Sleep behaviour relates to language skills in children with and without communication disorders

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Background: Sleep problems are common in children with autism spectrum disorder (ASD). There is also emerging evidence that sleep quality influences language learning in typical development. However, there is a gap within the literature in regards to sleep and developmental language disorder in children (DLD).
Objectives: The aims of this study were to: (i) compare sleep patterns of children with communication disorders to the sleep patterns of their typical peers, and (ii) ascertain whether sleep patterns related to language in this sample.
Method: The relationship between sleep and language was investigated via parental questionnaires. There were 65 child participants in total aged between 3 and 18 years. Parents reported on 28 children with a developmental communication disorder (CD; ASD n = 8 or DLD n = 20) and 37 who were typical developing.
Results: The children with a developmental communication disorder showed more sleep problems than their typical peers particularly in terms of getting to sleep and early waking. Furthermore, significant correlations were found between sleep behavior and language for children in both groups.
Conclusion: Children with CD may have poorer sleep patterns than their typical peers which could compound developmental language difficulties.

Keywords: sleep, language-impairment, language, survey

Introduction

Language and communication are key aspects of cognitive function in everyday life and there is now evidence that sleep plays an important role in consolidating these aspects of development in typical children (Fenn *et al.* 2003; Henderson *et al.* 2012; Williams and Horst 2014) as well as in adults (Tamminen *et al.* 2010; Kurdziel *et al.* in press). Notably, sleep has been found to boost learning of novel experimental words in childhood (see Axelsson *et al.* 2016 for an overview) and even in babies as young as 6 months (Simon *et al.* in press). Sleep patterns also associate with school achievement (Gruber *et al.* 2014). However, previous studies examining associations between sleep *problems* and language have largely recruited children with known sleep difficulties and subsequently reported their language skills (e.g. Dahl 1996; Lim and Dinges 2010). An alternative way to explore the same association is to examine sleep behaviors in children with known language difficulties; however, there is very little research in this area.

Two main groups of children with communication difficulties are those with developmental language disorder (DLD — sometimes referred to as specific language impairment but see Bishop 2014; Bishop *et al.* 2016) and those with autism spectrum disorder (ASD). On average the prevalence of DLD is 7% in children (Tomblin *et al.* 1997) and 1% for ASD (Taylor *et al.* 2013), together representing a substantial population of children. Both of these disorders share deficits in communication and also some familial heritability Conti-Ramsden *et al.* 2006). Thus, there is a good deal of overlap but it is not clear to what degree their etiology or wider symptoms such as sleep are shared (see Williams *et al.* 2008, for a discussion).

Children with ASD have been studied extensively in relation to sleep difficulties, showing an increased prevalence in this group. Mannion and Leader (2014) reviewed these studies and reported a range of prevalence rates from 33% (Goldman *et al.* 2011) to 80.9% (Mannion *et al.* 2013). Sleep difficulties include time getting to sleep and night-waking, but at the clinical level sleep disorders are predominantly described as insomnia (Cohen *et al.* 2014) or as 'unspecified' (Malow *et al.* 2016). The review by Cohen and colleagues (2014) attempted to unpick some of the relationships between sleep and behavior in children with ASD. Their report tentatively concludes that sleep difficulties lead to an increase in autistic symptoms and challenging behavior (p. 8). Many of the studies reviewed here also point to increased ADHD symptoms related to poor sleep. Children with ASD (Jang *et al.* 2013) and

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children with DLD (Cohen *et al.* 2000) are both at high risk of having co-morbid ADHD, which in turn is also associated with sleep disorder (Schneider *et al.* 2016).

However, within the existing literature, language has rarely been an outcome measure, and is often not even included in participant descriptions. Only one paper included in Cohen *et al.* (2014) reported on verbal skills (Taylor *et al.* 2012). One reason for this omission may be that not all children with ASD are felt to have linguistic difficulties (DSM-V; APA, 2013). Nevertheless, all children with autism will by definition have some impairment in communication, and thus it is still surprising that this has not been a focus of the literature to date.

To our knowledge, there is only one published study of sleep in children with language delay, as part of a wider cohort study (Dionne *et al.* 2011). In their longitudinal study, 5-year-old children with language delay were found to have less mature sleep–wake patterns at 6 and 18 months than children without delay. More studies in this area could be useful information, both clinically and theoretically. Cohen *et al.* (2014) note that sleep is often absent from intervention strategies for families of children with autism (perhaps with the exception of medication, see Malow *et al.* 2016), and this is also true for families of children with DLD. If children with DLD are found to have sleep difficulties this opens a theoretical question about whether autistic children with additional linguistic impairment are the same subgroup as those with sleep disturbance.

