

Original article

Sleep disturbances and teacher ratings of school achievement and temperament in children

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Abstract

Background: The current study examined the relationships between academic achievement, sleep, temperament and demographic-historical data in school-age children.

Methods: Teachers were asked to fill out the teacher temperament questionnaire and a form for school achievement, while mothers filled out a demographic-historical form and the sleep disturbance scale for children (SDSC), a 26-item questionnaire that consisted of six factors: difficulty in initiating and maintaining sleep (DIMS), sleep breathing disorders (SBD), arousal disorders (DA), sleep-wake transition disorders (SWTD), disorders of excessive somnolence (DOES), sleep hyperhydrosis (SHY).

From a sample of 380 school children, 264 (70%) were suitable for the analyses (141 M and 123 F aged 8–11 years, mean 9.6 years). A school achievement index (SAI) was derived, summing up four items (reading ability, reading comprehension, mathematics, executive ability) of the teacher form for school achievement.

Results: SAI mean for the total sample was 11.1 (SD=2.8). A significant gender difference was found: females have higher SAI than males. The analysis of the demographic-historical form showed that only two factors appeared to affect SAI score: enuresis and the low educational level of the mother. The pattern of correlations showed that (a) the SAI was negatively related to the SDSC total score, in particular to DIMS and DOES sub-factors, and (b) the SAI was significantly and positively correlated with the temperamental traits of task-orientation and personal-social flexibility. A multiple stepwise regression analysis showed that the temperamental traits task-orientation and personal-social flexibility are the most predictive factors for SAI while the mother's educational level and the SDSC total score, although they contributed significantly to the prediction of SAI, accounted for only a small portion of variance.

Conclusions: Temperament and sleep are important factors influencing school achievement, and their assessment could help to identify children at risk regarding school achievement.

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Keywords: School achievement; Sleep; Sleep disturbances; Temperament; Children

1. Introduction

Several studies have analysed the relationships between sleep and cognitive performance in adult populations [1,2] and, recently, a number of studies have been carried out in school-age children, mainly in

those with snoring or sleep-disordered breathing [3–8]. A meta-analysis study on sleep deprivation and performance in adults showed that sleep deprivation, either total or partial, has a clearly negative effect on cognitive and physical performance [9]. Since studies on sleep deprivation in children are very rare [10,11], the correlation between learning and sleep are often analysed through the alterations of the macrostructure of sleep, reporting mainly a reduction of REM sleep and/or a longer REM latency in mentally retarded subjects, in attention-deficit disorders or reading-disabled children, as

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well as an increase of REM sleep in children or adolescents after an intensive learning session [12–14].

A review on the effects of sleep loss or disruption on children's cognitive function based on a wide range of clinical and observational data showed that inadequate sleep results in tiredness, difficulties with focused attention, low threshold to express negative affect (irritability and easy frustration), and difficulty in modulating impulses and emotions [15]. Sleep manipulation, such as modest sleep restriction or extension, leads to significant differential effects on children's neurobehavioral functioning [16].

Apart from sleep, other factors that could have a strong influence on neurobehavioral functioning and school achievement are the temperamental traits [17–20]. Temperament appears to influence a child's ability to use what he knows and may facilitate or impede academic performance by “setting the stage” for the acquisition of new learning, through appropriate modulation of activity, persistence and adaptive responses to new situations [21]. Students in school must modify and direct their energies and activity levels appropriately and must respond adaptively and flexibly to challenging instructional demands. Some can respond successfully to such demands, and others give up early, while others ‘hang in’ until projects are finished. These differences are in part related to individual differences in temperament.

Since no detailed research was available on the relationships between both sleep and temperament and academic achievement, we have designed a study to identify paths that significantly predict school achievement from temperamental and sleep variables and demographic-historical data.

2. Methods

2.1. Participants and procedure

Three hundred and eighty children (197 M, 183 F, mean age 9.2 years) took part in the study. These children came from a public primary school of the urban area of Rome. The goal and the design of the study were explained during a meeting with parents and teachers. It was explained that, for each student, three questionnaires should be compiled: one to be filled out by the parents and two by the teachers. Since each class has three teachers, we requested that at least two of them filled out the questionnaires together. Teachers distributed a questionnaire to each student together with the joint letters from the headmaster and from the researchers to the parents. The forms were distributed to the parents and collected by the teachers.

