



Sleep disruption as a correlate to cognitive and adaptive behavior problems in autism spectrum disorders

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ABSTRACT

Sleep problems associated with autism spectrum disorders (ASD) have been well documented, but less is known about the effects of sleep problems on day-time cognitive and adaptive performance in this population. Children diagnosed with autism or pervasive developmental disorder-not otherwise specified (PDD-NOS) ($N = 335$) from 1 to 10 years of age ($M = 5.5$ years) were evaluated for the relationships of Behavioral Evaluation of Disorders of Sleep (BEDS; Schreck, 1998) scores to measures of intelligence and adaptive behavior. Results suggested that children who slept fewer hours per night had lower overall intelligence, verbal skills, overall adaptive functioning, daily living skills, socialization skills, and motor development. Children who slept fewer hours at night with waking during the night had more communication problems. Breathing related sleep problems and fewer hours of sleep related most often to problems with perceptual tasks. The results indicate that quality of sleep – especially sleep duration – may be related to problems with day-time cognitive and adaptive functioning in children with autism and PDD-NOS. However, future research must be conducted to further understand these relationships.

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1. Introduction

In 1964, 17-year-old Robert Gardner broke the world record for sleep deprivation by staying awake for 264 h without the aid of stimulants (Ross, 1965). This lack of sleep greatly impaired Mr. Gardner's ability to function. Gardner began to have trouble focusing his eyes by the second day of wakefulness. On day three, he experienced mood changes, nausea, and difficulty saying tongue twisters. In addition to his irritability, on the fourth day, Gardner experienced cognitive problems including difficulty concentrating and lapses in memory. Hallucinations and delusions followed, including mistaking a street sign for a person and believing that he was a famous football player being berated by fans. Throughout the rest of his marathon period of wakefulness, Gardner continued to experience these symptoms in addition to fragmented thinking, slurred speech, and blurred vision.

Similarly, sleep disruption has been shown to impair typically developing (TD) children's and adolescents' day-time functioning. Schreck (2010) reviewed the diagnostic relationships of sleep problems to day-time behavior for children and adolescents finding significant relationships. Research has supported Schreck's (2010) review, indicating that young children who sleep fewer hours per night continually experience more difficulty with perceptual tasks and cognitive ability measures

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than children who sleep more (Gruber et al., 2010). The impact of sleep deprivation on children's intellectual functioning also has been shown to impair their academic performance (Fredriksen, Rhodes, Reddy & Way, 2004; Wolfson & Carskadon, 1998).

In addition to lack of sleep in general, specific sleep problems have been shown to have negative effects on cognitive functioning and academic performance in TD children and adolescents. For example, TD children diagnosed with or at risk for sleep-disordered breathing have exhibited more difficulty (a) defining vocabulary words (Suratt et al., 2007); (b) sustaining attention (Blunden, Lushington, Kennedy, Martin, & Dawson, 2000; Owens, Spirito, Marcotte, McGuinn, & Berkelhammer, 2000; Suratt et al., 2007), (c) planning and problem solving (Karpinski, Scullin, & Montgomery-Downs, 2008), (d) inhibiting behavior (Karpinski et al., 2008), (e) performing in school (Montgomery-Downs, Jones, Molfese, & Gozal, 2003; Urschitz et al., 2003), and (f) remembering (Blunden et al., 2000). Like children with sleep disordered breathing, individuals with other sleep problems (e.g., insomnia) also have experienced difficulties with concentration and memory (Fernandez-Mendoza et al., 2009). O'Brien (2009) has asserted that sleep problems (e.g., poor sleep hygiene, sleep restriction, circadian rhythm problems, sleep-disordered breathing, restless legs syndrome, narcolepsy, and insomnia) also have consistently impaired children's attention. With the exception of restless leg syndrome, these sleep problems have also been associated with poor school performance (O'Brien, 2009).

The understanding of the impacts of sleep problems on day-time functioning becomes more vital for children with developmental disabilities (DD), because they tend to have more sleep problems than TD children (Cotton & Richdale, 2006; Goodlin-Jones, Tang, Liu, & Anders, 2009; Richdale, Francis, Gavidia-Payne, & Cotton, 2000). The increased amount of sleep problems for this population in combination with the deficits associated with DD (e.g., cognitive deficits) may result in an even more significant impact of sleep problems on day-time behavior. For example, Wiggs and Stores (1996) have reported that children with DD who have experienced more bed-time settling problems, night waking, and early morning waking have displayed a greater intensity and number of disruptive day-time behaviors than those without sleep disturbances.

