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Brief report on using neuropsychological computerized battery to measure the association between Poor Sleep and Cognitive Ability in Children with Autism Spectrum Disorder ASD

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ABSTRACT: *Poor sleep is a common feature in autism, but the impact of poor sleep on daytime cognitive functioning in autism is not well-known and we, therefore, investigated whether sleep in autism correlates with daytime cognitive performance. We used a Neuropsychological Test Cognitive Assessment (CANTAB). Significant correlations between sleep behavior and Big/little circle (BLC) were found. The findings of this study suggest that ASD children with sleep problems are facing deficits in learning and comprehension. However, the association between poor sleep and ASD requires the use of different types of Cognitive Assessment (CANTAB) tests and an increase in the sample size of the study.*

Keywords: *Autism, Sleep disorder, Cognitive Assessment*

I. INTRODUCTION

Autism spectrum disorders (ASD) are a group of developmental disorders estimated to affect about 1% of children in the general population (Baird et al., 2006; Baron-Cohen et al., 2009; Honda et al., 2005). It is believed to exist on a distribution curve of autism spectrum problems (ASP) that exist in the general population, one for which there is no easily defined cut-off between subclinical and clinical presentations. ASP can have profound effects on both the child and his/her family. In addition to the core symptoms of social/communication deficits and a restricted repertoire of behaviors, children with ASD often experience sleep problems (Allik et al., 2006a; Richdale, 1999; Wiggs and Stores, 2004).

The majority of studies on sleep in children with ASD include clinical samples and use of cross-sectional design (Goodlin-Jones et al., 2008; Richdale and Prior, 1995; Wiggs and Stores, 2004). A population-based case–control study on ASD and sleep (Krakowiak et al., 2008) found a high rate of sleep onset problems and night waking in two- to five-year-old children with ASD compared with typically developing children. In a clinical follow-up study of school age children, higher rates of sleep problems were found in those with autism as compared with children with 'normal' development (Allik et al., 2008). Changes in sleep pattern over time were similar in both groups. There are also retrospective clinical studies indicating that sleep problems in children with ASD are persistent (Giannotti et al., 2006; Wiggs and Stores, 2004), but to our knowledge, there are no population-based studies on sleep in older children with ASD. There is also a paucity of longitudinal studies in the literature assessing the development of sleep problems over time in children with ASD. We know from studies of the adult general population that chronic sleep problems have a severe impact on both quality of life and physical and mental health (Taylor et al., 2005, 2007). As such, sleep problems in children/adolescents with ASD will most likely constitute an additional burden on both the children and their families, as they are already affected by the severe symptoms of ASD. In addition, there are studies indicating that insomnia in itself aggravates the autistic symptoms (Allik et al., 2006a; Schreck et al., 2004).

Sleep is a critical component of health. Although we do not understand all its functions, sleep is essential to grow, to restore our body and immune system and to enhance and solidify memory and learning.

For children with ASD, insufficient sleep appears to impact daytime behaviors, making challenging behaviors worse. Sleeping difficulties for the child also lead to sleeping difficulties for parents and sometimes siblings consequently adding to the stresses and challenges of parenting a child who has autism. No one can function at their best when they are sleep deprived.

Based on the above considerations, the aim of this study was to assess the correlation between sleep problems in children with ASD, and cognitive ability; our specific aims were to assess the effect of sleep behavior, bedtime, waking during the night, morning wake on learning comprehension, attention and memory in children with Autism Spectrum Disorder ASD.

II. Materials and Method

Participants

14 children with ASDs aged 4 years old participated in this study. ASDs were diagnosed by a child psychologist based on DSM-IV criteria (14). The Autism Diagnostic Observation Scale (ADOS) and Childhood Autism Rating Scale (CARS) was also administered to confirm the diagnosis. All participants had IQ above 70 based on Stanford Binet 4 (SB4).

Measures

1-Visual and memory tasks were assessed in all participants using some tests from Cambridge Neuropsychological Test Automated Battery (CANTAB):

(a) Big/Little Circle (BLC): BLC is a simple test of comprehension this is a visual discrimination test , in this test the subject is presented with series of pairs of circles , one large and one small , the subject instructed first to touch the small circle and then ,after 20 trials , to touch the larger circle for a further 20 trials.