Parents filled out the questionnaire at their home. Teachers were completely blind to parents' rating and vice versa.

2.2. Instruments

2.2.1. Teacher ratings

Teachers were asked to fill out two different types of questionnaires: the teacher temperament questionnaire [22] and a form to evaluate academic achievement.

The teacher temperament questionnaire (TTQ) is a 23-item scale developed to assess eight temperamental dimensions, and it derived from a more extensive version comprising 64 items [23]. In this form of the TTQ the teacher is asked to rate each item on a six-point scale from ‘hardly ever’ to ‘almost always’. The questionnaire analysed eight dimensions that defined temperament: activity, approach/withdrawal, adaptability, intensity of response, mood, persistence, distractibility, threshold of response). We assessed the psychometric properties of the Italian version of the TTQ on an Italian sample of 337 school-aged children [24]. According to Keogh [21,22], three reliable temperamental factors were identified: (1) task-orientation (defined by nine items pertaining to the following dimensions: activity, distractibility and persistence), with higher scores indicating a higher capability to focus attention and ability to persist in a determinate behavior in order to reach a goal (reliability in the normative Italian sample = .84; in our sample, alpha = .92); (2) personal-social flexibility (defined by eight items pertaining to the following dimensions: adaptability, approach/withdrawal, positive mood), with higher scores indicating greater adaptability and social abilities (reliability in the normative Italian sample = .84; in our sample, alpha = .90); (3) reactivity (defined by six items pertaining to the following dimensions: intensity, threshold and negative mood), with higher scores referring to a greater emotional reactivity (reliability in the normative Italian sample = .62; in our sample, alpha = .65).

Teacher school achievement form. The school achievement form, developed by the authors, is composed of six items and each response was given on a four-point Likert scale, ranging from ‘severe difficulties’ to ‘above the average’. The six items refer to different aspects relevant to school achievement (reading ability, reading comprehension, mathematics, executive ability, interest, attention).

2.2.2. Parental ratings

Parents were asked to fill out a questionnaire (sleep disturbance scale for children (SDSC)) (see Appendix) designed to assess a variety of sleep-related behaviors in childhood and adolescence [25].

The sleep disturbance scale for children (SDSC). The questionnaire assessed sleep behavior and disturbances during the previous six months and was constituted by 26 items in a Likert-type scale with values 1–5. The SDSC consisted of six factors which represented the most common areas of sleep disorders in childhood and adolescence: difficulty in initiating and maintaining sleep (DIMS), sleep breathing disorders (SBD), arousal disorders (DA),

sleep–wake transition disorders (SWTD), disorders of excessive somnolence (DOES), sleep hyperhydrosis (SHY).

Demographic-historical form. Mothers were asked to fill out a form on demographic data about child, family composition, parents' education and professional activities, as well as clinical data about pregnancy, delivery and medical history of the child, with specific questions regarding pathologies that could affect sleep: birth weight, length of gestation, pregnancy, delivery, condition at birth, feeding method, co-sleeping, birth order, report of sleep problems in infancy, allergy to cow's milk, colic during the first months, recurrent adenotonsillitis, asthma or allergic rhinitis or bronchitis, food allergy, enuresis.

2.3. Data analysis

Descriptive statistics were computed for all the relevant factors of the study. Teachers' evaluations were analysed computing multiple squared correlations and Cronbach alpha index of internal consistency. Differences in school achievement were analysed by means of analysis of variance (ANOVA) designs (significance level=.05). In order to avoid an increase of type I error, Bonferroni correction for the multiple comparisons was applied.

The relationships between sleep quality dimensions, achievement and temperament were analysed, computing Pearson correlation coefficients and by means of a linear regression analysis. Statistical analyses were conducted with SPSS 10 Software, a statistical package of SPSS Inc.