Like children with DD in general, children with Autism Spectrum Disorders (ASD) have consistently been diagnosed with sleep problems (Couturier et al., 2005; Honomichl, Goodlin-Jones, Burnham, Gaylor, & Anders, 2002; Malow, Marzec, et al., 2006; Polimeni, Richdale, & Francis, 2005; Richdale & Prior, 1995; Souders et al., 2009). In fact, research has suggested that those with ASD have more sleep problems than TD children and those with other DDs (Allik, Larsson, & Smedje, 2006b; Giannotti et al., 2008; Krakowiak, Goodlin-Jones, Hertz-Picciotto, Croen, & Hansen, 2008; Miano et al., 2007; Paavonen et al., 2008; Schreck & Mulick, 2000; Souders et al., 2009; Tani et al., 2003). When compared with TD children, these problems have resulted in inefficient sleep, such as night waking or lack of sleep (Allik, Larsson, & Smedje, 2008; Bruni et al., 2007; Couturier et al., 2005; Elia et al., 2000; Giannotti et al., 2008; Goldman et al., 2009, 2011; Krakowiak et al., 2008; Limoges, Mottron, Bolduc, Berthiaume, & Godbout, 2005; Miano et al., 2007; Øyane & Bjorvatn, 2005; Paavonen et al., 2008; Patzold, Richdale, & Tonge, 1998; Schreck & Mulick, 2000; Souders et al., 2009; Wiggs & Stores, 2004).

One category of sleep problems common in children with ASD, insomnia, presents as difficulty initiating or maintaining sleep (see Richdale & Schreck, 2009). Children who have ASD have been known to engage in escape behavior at bedtime in attempts to avoid having to go to sleep (Allik, Larsson, & Smedje, 2006a; Bruni et al., 2007; Giannotti et al., 2008; Goldman, Richdale, Clemons, & Malow, in press; Goldman et al., 2009; Paavonen et al., 2008). Even when children go to bed when asked, they often experience difficulty falling asleep (Allik et al., 2006a, 2006b; Allik et al., 2008; Bruni et al., 2007; Giannotti et al., 2008; Goldman et al., 2009, in press; Honomichl et al., 2002; Hoshino, Watanabe, Yashima, Kaneko, & Kumashiro, 1984; Limoges et al., 2005; Miano et al., 2007; Paavonen et al., 2008; Patzold et al., 1998; Richdale, 2001; Richdale & Prior, 1995; Segawa, 1985, as cited in Segawa, Katoh, Katoh, & Nomura, 1992; Souders et al., 2009; Takase, Taira, & Sasaki, 1998; Tani et al., 2003; Wiggs & Stores, 2004; Williams, Sears, & Allard, 2004). Remaining asleep also poses a challenge for this population, as most research has suggested that children with ASD often wake up during the night or early in the morning (Allik et al., 2006a, 2006b, 2008; Bruni et al., 2007; Giannotti et al., 2008; Goldman et al., 2009, in press; Honomichl et al., 2002; Hoshino et al., 1984; Limoges et al., 2005; Miano et al., 2007; Paavonen et al., 2008; Patzold et al., 1998; Richdale, 2001; Richdale & Prior, 1995; Segawa, 1985 as cited in Segawa et al., 1992; Souders et al., 2009; Takase et al., 1998; Tani et al., 2003; Wiggs & Stores, 2004; Williams et al., 2004).

In addition to insomnia, children with ASD may experience circadian rhythm sleep disorders (i.e., delays in falling asleep, waking in a confused state, feeling sleepy during the day, and waking early in the morning). As discussed above, individuals with ASD often have difficulty maintaining and initiating sleep, suggesting problems establishing appropriate sleep-wake cycles. Preliminary research has supported this notion (Giannotti et al., 2008; Segawa et al., 1992). Children in this population have experienced other sleep-quality problems. These sleep-quality problems, such as parasomnias (e.g., confusional arousal, bedwetting, sleep walking, sleep terrors, nightmare disorders), sleep movement disorders (e.g., restless leg, teeth grinding, periodic leg movements, and stereotypic movements), and sleep disordered breathing likely have contributed to night-waking in ASD (Schreck, in preparation; Schreck & Mulick, 2000). These night waking episodes have disrupted sleep for children with ASD more so than children who are TD or have other DDs (Couturier et al., 2005; Goldman et al., 2011; Giannotti et al., 2008; Polimeni et al., 2005; Schreck & Mulick, 2000; Souders et al., 2009).

These types of sleep problems associated with ASD have received considerably more attention from researchers than clarification of their day-time implications. Therefore, knowledge regarding the influence of sleep problems on cognition and adaptive functioning in this population has remained limited. Preliminary research has suggested that a history of decreased sleep duration or poor sleep quality for children with ASD has correlated with nonverbal intelligence deficits (Elia et al., 2000; Gabriels, Cuccaro, Hill, Ivers, & Goldson, 2005), communication problems (Schreck, Mulick, & Smith, 2004), and academic performance difficulties (Paavonen, Nieminen-von Wendt, Vanhala, Aronen, & von Wendt, 2003). However, not all

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