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Daily dynamics in sleep and behavior of young African-American children: A convoluted dyad?!

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ABSTRACT

Prior research has provided evidence that in children sleep and behavior are related. We aimed to determine the association between naturalistic daily variations in sleep and behavioral functioning. African American children, 5.4 ± 1.7 years old, living on the south side of Chicago participated in a repeated measures study to assess this sleep–behavior link. Data was obtained from three separate two-week periods of 24-hour actigraphy and the parental version of the Behavioral Assessment System for Children. Canonical correlations analyses were applied to investigate the relation between individual changes in sleep and behavior.

After 1-month, weekday average sleep duration primarily related to internalizing behaviors, while within-child variability of sleep related to behavioral changes which may involve internalizing and externalizing symptoms. Week-weekend differences in sleep associated with maladaptive social skills. Over a 6-week period, sleep onset latency and sleep offset latency related to behavioral symptoms and maladaptive skills. Over a period of 3-months, sleep associated with symptomatic behaviors while the adverse impact of within-child variability of sleep attenuated. Alternatively, the week-weekend differences in bedtime, wake-up time, wake after sleep onset and sleep onset latency in particular related to internalizing and externalizing behavior problems.

Findings showed that poor sleep related to dysfunctional behaviors. While maladaptive at the beginning, they may develop into symptomatic behaviors with potentially internalizing characteristics. As time goes on, individual changes in sleep onset and offset might be important clinical markers of a chronic 'social dysregulation'. Continued sufficient and regular sleep may improve daytime and nighttime behavioral regulation in early childhood.

1. Introduction

Disturbed sleep has extensively been linked to behavioral difficulties (Arman et al., 2011; Barclay and Gregory, 2013; Bates et al., 2002; Beebe, 2011; Carvalho Bos et al., 2009; Gregory et al., 2004; Gregory and O'Connor, 2002; Gregory and Sadeh, 2012; Nixon et al., 2008; Pesonen et al., 2010; Sadeh et al., 2003), yet this relationship is still unclear. In typically developing children various sleep disturbances have been associated with for instance anxious-depressive behaviors (Gregory and Sadeh, 2012), hyperactive symptoms (Smedje et al., 2001), or attention deficit hyperactivity disorder [ADHD] (Owens, 2008b). Problematic sleep has also been reported in children with psychopathological problems such as autism (Allik et al., 2009; Kotagal and Broomall, 2012), psychiatric disorders (Dueck et al., 2012), ADHD (Kirov and Brand, 2014), and syndromes such as Down syndrome (Churchill et al., 2014). In fact, the sleep–behavior link is not only prevalent in clinical populations, who are referred for sleep problems and/or behavioral problems, but also in epidemiological or non-referral populations and in general pediatric practices (Allik et al., 2009; Bates et al., 2002; Churchill et al., 2014; Dueck et al., 2012; Gregory and Sadeh, 2012; Kirov and Brand, 2014; Kotagal and Broomall, 2012; Owens, 2008b; Smedje et al., 2001).

In contrast to sleep duration, fewer reports exist on the role of sleep parameters such as bedtime, wake up time or irregular sleep in relation to behavioral problems (Biggs et al., 2011; Holley et al., 2011; Kelly et al., 2013; Komada et al., 2011; Kouros and El-Sheikh, 2014; Maski and Kothare, 2013; Nixon et al., 2008). Diversity in methodologies in various studies makes it difficult to disentangle the (bi)directional relationship between sleep and behavior in early childhood. Namely, earlier reports based on the categorical Child Behavior Checklist items, such as "sleeps more/less than most children,"(Gregory and O'Connor, 2002) suggested a sleep–behavior link to be understood as a non-specific correlate (i.e., sleep and behavior problems showed moderate overlap) and as a

Abbreviations: SV, shared variance; WE, weekendday; WK, weekday.

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specific association given that the overlap increased with age. Other studies using subjective (Biggs et al., 2011) and objective (Holley et al., 2011; Nixon et al., 2008; Pesonen et al., 2010) measures of sleep duration are associating internalizing (e.g., thought problems, emotional behaviors and somatic complaints) as well as externalizing behaviors (e.g., conduct problems, ADHD) with differently defined 'short' sleep. There are less consistent findings regarding bedtime (Bates et al., 2002; Biggs et al., 2011; Kelly et al., 2013), wake-up time (Biggs et al., 2011), awakenings (Sadeh et al., 2002) and especially irregular sleep (Biggs et al., 2011) with most studies reporting a negative association between these sleep parameters and behavioral functioning. Bates et al. (2002) further discussed that within-child variability in amount of sleep may predict less optimal adjustment in preschoolers. The idea of 'variability or irregularity' of sleep gained interest in subsequent studies, yet again cut-offs and definitions of 'irregular' sleep vary greatly in literature (Bates et al., 2002; Biggs et al., 2011; Fuligni and Hardway, 2006; Pesonen et al., 2010). For instance, the week-weekend 'irregularity' (Biggs et al., 2011; Pesonen et al., 2010) showed associations with behavioral problems.