Present study

The focus of this study was to compare sleep patterns of children with DLD and ASD to the sleep patterns of their typical peers using parental survey report. Specifically, our research aims are to investigate (i) whether sleep is reportedly poorer in children with communication disorders and (ii) whether specific sleep behaviors correlate with reported language skill.

Methods

Participants

In total 69 parents completed a survey aimed at parents of children with and without communication disorders. Three parents started the questionnaire but did not agree to the initial consent question and therefore were not able to complete the questionnaire leaving 66 participants. One respondent reported on a child with a diagnosis of attention deficit hyperactivity disorder (ADHD) rather than a communication disorder, and this participant's data were not included here. Only two children (both ASD) reported co-morbid diagnoses of ADHD and these children were included. Thus, 65 parent survey responses are included in the final analyses. These parents reported on their children who were between the ages of 3–18, 41 male and 24 female. Each parent could only access the survey once, so all of the children reported upon are from different families. Thirty-seven of the participants completed the survey about a typically developing child (TD). The mean age of these children was 5:6 (SD = 3:9). Twenty-eight children had a developmental communication disorder (CD) (mean age = 7:1 SD = 3:7). Eight of these had ASD and the remaining 20 had Li. There were no significant differences between ASD and Li participants on any demographic or outcome variable except non-verbal communication which was rated by parents as more difficult for ASD children. The CD groups have therefore been combined for the purpose of analysis. There were significantly more boys in the CD group (23/28; 82%) compared to boys in the TD group (18/37; 49%) (Fisher's exact $p = 0.009$). This is not unexpected when studying developmental communication disorders using an open recruitment approach. There was no significant difference in age across the two groups ($p > 0.1$).

Materials

The survey was a novel questionnaire designed by the second author based on similar surveys (Schreck and Mulick 2000; Robinson and Richdale 2004; Polimeni *et al.* 2005). The language questions used were scales from the Children's Communication Checklist (Bishop 1998).

Questions covered five main areas but the order of questions was not by topic area, instead items from each area were interspersed during survey presentation:

(1) Demographic information — Gender; diagnosis; age of diagnosis; current age of the child.
(2) Sleep behavior — Child's bedtime; time taken to fall asleep; usual duration spent asleep; usual waking time; number of times awake in the night; whether the child sleeps alone at night (yes/no).
(3) Reported sleep difficulties — Restlessness in sleep; problems getting off to sleep; waking earlier than expected by parents for age; interrupted/irregular breathing while asleep. Parents were required to state yes or No.
(4) Language — these questions used scales from the Children's Communication Checklist (Bishop 1998). This measure is a parent / teacher report measure that has nine sub-scales tapping into communication (speech, syntax, initiation, coherence, stereotypy; context, rapport, social, and interests). Three of these were used for this study: speech (output, intelligibility, fluency, e.g. people can understand virtually everything he or she says); syntax, (complexity of spoken grammar, e.g. speech is mostly two to three word phrases such as 'me got ball' or 'give dolly'); and coherence (making sense in conversation, e.g. uses terms like 'he' and 'it' without making it clear what he or she is talking about). The whole questionnaire was felt to be too lengthy for an online survey and these scales were chosen to be indicative of key language difficulties. The CCC has been shown to have good inter-rater reliability (0.80), internal consistency (between 0.80 and 0.87), and validity (Bishop, 1998). Each scale comprises a series of statements, and is scored on a scale of how much each statement applies to the individual. The options given are 'does not apply,' 'applies somewhat,' 'definitely applies,' and 'unable to judge.' These responses are numerically coded and summed to give a score for each scale. Parents were also asking to rate overall expressive, receptive and social communication ability using a five-point scale from 'extremely easy' (1) to 'extremely difficult'(5).

Table 1 Mean (SD) parent ratings of developmental difficulties*

	TD group	CD group	Statistics
Expressive communication	1.78 (0.95)	3.64 (1.06)	$t(63) = -7.4$, $p < 0.001$
Receptive communication	1.65 (0.89)	3.50 (1.11)	$t(63) = -7.5$, $p < 0.001$
Social communication	1.92 (0.95)	3.64 (1.13)	$t(63) = -6.7$, $p < 0.001$
Non-verbal communication	2.19 (0.94)	3.25 (1.27)	$t(63) = -3.9$, $p < 0.001$
Attention and listening	2.41 (1.12)	4.00 (0.82)	$t(63) = -6.4$, $p < 0.001$
Memory	1.73 (0.90)	3.14 (1.41)	$t(63) = -4.9$, $p < 0.001$
Reading	2.76 (1.42)	3.79 (1.37)	$t(63) = -2.9$, $p = 0.005$
Writing	2.73 (1.34)	4.07 (1.11)	$t(63) = -4.3$, $p < 0.001$

*1–5 scale where higher scored = more reported difficulties.

