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## The impact of specific language impairment on working memory in children with ADHD combined subtype

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### Abstract

The objective of this study was to examine the impact of comorbid specific language impairment (SLI) on verbal and spatial working memory in children with DSM-IV combined subtype Attention Deficit Hyperactivity Disorder (ADHD-C). Participants were a clinical sample of 8½- to 12½-year-old children diagnosed with ADHD-C. A group of ADHD-C with SLI was compared to a group of ADHD-C without SLI, and a group of normal children, matched on age and nonverbal intelligence. The results show that ADHD-C children with SLI scored significantly lower than those without SLI and normal children, on verbal working memory measures only. Both ADHD groups performed normally on spatial working memory measures. It is concluded that working memory deficits are not a specific characteristic of ADHD but are associated with language impairments. The importance of screening for language disorders in studies of neuropsychological functioning in children with ADHD is emphasized. © 2004 National Academy of Neuropsychology. Published by Elsevier Ltd. All rights reserved.

*Keywords:* Attention Deficit Hyperactivity Disorder; (Specific) Language impairment; Children; Verbal working memory; Spatial working memory

*Abbreviations:* K-ABC, Kaufman Assessment Battery for Children; ADHD, attention/deficit hyperactivity disorder; TOLD-2I, Test of Language Development-2 Intermediate; LI, language impairment; SLI, specific language impairment; WM, working memory; SLQ, spoken language quotient

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Attention deficit hyperactivity disorder (ADHD) is the most common neuropsychiatric disorder of childhood, affecting approximately 1–7% of school-aged children, depending on the stringency of criteria used (American Psychiatric Association, 1994; Swanson et al., 1998). The main characteristics of the disorder are inattention, hyperactivity and impulsivity. DSM-IV differentiates three subtypes of the disorder according to levels of presenting symptoms: the combined subtype (ADHD-C), the predominantly inattentive subtype (ADHD-I), and the predominantly hyperactive-impulsive subtype (ADHD-HI). Denckla (2003) has proposed that many of the externally observable diagnostic characteristics of ADHD, particularly of the ADHD-I subtype, can really be caused by language processing difficulties.

Language impairment (LI) is a highly prevalent comorbidity in children with psychiatric disorders and behavioural problems (Beitchman, Nair, Clegg, Ferguson, & Patel, 1986a; Beitchman, Nair, Clegg, & Patel, 1986b; Beitchman, Wilson, Brownlie, Walters, & Lancee, 1996a; Beitchman, Wilson, Brownlie, Walters, Inglis, et al., 1996; Cantwell & Baker, 1987; Cohen, Barwick, Horodezky, Vallance, & Im, 1998; Cohen, Davine, Horodezky, Lipsett, & Isaacson, 1993; Young et al., 2002). The most common psychiatric diagnosis among children with LI is ADHD (Cohen et al., 1998), and conversely, LI is a frequent comorbidity found in children with ADHD (Cantwell, 1996; Kovac, Garabedian, Du Souich, & Palmour, 2001; Purvis & Tannock, 1997). One study found that approximately two thirds of a consecutively referred ADHD sample reached criteria for LI (Cohen et al., 1998). Despite the frequent co-occurrence of these two common disorders, there have been relatively few studies that specifically investigate language abilities of children with ADHD (Cohen et al., 2000; McInnes, Humphries, Hogg-Johnson, & Tannock, 2003), and it is seldom screened for in studies on neuropsychological deficits in children with ADHD (Sergeant, Geurts, & Oosterlaan, 2002).

The term specific language impairment (SLI) has been used by many researchers to refer to children with normal nonverbal intelligence and a deficit in expressive and/or receptive language that does not appear to be a secondary manifestation of an associated medical disorder (Bartlett et al., 2002; Bishop, 1992; Williams, Stott, Goodyer, & Sahakian, 2000). SLI is believed to affect approximately 7% of children (Leonard, 1998; Tomblin, Smith, & Zhang, 1997). Neuropsychological studies of SLI have revealed deficits in verbal working memory (Hulme & Roodenrys, 1995; Kamhi, Catts, Mauer, Apel, & Gentry, 1988) which is believed by many researchers to be at the root of the language difficulties (e.g., Baddeley & Wilson, 1993; Gathercole & Baddeley, 1989; Swank, 1999). According to Montgomery (2003), some researchers have proposed, that deficient verbal working memory might serve as “a reliable, culture-free marker of SLI”.

Decreased working memory, both verbal and spatial, are among the cognitive deficits purported to be characteristic of ADHD (Barkley, 1997, 2003; Karatekin & Asarnow, 1998; Tannock, 1998). Working memory is one of four executive functions considered to be impaired in ADHD as a result of a lack in behavioural inhibition (Oosterlaan, Logan, & Sergeant, 1998), which in turn has been proposed by Barkley (1997) to be the fundamental impairment in children with ADHD. Studies on working memory in ADHD have shown conflicting results (e.g., Bedard, Martinussen, Ickowicz, & Tannock, 2004; Cohen et al., 2000; Geurts, Verté, Oosterlaan, Roeyers, & Sergeant, 2004; Karatekin & Asarnow, 1998; McInnes et al., 2003; Muir-Broadbent, Rosenstein, Medina, & Soderberg, 2002; Scheres et al., 2004; Siklos & Kerns,

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