The lack of standardized criteria for defining (ab)normal sleep in children, throughout the course of their development, is potentially hindering progress towards more consistent and refined findings (Galland et al., 2012; Jenni et al., 2007; Matricciani et al., 2012a; Matricciani et al., 2012b; Owens, 2008a). Therefore, different approaches might be required to investigate the intricate sleep–behavior association (Blumberg, 2013; Blumberg et al., 2014). These approaches preferably account for the child's prior level of functioning as well as the within-child variability. Equally relevant in this quest is whether such associations are chronic or episodic effects. As far as we are aware, no research has investigated the relationship between repeatedly 'changing' sleep and daytime behavior in children. This lack of evidence is alarming given the acknowledged state of 'social jetlag' or the misalignment of biological and social time, which is characterized by nagging fatigue, cognitive or emotional and behavioral difficulties (de Souza and Hidalgo, 2014; Foster et al., 2013; Haraszti et al., 2014). Altogether, since self-regulation abilities, which is the capacity to control one's impulses allowing one to adjust to his/her environment, continuously develops during early childhood, research on daily variations in wake and sleep behavior would fill a significant gap in the literature, and would inform short and long term prevention and treatment of dysfunctional behavior in childhood.

Then again, the duality in sleep–behavior associations discussed in literature might be explained in terms of biases in researchers' perspectives, since both the sleep and wake state are social and bioregulatory phenomena. For example, sleep research studies have suggested that variables, such as emotional insecurity (El-Sheikh et al., 2007), daily mood (Kouros and El-Sheikh, 2014), violence (Spilsbury, 2009), sleeping through the night (Anders et al., 1992) and mother's life stress (Caldwell and Redeker, 2014) play a role in the child's problematic sleeping, further affecting the child's daytime behavior. But isn't the reverse equally possible? Additionally, scant data exists on the social regulation of sleep or the biocultural interactions influencing sleep of the young child (Worthman and Brown, 2007, 2013). In early childhood, the child is indeed thought to grow to be self-regulating, thoughtful, and a productive member of the family, community, and society. However, a disconcerting lack of sleep research among African-American children exists (Spruyt et al., 2014b). Primarily post-hoc analyses showed that they tend to nap more, longer and till an older age (El-Sheikh, 2011; Hale et al., 2009; Lavigne et al., 1999). Survey results indicated that sleep-impeding circumstances may characterize underrepresented youth's sleep (Spruyt et al., 2014b).We recently reported that their sleep is a daily challenge, with sleep occurring as a need and a chance within a 24-hour society (Spruyt et al., 2014a; Spruyt et al., 2014b). These findings may suggest biocultural dynamics playing a role in the sleep of African-American children.

The current study aims to examine the daily variations in the sleep–behavior association in an underserved sample of African-American children, and to explore on the short-term and long-term bidirectional relationships between sleep and behavior. Based on the consistent observation that poor sleep can become manifest as affective symptomatology, we hypothesized that in early childhood, on the short term, poor sleep will relate to primarily internalizing problems, i.e., an increased sleep propensity may initially present as a withdrawn behavioral repertoire (e.g., blunting of emotions, reduced social responsiveness, dozing off). Week-weekend differences may associate with maladaptive behaviors (e.g., poor social skills, adaptability). Whereas persistent poor sleep may associate with a more differentially affected behavioral profile characterized by symptomatic behaviors (e.g., inattention, somatization and atypicality).

2. Material and methods

2.1. Subjects

This study was approved by the Institutional Review Board of The University of Chicago (IRB 10-677-B) and participating community centers. We obtained informed consent from parents and when applicable assent from children. Subjects were 3 to 9 years of age, lived in the south side of Chicago area and were self-defined as being African Americans.

2.2. Measures

2.2.1. Sleep

The Actiwatch-2 is a non-dominant wrist accelerometer (Philips-Respironics Inc. 2009, version 5) that objectively records sleep and wake states over 24-h. Sleep intervals over a 24-hour period were manually marked based on parental logs and clinical experience (Dayyat et al., 2011; Spruyt et al., 2011a; Spruyt et al., 2011b). Twice a logistic issue resulted in <7 days of recording, that is, for a child in the second and for another child at the third recording period, and hence, data were replaced by regression missing data imputation per child. Sleep parameters of interest are printed in Table 1. Sleep data is expressed in terms of mean and within-child variability (Spruyt et al., 2011b) (i.e., how variable the child sleeps relative to its individual mean) for nighttime sleep; weekdays (Sunday–Thursday; a total of 10 days) and weekenddays (Friday–Saturday; a total of 4 days) given the 14-day recording period.

The Actiwatch-2 was worn on the non-dominant wrist via hospital wristbands. Setting was 1-min epoch and medium threshold. *Bedtime and Wake up time* are the Start time and End time of (longest) rest intervals in that 24-h day. *Total Sleep Time* is representing the amount of time between Start and End times scored as 'sleep'. *Sleep Onset Latency* which is the period between Start Time of the given interval and Sleep Start expressed in minutes. *Wake After Sleep Onset* is calculated as the amount of time between Start and End times of the given interval scored as 'wake' expressed in minutes. *Sleep Offset Latency* is the period between End Time of the given interval and Sleep End expressed in minutes. *Fragmentation Index* being the sum of Percent Mobile and Percent Immobile Bouts Less than 1-minute duration to the Number of Immobile Bouts, for the given interval, or also considered as an Index of Restlessness.

All sleep parameters (except the Bedtime, Wake up Time, Sleep Onset Latency, Sleep Offset Latency and Fragmentation index) were calculated through an enhanced software algorithm applying polysomnography-derived correction factors and using statistics from surrounding major rest periods to improve the sleep statistics for a particular sleep interval recorded by actigraphy. (http://actigraphy.respironics.com/resources.aspx).