(b) Intra/Extra Dimensional Set Shift (IED): Intra / Extra dimensional set shift is a test of rule acquisition and reversal. It features: Visual discrimination and attention set formation and, maintenance, shifting and flexibility of attention. This test is primarily sensitive to changes to the fronto-striatal areas of the brain.

Two artificial dimensions are used in the test: color – filled shapes, white lines, simple stimuli are made up of just one of these dimensions, whereas compound stimuli are made up of both, namely white lines over lying color-filled shapes.

Subject progresses through the test by satisfying a set criterion of learning at each stage (6 consecutive correct responses). If at any stage the subject fails to reach this criterion after 50 trials, the test terminates. The test starts with block 1, the presentation of two simple color–filled shapes. The subject must learn which of stimuli is correct by touching it, and continue until the criterion is reached. In block 2, the contingencies are reversed, so that now the previously incorrect stimulus is correct. In block 3, the second dimension is then introduced initially lying adjacent to and then, for block 4, overlapping.

(c) Spatial Recognition Memory (SRM): it is a test of spatial recognition memory in a forced – choice paradigm. This test is primarily sensitive to dysfunction in frontal lobe, and relatively insensitive to temporal lobe damage.

A white square is shown on the screen in various locations. In the presentation phase, a white square is shown on the screen in five different locations. Each appearance of a square marks a location on the screen which the subject must later remember. In the recognition phase, the square reappears in the same five locations as in the presentation phase, in reverse order.

On each appearance, it is paired with an identical distracter square in a location not used in the presentation phase. The subject must touch the square in the location that has appeared before, whilst ignoring the distracter this is one block. This block is repeated three more times, each time with five new locations. The test is scored using four indices: (a) Mean correct latency; (b) maximum correct latency, (c) S.D. correct latency; (d) Total corrects.

2-The Stanford Binet 4 (SB4): It was administered to evaluate the participants' intellectual abilities.

3-Autism Diagnostic Observation (ADOS): the ADOS is a standardized, semi structured observation of communication, social interaction, and repetitive behaviors of individuals with possible autism spectrum disorder. Items are scored from 0 (not abnormal) to 2 or 3 (most abnormal), and a diagnoses of autism or ASD is established cut-off values in the communication domain, the social domain, and the sum of the two.

4-Childood Autism Rating Scale (CARS): rates the child from 1 to 4 in each of the 15 areas (relating to people, emotional response, imitation, body use, object use, listening response, visual response, verbal communication, nonverbal communication, activity level, level of intellectual response, adaptation to change, touch and smell response, general impression.

5-Sleep Habit Questionnaire: The parents completed the Children's Sleep Habits Questionnaire (CSHQ). A questionnaire validated in children ages 4-10 years. The CSHQ has been used to examine sleep behavior in children with variety of conditions including ASD, and include four domains: bedtime, sleep behavior, waking during the night, and morning wake.

Procedure

The participants were firstly interviewed by a child psychologist and diagnosed as having Autism Spectrum Disorders based on DSM-IV criteria. Next, they were evaluated using the Autism Diagnostic Observation Scale (ADOS) and Childhood Autism Rating Scale CARS score to confirm the diagnosis, and were then answered the sleep questionnaire during structured interview, and examined using neuropsychological tests (CANTAB).

Statistical Analysis

Spearman correlations were used to study the effect of sleep problems on cognitive ability in terms of different variables. In this research, all statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 20.

Result

The mean age of children with ASDs was 4.5 while the mean IQ was 53.13 (SD=25.06) There were no significant differences between groups in terms of age and IQ (Table 1).

There was a significant correlation between the sleep behavior and Big/Little circle (BLC) On the "Percent of Correct" score (correlation = 0.6, p=0.02), but no significant correlation between Big/Little circle (BLC) and bed time (correlation =0.07, p=0.79), waking during the night and Big/Little circle (BLC) (correlation=0.04, p= 0.88), morning wake and Big/Little circle (BLC) (correlation=0.14, p=0.61) (Table 2).There was no significant correlation between the bedtime and Intra/Extra dimensional set shift (IED) "Total Error 1" and bedtime (correlation=0.39, p=0.23), Intra /Extra dimensional set shift (IED) "Total Error 2" and bedtime (correlation=0.04, p=0.86).

