visuospatial or linguistic domain (e.g., Loth et al., 2008). To address these uncertainties, the present research will utilize both visuospatial and linguistic tasks to assess Weak Central Coherence in children with ASD and TD children. The findings will illustrate whether there are distinct profiles of Weak Central Coherence across task domains.

### 1.2. Executive Dysfunction theory

The Executive Dysfunction theory has also been proposed to account for the cognitive and behavioral profiles in ASD (e.g., Ozonoff, Pennington, & Rogers, 1991). Individuals with ASD have demonstrated Executive Dysfunction, with difficulties in inhibition (e.g., Verté, Geurts, Roeyers, Oosterlaan, & Sergeant, 2006), planning (e.g., Geurts, Verté, Oosterlaan, Roeyers, & Sergeant, 2004), and cognitive flexibility (e.g., Semrud-Clikeman, Fine, & Bledsoe, 2014).

However, some studies evaluating executive functioning in ASD have yielded conflicting results due to the definitions and methods employed (e.g., Joseph, McGrath, & Tager-Flusberg, 2005; Robinson, Goddard, Dritschel, Wisley, & Howlin, 2009). Moreover, findings may not always be replicated (e.g., Hill, 2004; Hill & Bird, 2006; Kleinmans, Akshoomoff, & Delis, 2005). Nevertheless, there is a growing body of research that has shown that Executive Dysfunction in children with ASD is more consistently found in cognitive flexibility tasks or tasks that require children to shift from one frame of thought to another (e.g., Reed, Watts, & Truzoli, 2013; Rosenthal et al., 2013; Van Eylen et al., 2011).

Studies of Executive Dysfunction may be further complicated by the discrepancies between lab-based tasks and real-life behavioral reports (e.g., parent, teacher). Reviews of Executive Dysfunction in children with ASD have recommended the use of both types measures as vital in obtaining a comprehensive analysis of children's abilities (e.g., Isquith, Roth, & Gioia, 2013; Toplak, West, & Stanovich, 2013). However, studies that actually implement these methods to our knowledge are few. The present study addresses this issue by incorporating a lab-based task and real-life behavioral report to measure Executive Dysfunction in children with ASD and TD children.

### 1.3. Systemizing theory

According to Systemizing theory, individuals with ASD learn new information by seeking predictable relationships and following set rules (Baron-Cohen, 2002). To systemize one must initially observe the *Input*, understand its *Operation*, or the rules by which the *Input* functions, and finally arrive at the predicted *Output*. By following these steps, individuals can reliably predict change (Baron-Cohen, 2006).

Systemizing has been proposed as the cognitive drive for repetitive ("stimming") behaviors, obsessions, and resistance to change (Baron-Cohen, 2006; Wheelwright & Baron-Cohen, 2011), thus presenting a compelling framework to understand cognitive processes in children with ASD. Assessments of Systemizing ability have typically relied on behavioral

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