3. Results

Of the 380 questionnaires, for 42 children (11%) both parental and teacher questionnaires were not returned. Evaluations of 74 (19%) children were excluded because questionnaires were filled out either only by parents or only by teachers or because they contain multiple missing values.

Therefore, 264 questionnaires (70%) were suitable for the analyses. The sample was composed of 141 males and 123 females aged 8–11 years (mean 9.07 years; SD=.87). Descriptive statistics for child history variables and school achievement are reported in Table 1.

Among the teachers' evaluations, the highest prevalence (19.8%) of severe difficulties was found for failure in attention, followed by ability in logic-mathematics, reading comprehension and executive ability. Considering the conceptual overlapping between attention and interest items of the teacher school achievement form and some temperamental traits (mainly, the distractibility), we computed a school achievement index (SAI) summing up only four (reading ability, reading comprehension, mathematics, executive ability) of the six items in order to not inflate the correlations. The four items were highly correlated with each other (mean of multiple square correlations was 0.68) and the reliability of the SAI was

Table 1
Characteristics of the study group

Mean age (SD)	9.07 (0.87)
Male gender	53%
Low mother's educational level	18%
Difficulties in pregnancy	15%
Bad conditions at birth	8%
Bottle feeding	37%
Sleep problems in infancy	9%
Cow's milk allergy	9%
Colics during the first months	31%
Recurrent tonsillitis or adenotonsillitis	27%
Asthma or allergic rhinitis or bronchitis	7%
Food allergy	4%
Hospitalizations	2%
Failure in reading ability	3.4%
Failure in reading comprehension	7.3%
Failure in logic and mathematics	9.5%
Failure in executive ability	6.5%
Failure in interest	2.2%
Failure in attention	19.8%

high [Cronbach alpha=0.91]. The school achievement index (SAI) was used in the following analyses.

SAI mean for the total sample was 11.1 (SD =2.8). A significant gender difference was found [$F_{(1,260)}=4.33$; $P=0.04$]: females (mean=11.5; SD=2.8) have higher SAI than males (mean=10.7; SD=2.8).

Most of the family-related factors (the presence of brothers/sisters, work status, etc. of the father and mother) and medical/historical factors (pregnancy difficulty; developmental diseases, etc.) assessed did not influence the SAI. Among these variables, only two factors appeared to affect SAI scores: enuresis and the educational level of the mother. Thus, 23 parents (8.7%) reported that their children presented enuresis: these 23 children obtained significantly lower SAI scores (mean=9.6; SD=3.1) than the other children [mean=11.2; SD=2.7; $F_{(1,260)}=7.0$; $P=.008$].

As for the significant effect of the mother's educational level [$F_{(1,260)}=11.2$; $P<.001$], post hoc comparison evidenced that children whose mother had a college degree obtained higher SAI scores (mean=12.1; SD=2.4) than children whose mother had a secondary (mean=11.0; SD=2.7; Bonferroni test prob<.05) or primary school degree (mean=9.7; SD=3.2, Bonferroni test prob<.05).

Mean of the total scores of the SDSC compiled by the parents was 36.85 (SD=7.5), which is comparable with the score obtained in the validation sample [25]. The relationship between temperamental dimensions, SAI, and SDSC total scores is reported in Table 2.

Table 2
Correlation of temperament with SDSC total score and SAI

	SAI	Total SDSC
Task-orientation	0.65**	-0.13*
Personal-social flexibility	0.40**	0.03
Reactivity	-0.21**	0.14*
SDSC total score	-0.16*	1

* $P<.05$; ** $P<.01$.

Table 3
Stepwise regression analysis

	Variables in the equation	Parameters estimates			Model significance and <i>r</i> square		
		Beta	<i>t</i>	Prob.	<i>F</i>	Sig.	<i>r</i> square
1 step	Task-orientation	.56	12.84	<.001	174.58	<.001	.413
2 step	Personal–social flexibility	.32	7.41	<.001	130.52	<.001	.514
3 step	Mother’s educational level	.22	5.05	<.001	102.12	<.001	.555
4 step	SDSC total score	–.11	–2.55	<.05	79.94	<.001	.566

The pattern of correlations showed the following:

- (a) the SAI was negatively related to the SDSC total score, indicating inverse relationship between school achievement and sleep disturbances. Correlation analyses evidenced that SAI was significantly related only with DIMS ($r = -.17$; $P = .007$) and DOES ($r = -.16$; $P = .009$) sub-factors of the SDSC;
- (b) the SAI was significantly and positively correlated with task-orientation and personal – social flexibility;
- (c) lower but statistically significant correlations were observed between the SDSC total score and the temperament traits of task-orientation (negative correlation) and reactivity.