(5) Other developmental skills — Parents were asked about the following related developmental skills using the same five-point scale: Attention and listening, non-verbal communication, memory, reading, and writing.

Procedure

The questionnaires were completed online using a link shared via professionals and social media sites. The questionnaire was hosted using the Survey Monkey research tool. Following ethical approval by the LCS proportionate ethical review panel, City University London, the questionnaire was completed by five individuals as a procedural pilot test. These completed surveys were not used for the final research results but did help in determining the length of time it took for individuals to complete the survey. The time ranged from 8 to 16 min which was deemed to be appropriate. Parents clicking on the web-link were first shown an information and consent page where they were asked to give permission for the collection and use of the data for the described research purpose. The information sheet also explained the questionnaire's length and approximate completion time, instructions, and aims. It provided researcher contact information as well as independent complaint procedure directions. Participants were reassured that the survey was voluntary, they could close the link at any time without a penalty of any kind, and that all questionnaire responses were anonymous.

Statistical analysis

Because of the relatively small sample size, simple comparative and associative statistics were performed in the form of t-tests and correlations / chi-square analyses, respectively.

Results

Language and other developmental skills

The CCC items confirmed that children with CD had lower language ability than TD peers in speech, syntax, and semantic/pragmatic domains.

Speech problems: Children with CD had more speech difficulties ($M = 12.2$, SD = 5.07 compared to the TD group ($M = 5.50$, SD = 4.13) ($t(50) = -5.074$; $p < 0.001$).

Syntax problems: The CD mean for syntax problems was also significantly lower ($M = 4.37$, SD = 2.23) compared to the TD group ($M = 1.69$, SD = 2.15) ($t(60) = -4.785$; $p < 0.001$).

Semantic/pragmatic problems: The developmental disorder group had significantly more difficulties with coherence (mean = 10.12, SD = 4.314) compared to TD peers (mean = 3.900, SD = 4.088) ($t(53) = -5.479$; $p < 0.001$)

Parents also rated communication and other developmental skills as poorer for the CD group. See Table 1 for details.

Sleep behavior

On average, the time it took the communication disorder group to sleep was significantly more than the typically developing group. A significant minority of the CD group (9/28; 32%) needed longer than 45mins to fall asleep, whereas the modal response for the TD was a period of 10–15 mins to fall asleep (18/37; 49%) ($\chi^2(4) = 11.620$, $p = 0.020$). Children with developmental communication disorders were also less likely to sleep alone (16/28; 57%) compared to the TD group (32/37; 86%; Fisher's exact $p = 0.011$).

Bedtime was split into three categories: early (18:00–19:30), late (20:00–21:00), and very late (22:00–24:30). There were no significant differences by group with nearly half of the both groups falling into the 'late' category (CD: 12/28; 43%; TD: 15/37; 41%; χ^2 0.599 (2) $p = 0.741$). The duration of time spent asleep also showed no significant difference between the CD group (mean = 9.09, SD = 2.62) compared to the TD group (mean = 10.14, SD = 1.89) ($t(63) = 1.832$; $p = 0.072$). This was also true for the number of nighttime wakings (CD mean = 1.57, SD = 1.574; TD mean = 1.24, SD = 3.55; $t(63)$=-0.455; $p = 0.650$).

Sleep difficulties

There were significantly more participants in the CD group (9/28; 32%) who 'woke up very early for their age' compared to the typical group (1/37; 3%) (Fisher's exact test $p = 0.002$).

Results for participants fitting the description of being a 'restless sleeper' showed no significant difference between the CD group (17/28; 60%) compared to the TD group (14/37; 37%) (Fisher's exact test $p = 0.083$) but there was a trend for the CD to be more restless. There were also no significant differences between the two groups in having interrupted or irregular breaths during their sleep although again this was slightly higher in the CD group (9/28; 32%) compared to TD peers (6/37; 16%) (Fisher's exact test $p = 0.150$).

