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Executive functions in Asperger's syndrome: An empirical investigation of verbal and nonverbal skills☆

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ABSTRACT

Deficits in executive functioning (EF) have been proposed to underlie the behavioural patterns of individuals with an autism spectrum disorder. Researchers have shown that the Asperger's syndrome (AS) population performs more poorly than typically developing controls on many EF tasks. However, the research literature is inconsistent in identifying the specific features or aspects of EF that are affected in this population. This study investigated EF in AS using a bottom-up empirical method. Four visually mediated and three verbally mediated EF tasks from the Delis–Kaplan Executive Functioning System were administered to 33 adolescents with AS and 33 age- and gender-matched controls. Two-step cluster analysis was then used to derive subgroups. Diagnostic composition of these subgroups (AS versus control) was examined to provide empirical evidence of a performance bias towards verbal EF for the AS group. A two cluster solution best fits the data with 73% of the AS participants being classified into one cluster and 64% of the control participants classified into another. Assignment into cluster A was based primarily upon low performance on the four visual EF tasks whereas assignment into cluster B was based primarily upon good performance on the four visual EF tasks and one verbal EF task.

1. Introduction

Researchers have focused on a description and characterization of executive functions (EFs) in individuals with Asperger's syndrome (AS) (e.g., Ozonoff, Rogers, & Pennington, 1991). Despite reports documenting EF deficits, there are no consistent findings describing the specific EF abilities of individuals with AS, nor is there unequivocal evidence differentiating AS from related disorders, such as Autistic Disorder and Pervasive Developmental Disorder – Not Otherwise Specified, based on EF dysfunction. This study investigated EF abilities in adolescents and young adults with AS via a bottom-up empirical design to understand better the specific EF strengths and weaknesses of these individuals.

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1.1. Asperger's syndrome: diagnostic criteria

Both the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision* (DSM-IV-TR; American Psychiatric Association, 2000) and *International Classification of Diseases, Tenth Edition* (ICD-10; World Health Organization, 1994) clinical classification systems currently recognize AS as a separate and distinct diagnostic disorder. AS is clinically described by impairments in social interaction and repetitive and stereotyped behavioural patterns, with no significant delay in language, cognitive, or adaptive development. Additionally, the criteria for another autism spectrum disorder (ASD) cannot be met for a diagnosis of AS. The prevalence rate of AS is conservatively reported to be 2.5–2.6 per 10,000 children (Fombonne, 2003, 2005).

1.2. Neuropsychological Functioning

A common definition of intelligence (IQ) is "the aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment" (Wechsler, 1944). Asperger's original accounts (Asperger, 1944/1991) described his cases as possessing normal cognitive intelligence and being capable of gainful employment. However, researchers have found that individuals with AS manifest higher verbal (VIQ) and lower performance (PIQ) skills (Ehlers et al., 1997; Ghaziuddin & Mountain-Kimchi, 2004; Klin, Volkmar, Sparrow, Cicchetti, & Rourke, 1995; Koyama, Tachimori, Osada, Takeda, & Kurita, 2007; Lincoln, Allen, & Killman, 1995; Lincoln, Courchesne, Allen, Hanson, & Ene, 1998; Miller & Ozonoff, 2000; Ozonoff, South, & Miller, 2000). Furthermore, relative strengths in the verbally mediated cognitive subtests of the Wechsler scales (e.g., Information, Vocabulary, Comprehension, Similarities, and Arithmetic) (Ehlers et al., 1997; Ghaziuddin & Mountain-Kimchi, 2004; Ozonoff et al., 2000) and relative weaknesses in perceptually mediated subtests (e.g., Block Design, Object Assembly, Coding) (Ehlers et al., 1997) have been reported. In line with this is evidence of concordance between the cognitive profiles of AS and Nonverbal Learning Disability (NLD), with strengths in verbally mediated skills (e.g., vocabulary, rote knowledge, verbal memory, and verbal output) and a resulting right hemisphere dysfunction (Klin et al., 1995). However, other researchers have reported no modality differences (Ambery, Russell, Perry, Morris, & Murphy, 2006; Manjiviona & Prior, 1999; Ozonoff, Rogers, et al., 1991; Szatmari, Tuff, Finlayson, & Bartolucci, 1990).

Although finding a distinct IQ profile of AS (especially in light of the concordance with NLD) is thought to be an effective description of their skills and abilities and compelling evidence of a taxonomical distinction between AS and other clinical disorders within the ASD category, this line of evidence cannot be used to describe or differentiate AS from the other ASDs, due to the current diagnostic criteria for these disorders. Indeed, researchers have pointed out that as many as 20% of individuals with AS do not fit this profile, yet still meet the diagnostic criteria for AS (Klin, Pauls, Schultz, & Volkmar, 2005; Klin et al., 1995). Specifically, the diagnostic criteria for AS require that normal language developmental milestones be met. It is therefore not surprising that the majority of individuals with AS demonstrate relative strengths on verbal intelligence tasks. In other words, the diagnostic criteria specify the cognitive, linguistic, and behavioural parameters, resulting in a self-fulfilling prophecy when these factors are examined in research. As such, research investigating the specific skills and abilities of individuals with AS should focus on aspects other than a differentiation in functioning related to verbal intellectual ability.

Several models have been proposed to further investigate the specific skills and abilities of individuals with an ASD, such as AS. One such model used to provide an account of the core symptoms of such disorders is executive functioning.

1.3. Executive functioning in Asperger's disorder

Executive functions (EFs) are defined as "the ability to maintain an appropriate problem-solving set for attainment of a future goal" (Ozonoff, Pennington, & Rogers, 1991). They refer to higher mental processes including a number of interacting, yet theoretically distinct, processes including inhibition, working memory, selective attention, planning, and cognitive and behavioural flexibility (Joseph & Tager-Flusburg, 2004). Executive dysfunction has been proposed to potentially explain restricted interests and repetitive behaviours commonly displayed by individuals diagnosed with an ASD (Lopez, Lincoln, Ozonoff, & Lai, 2005; Pennington, 2002; Turner, 1997, 1999). EF variables commonly investigated in individuals with AS include mental flexibility, planning, and inhibition (Pennington, 1997).

Mental flexibility, or set shifting, is the ability to perceive things in a different manner, respond in unique ways and/or to make necessary cognitive adjustments to assist goal attainment, whereas planning is defined as the ability to form a strategy for goal attainment and see it through regardless of the number of required steps (Calhoun, 2006). Individuals with AS have been observed to perform significantly below typically developing matched controls on measures of mental flexibility and planning such as the Wisconsin Card Sorting Task (Ambery et al., 2006; Ozonoff, Rogers, et al., 1991; Verte, Guerts, Roeyers, Oosterlaan, & Sergeant, 2006), Tower of Hanoi (Ozonoff, Rogers, et al., 1991), and the Tower of London (Verte et al., 2006). It has been suggested that this pattern of reduced mental flexibility and planning could be more commonly displayed as an inability to disengage from an object and shift from an external to an internal point of reference (perseveration) resulting in difficulties relating to people and engaging in conversation where the topic of discussion often changes over time (Hughes & Russell, 1993; Russel, Mauthner, Sharpe, & Tidswell, 1991). However, it should be noted that some researchers have reported no EF deficits in individuals with AS on a local–global shifting task (Rinehart, Bradshaw, Moss, Brereton, & Tonge, 2001) and the WCST (Miller & Ozonoff, 2000; Nyden, Gillberg, Hjelmquist, & Heiman, 1999).