In order to evaluate the predictive value of sleep and temperament on SAI score, a multiple stepwise regression was performed, including the following variables: the three temperamental dimensions of the TTQ (task-orientation, personal–social flexibility and reactivity), the SDSC total score and the variables that emerged to be relevant in the bivariate analysis reported above (gender, enuresis, and the mother’s educational level). The results of the regression analysis are summarised in Table 3. The equation explained 56.6% of the variance of SAI. Temperamental dimensions of task-orientation and social flexibility are the most predictive factors for SAI, accounting for about 51% of the total variance. The mother’s educational level and the SDSC total score entered into the equation contributed significantly to the prediction of SAI, even if they accounted for a little portion of variance.

4. Discussion

The results of the present study should be considered with some cautions: (1) data were derived from questionnaires; (2) the high correlation between achievement scales and temperament could be linked to the fact that teachers filled out the two questionnaires; and (3) parents’ reports of sleep behavior may not be as accurate as data obtained by an objective method (i.e. polysomnography or actigraphic recordings). Notwithstanding these limitations, our data represent the first attempt to evaluate both sleep and temperament as variables involved in academic achievement.

Concerning demographic-historical factors, our study confirmed the predictive value of low maternal education

and enuresis according to the literature: low maternal education and enuresis were two of the several factors associated with increased risk of grade retention in addition to poverty, male gender, deafness, speech defects, and exposure to household smoking [31]. Enuresis was associated with increased risk of learning disabilities and impaired school achievement in normal children [32]; the prevalence of academic underachievement was 3.5 times higher among enuretic children compared to those without enuresis.

We found an inverse relationship between school achievement index and SDSC total score that is in line with the reports on the effect of sleep loss/deprivation on performance requiring attention and concentration [9]. The effects of insufficient sleep or sleep loss on academic performances could be greater than hypothesised since there is increasing evidence that chronic sleep deprivation in children probably begins at an early age [27,28] and becomes evident in school age [29]. The consequences of this chronic sleep deprivation could have a great impact on school performance. Recent studies examined the associations between sleep parameters objectively measured by actigraphy and neurobehavioral functioning (NBF) in school-age children [30,34]; children with fragmented sleep were characterised by lower performance on NBF measures, particularly those associated with more complex tasks such as a continuous performance test and a symbol-digit substitution test. These findings were in agreement with our data showing that the DIMS and DOES sub-factors displayed a significant negative relationship with SAI. On the other hand, several studies demonstrated a relationship between sleep-related obstructive disorders and decreased cognitive performances [3–8,35–37], but our data failed to support a relationship between SAI and the SBD sub-factor in a non-clinical population.

Considering sleep and temperament, we found a low but statistically significant correlation between the SDSC total score and the temperament traits of task-orientation (negative correlation) and reactivity.

It is often difficult to determine whether disturbed sleep was caused initially by a specific temperament trait or by a parental behaviour (in response to a trait or independently) because interactive effects always evolve. On the other hand, the sleep deficit could cause either impairment of learning, lack of concentration, difficulty maintaining focused attention and fatigue that indirectly trigger a chemically

stimulated stress response in the child that becomes over-aroused, more difficult, or more excitable [26].

Temperamental traits such as task-orientation (activity, persistence and distractibility) and personal–social flexibility (approach, adaptability and mood) showed high correlation with the SAI and significantly contributed to the prediction of the SAI. These data supported Keogh’s findings on the involvement of these temperamental dimensions in predicting low achievement [38]. Keogh found school children’s performance problems to be related to temperament factors of low task-orientation (high activity, low persistence, and high distractibility) and low personal–social flexibility (low approach, adaptability and mood).