Relationship between sleep patterns and language

The relationship between sleep and communication and other developmental skills was examined with the whole

Table 2 Correlations between sleep behavior and communication/developmental skills Whole sample in bold, TD group in normal type, CD group in italics

	Time getting off to sleep			Duration of sleep			Night wakings		
CCC speech problems	**0.26**	0.18	*0.14*	**–0.20**	–0.10	*–0.05*	**0.02**	0.11	*0.24*
CCC syntax problems	**0.27***	0.02	*0.07*	**–0.17**	–0.06	*–0.06*	**0.07**	0.09	*0.08*
CCC coherence problems	**0.45****	0.28	*0.31*	**–0.25**	–0.11	*–0.17*	**0.14**	0.13	*0.16*
Expressive communication	**0.37****	0.24	*0.03*	**–0.37****	–0.31	*–0.30*	**0.16**	0.19	*0.13*
Receptive communication	**0.43****	0.19	*0.24*	**–0.35****	–0.21	*–0.34*	**0.26***	0.41	*0.17*
Social communication	**0.34****	0.34	*0.16*	**–0.34****	–0.18	*–0.33*	**0.24**	0.13	*0.18*
Non-verbal communication	**0.28***	0.24	*0.02*	**–0.26***	–0.15	*–0.21*	**0.23**	0.28	*0.19*
Attention and listening	**0.32****	0.04	*0.26*	**–0.24**	–0.06	*–0.23*	**0.29***	0.37	*0.17*
Memory	**0.28***	0.02	*0.14*	**–0.29***	–0.34	*–0.12*	**0.26***	0.37	*0.21*
Reading	**0.16**	0.01	*0.05*	**–0.03**	–0.03	*–0.08*	**0.06**	0.12	*0.07*
Writing	**0.23**	0.10	*0.23*	**–0.16**	–0.04	*–0.19*	**0.10**	0.13	*0.07*

*$p < 0.05$
**$p < 0.01$
Dark grey shaded boxes indicate significant relationships that are present in both groups.
Light grey shaded boxes indicate significant relationships that are present in one group.

sample combined. Table 2 shows all correlations between sleep and development, and also with groups separate.

Language ability showed a relationship with sleep behavior, particularly with difficulties getting off to sleep: there were significant correlations between 'time getting off to sleep' and CCC syntax ($r = 0.27$, $p = 0.036$) and between 'time getting off to sleep' and CCC semantic/pragmatic ability ($r = 0.45$, $p = 0.001$). This factor also correlated significantly with all parent ratings of development except reading and writing. In addition, 'time spent asleep' associated significantly with all parent ratings of communication and memory, and the number of nighttime wakings was correlated significantly to attention and listening, receptive language and memory.

When correlations were examined separately, similar patterns were seen. For both groups, CCC semantic/pragmatic language ability related to the amount of time getting to sleep; and duration of sleep related to parent-rated expressive and receptive communication difficulties. However, CCC Syntax was not related to sleep in either group suggesting that the whole sample correlation may be led by co-morbid but unrelated group differences in both sleep and syntax. See Table 2 for details.

Discussion

The role of sleep in development is important, but not well understood, especially in developmental disorders. This study provides evidence for a direct association between everyday sleep behaviors and language ability in a clinical population. It does this in two ways: Firstly, children with communication disorders showed more sleep difficulties than their typically developing peers; second, sleep behaviors predicted expressive, receptive and social-language difficulties in both groups, and receptive communication in children with communication disorders. Sleep behaviors also related to other important developmental skills rated by parents such as attention and listening. Although at first syntax appears related, when groups were examined separately data suggest that syntax and sleep may be co-occurring but unrelated characteristics of communication disorder, or that a more complex developmental causality is involved (i.e. that poor sleep at one age might lead to poor syntax at a later point, but not concurrently). Reading and writing were not correlated but this may be because of the relatively young age of the children being rated, or because parents are not as sensitive at judging these skills which are largely measured at school rather than at home.

This study supports previous evidence from children with autism that indicates increased sleep difficulties for that group (Liu *et al.* 2006; Goldman *et al.* 2011; Mannion *et al.* 2013; Mannion and Leader 2014). However, it is to our knowledge one of the first to document sleep behaviors in children with language impairment, and to look at the relationship between language and sleep in either population. Findings support the one study that has reported a relationship between language delay and sleep (Dionne *et al.* 2011). Although eight of our group of children with CD had ASD, there were no differences between the ASD and Li groups on sleep behavior, which suggests that sleep disturbance is a shared symptom between these groups. Parental report is a useful way to access information about sleep because sleep is a difficult behavior to observe with any ecological validity. Studies carried out in sleep clinics are unlikely to reveal information about everyday sleep behavior and may be disturbing for children with Li and autism. Nevertheless, parental report has obvious drawbacks: respondents cannot be blind to their child's diagnosis; they may over- or under-report certain behaviors; and in this study they are a self-selecting sample who may be particularly concerned about their child's sleep. Indeed, Herring *et al.* (1999) found that physiological sleep-pattern results of autistic children were similar to those in typically developing children, and concluded that parental over-sensitivity to sleep difficulties was the reason for their