In regards to sleep behavior, no significant correlation between the sleep behavior and Intra/Extra dimensional set shift (IED) "Total Error 1" and sleep behavior (correlation=0.3, p=0.28), Intra/Extra dimensional set shift (IED) "Total Error 2" and sleep behavior (correlation=0.32, p=0.25) was found.

In terms of waking during the night, no significant correlation between waking during the night and Intra/Extra dimensional set shift (IED) "Total Error 1" and waking during the night (correlation=0.19, p=0.51), Intra /Extra dimensional set shift (IED) "Total Error 2" and waking during the night (correlation=0.10, p=0.72) was found.

With regards to morning wake, no significant correlation between the morning wake and Intra /Extra dimensional set shift (IED) "Total Error 1" and morning wake (correlation=0.24, p=0.39), Intra /Extra dimensional set shift (IED) "Total Error 2" and morning wake (correlation=0.32, p=0.26) was found.

And no significant correlations between bedtime and Spatial Recognition Memory (SRM) task percent correct (correlation =0.24, p=0.39), sleep behavior and Spatial Recognition Memory (SRM) task percent correct (correlation=0.47, p= 0.08), waking during the night and Spatial Recognition Memory (SRM) task percent correct (correlation=0.04, p=0.88), morning wake and Spatial Recognition Memory (SRM) task percent correct (correlation=0.09, p=0.75) was found.

SUBJECTS					
	N	**Mean**	**SD**	**T**	**p value**
age	14	4.5	0.51	32.45	0.00
IQ	14	78.71	8.21	35.86	0.00

Table 1. Demographic Variables in Children with ASD.

Table 2. Results of CANTAB tests in Children with ASD.

		Bed time	Sleep behaviour	Waking during the night	Morning wake
CANTAB tests					
Big / Little circle (BLC)					
	correlation	0.07	0.6	0.04	0.14
Percent correct	**P value**	0.79	0.02	0.88	0.61
Intra /Extra dimensional set shift (IED)					
	correlation	0.31	0.3	0.19	0.24
total errors 1	**P value**	0.23	0.28	0.51	0.39
	correlation	0.04	0.32	0.10	0.32
total errors 2	**P value**	0.86	0.25	0.72	0.26
Spatial Recognition Memory (SRM)					
	correlation	0.24	0.47	0.04	0.09
percent correct	**P value**	0.39	0.08	0.88	0.75

Discussion

Researchers have been investigating sleep problems in children with autism for some time now. It is accepted that sleep problems are more common in autism than in most other developmental disorders (Richdale and Prior, 1995), but we still do not know why and in what ways it affects the cognitive ability. The aim of this study was to assess the effect of sleep behavior, bedtime, waking during the night, morning wake on learning comprehension, attention and memory in children with Autism Spectrum Disorder (ASD). The result was a significant correlation between sleep behavior and Big/little circle (BLC), this means that there is a significant correlation between the amount of child sleep, moving during sleep, grinding on teeth, snoring screaming, being uncomfortable during the sleep, and learning comprehension in children with Autism Spectrum Disorder ASD.

Sleep problems seem to occur in children with autism at all IQ levels including those who do not have an intellectual disability. The sleep difficulties reported in children with autism include problems with: Sleep onset and maintenance, irregular sleep-wake patterns, poor sleep, early waking, alterations in sleep onset and wake times and night waking. These problems tend to improve with age but older children with autism have been found to sleep less at night than other children. Some children with autism have unusual routines for settling to sleep and may sleep walk and have nightmares more than other children.
Future researches should also focus on the relationship between these sleep problems and use different types of CANTAB tests to study the correlation.

Conclusion

We conclude that significant signs reflecting the presence of poor sleep in children with autism correlate with various aspects of learning difficulties on nonverbal performance tasks in the CANTAB test.
The findings of this study suggest that ASD children with sleep problems are facing deficits in learning, comprehension. However, the modest gains that were observed require the use of different types of CANTAB tests and an increase in the sample size of the study.

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