The dimensions involved in these two temperamental factors were already reported as being particularly important in the school context: for example, higher adaptability was associated with higher scores in two tests of achievement and also correlated with the teachers’ ratings for ability [33]; also, persistence was significantly associated with high achievement [19] and children who did not persist well and who were distractible had lower achievement compared with their peers [38].

Finally, it should be taken into account that, probably, sleep and temperament could be mutually involved in determining low achievement; disturbed sleep may

negatively affect persistence and distractibility and, thus, may so affect achievement.

Although we know that multiple risk factors have cumulative effects in increasing a child’s risk of failure in school, sleep disorders and temperamental characteristics could play an important role. The prevention of sleep disorders and the modification of teachers’ approach through the knowledge of child temperament could be used to prevent underachievement or to improve children’s school performances. Our study supports the need to assess temperament and sleep problems and identify children at risk regarding school achievement.

Appendix. Sleep disturbances scale for children

A.1. Instructions

This questionnaire will allow to your doctor to have a better understanding of the sleep–wake rhythm of your child and of any problems in his/her sleep behaviour. Try to answer every question; in answering, consider each question as pertaining to the past 6 months of the child’s life. Please answer the questions by circling or striking the number 1 to 5.

Name: _____ Age: _____ Date: _____	1 9–11 h	2 8–9 h	3 7–8 h	4 5–7 h	5 Less than 5 h	
How many hours of sleep does your child get on most nights	1 9–11 h	2 8–9 h	3 7–8 h	4 5–7 h	5 Less than 5 h	
How long after going to bed does your child usually fall asleep	1 Less than 15'	2 15–30'	3 30–45'	4 45–60'	5 More than 60'	
The child goes to bed reluctantly		1	2	3	4	5
The child has difficulty getting to sleep at night		1	2	3	4	5
The child feels anxious or afraid when falling asleep		1	2	3	4	5
The child startles or jerks parts of the body while falling asleep		1	2	3	4	5
The child shows repetitive actions such as rocking or head banging while falling asleep		1	2	3	4	5
The child experiences vivid dream-like scenes while falling asleep		1	2	3	4	5
The child sweats excessively while falling asleep		1	2	3	4	5
The child wakes up more than twice per night		1	2	3	4	5
After waking up in the night, the child has difficulty to fall asleep again		1	2	3	4	5
The child has frequent twitching or jerking of legs while asleep or often changes position during the night or kicks the covers off the bed		1	2	3	4	5
The child has difficulty in breathing during the night		1	2	3	4	5
The child gasps for breath or is unable to breathe during sleep		1	2	3	4	5
The child snores		1	2	3	4	5
The child sweats excessively during the night		1	2	3	4	5
You have observed the child sleepwalking		1	2	3	4	5
You have observed the child talking in his/her sleep		1	2	3	4	5
The child grinds teeth during sleep		1	2	3	4	5
The child wakes from sleep screaming or confused so that you cannot seem to get through to him/her, but has no memory of these events the next morning		1	2	3	4	5
The child has nightmares which he/she does not remember the next day		1	2	3	4	5
The child is unusually difficult to wake up in the morning		1	2	3	4	5
The child awakes in the morning feeling tired		1	2	3	4	5
The child feels unable to move when waking up in the morning		1	2	3	4	5
The child experiences daytime somnolence		1	2	3	4	5
The child falls asleep suddenly in inappropriate situations		1	2	3	4	5
Disorders of initiating and maintaining sleep (sum the score of the items 1, 2, 3, 4, 5, 10, 11)						
Sleep breathing disorders (sum the score of the items 13, 14, 15)						
Disorders of arousal (sum the score of the items 17, 20, 21)						
Sleep–wake transition disorders (sum the score of the items 6, 7, 8, 12, 18, 19)						
Disorders of excessive somnolence (sum the score of the items 22, 23, 24, 25, 26)						
Sleep hyperhydrosis (sum the score of the items 9, 16)						
Total score (sum 6 factors’ scores)						

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