higher prevalence in surveyed sleep data. Despite this, parents have been reported to be highly accurate reporters of basic sleep schedule information (Sadeh 1996) and the fact that our data do not show the signs of 'blanket' responses from parents (e.g. they did not report that *all* sleep behaviors were different) reassures us that the participants have answered in a reliable way, and that general 'over-sensitivity' has not driven the results. Furthermore, the relationship between sleep schedules and language ability is less susceptible to reporting bias.

Because the survey was anonymous and hosted online, a further limitation is that we only have parental report to confirm clinical status. Nevertheless, the parent report scales used from the CCC have been found to show good validity and reliability, and information was also gathered to confirm group membership, such as age of diagnosis and overall parental rating of communication. Not only are we confident therefore that the groups reported have difficulties pertaining to language, but our findings suggest that regardless of clinical status children who sleep well have better language skills. This dimensional approach to considering the relationship between sleep and language might be more informative.

Several studies into sleep duration/sleep efficiency and its effects on language processing in typically developing children have shown convincing associations (Dahl 1996; Lim and Dinges 2010; Gruber *et al.* 2014). It is possible therefore, that impoverished sleep has a role in poor language development, even within groups with communication disorders. Spending more time falling asleep could potentially interfere with the process of consolidation, especially in the context of an already compromised language system. This would be in line with findings reported by Henderson *et al.* (2012) who investigated the relationship between acquisition of words and sleep associated consolidation and concluded that declarative systems were particularly affected. In the current study, syntax and social communication problems were also related to sleep behavior which may implicate other storage processes.

Alternatively, it is possible that children with language impairments experience poorer sleep alongside impaired communication because of other factors. These could include internal factors such as co-morbid anxiety which is common in Li (Conti-Ramsden and Botting 2008) as well as in ASD (Simonoff *et al.* 2008). Furthermore, ADHD is one of the most frequently diagnosed comorbidities for both disorders. In this study, only two parents reported co-morbid ADHD and although this is known to be a risk factor for sleep problems (Schneider *et al.* 2016), this was not a factor driving the results in the current study. Nevertheless, it would be interesting in future studies to directly compare the sleep of children with communication disorders who do and do not have additional ADHD and or anxiety symptoms. Alternatively, external factors such as bedtime routines may play a role. For example, it is known that children with language impairment enjoy book-time less (Kaderavek and Sulzby 1998), and since this is a regular component of pre-bedtime relaxation in many UK homes, this may also contribute to an indirect association between language and sleep. Thus, the relationships seen here between aspects of sleep behavior and language could be mediated by other factors. Future studies should include a wider set of measures such as anxiety and bedtime routine to unpick this further. In addition, other variables that may relate to sleep should be investigated more comprehensively, in particular the role of socioeconomic status and history of parental language difficulties.

Clinical implications

The children in this study and the studies that have been explored have a common factor that is, the less they sleep, the poorer their language skill. Even in the case of a non-causal explanation for this association, one possibility is that improving these children's sleep patterns may also improve their language skills. Sleep intervention studies have indicated some success with other populations. For example, a study by Hiscock *et al.* (2015) explored whether behavioral strategies designed to improve sleep problems could also improve the symptoms, behavior and working memory of children with ADHD and achieved favorable results compared to a control group. In a similar vein, Quanch *et al.* (2011) evaluated a behavioral sleep intervention for improving typically developing children's outcomes in their first year in schooling and found benefits relevant to school transition. Therefore, health professionals involved with families who have communication disorders might consider suggesting interventions that involve sleep behavior when advising on strategies that might ameliorate communication difficulties. At the very least, including questions about sleep behavior when taking clinical histories may be useful. However, we acknowledge that our study presents only preliminary data on this aspect of development in children with CD, and larger scale studies are now needed to inform practice, as well as studies that measure sleep physiologically.

This study has identified that children with a communication disorder have poorer sleep, and that sleep patterns relate directly to communication skills. In conclusion, it is evident from the study that sleep is an important aspect of development which is sometimes neglected in the management of communication difficulties.

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