

Received: 03.01.2020

Accepted: 18.02.2020

A – Study Design
 B – Data Collection
 C – Statistical Analysis
 D – Data Interpretation
 E – Manuscript Preparation
 F – Literature Search
 G – Funds Collection

WHEN LACK OF SLEEP TAKES ITS TOLL ON COMMUNICATION: AN ASSESSMENT OF PRAGMATIC ABILITIES IN TWO CHILDREN FOLLOWING SLEEP DEPRIVATION

Georgios Chatzopoulos^{1(A,B,C,D,E,F)}, Evgenia-Peristera Kouki^{2(A,B,C,D,E,F)}, Athanasios Evangelios^{3(A,B,C,D,E,F)}, Amaryllis C Malegiannaki^{2(A,B,C,D,E,F)}, Ariadne Loutrari^{4(A,B,C,D,E,F)}, Félix Díaz-Martínez^{5(A,B,C,D,E,F)}, Kalliopi Tsakpounidou^{1(A,B,C,D,E,F)}, Hariklia Proios^{1(A,B,C,D,E,F)}

¹ Department of Educational and Social Policy, The University of Macedonia, Thessaloniki, Greece

² Lab of Cognitive Neuroscience, School of Psychology, The Aristotle University of Thessaloniki, Greece

³ 4th University Pediatrics Clinic, Papageorgiou Hospital, Thessaloniki, Greece

⁴ Department of Applied Linguistics and Communication, Birkbeck, University of London, United Kingdom

⁵ Department of Psychology, University of Castilla la Mancha, Spain

SUMMARY

Background:

Sleep deprivation affects numerous cognitive processes. Children populations have not been studied thoroughly, with regard to the effect of sleep deprivation on communication abilities. In this study, we investigate the pragmatic competence following acute sleep deprivation.

Case studies:

Two eleven-year-old boys were evaluated on their pragmatic ability before and following sleep deprivation. The conversations were video-recorded, transcribed and analyzed using the CHAT conventions. The Pragmatic Evaluation Protocol Revised (PREP-R) was administered for the investigation of pragmatic ability.

Results:

Both children demonstrated a significantly lower performance following acute sleep deprivation. Their specific pragmatic ability and grammatically-based pragmatic ability were impaired. The subjects were unable to use lexical, morphological and syntactic cohesion, and encountered difficulties in the interaction and the managing of pauses.

Conclusions:

Acute sleep deprivation affects pragmatic competence, mainly due to difficulties in alertness, attention, working memory, and executive dysfunction in general. Variability in the pragmatic ability of the two subjects implies that more studies, focused on the cognitive deficits after sleep deprivation can cast more light on the evaluation of pragmatic ability.

Key words: sleep deprivation, pragmatics, communication, PREP-R, cognition

INTRODUCTION

There is growing evidence that chronic or acute sleep deprivation leads to cognitive as well as emotional dysfunction. Among the most pronounced cognitive difficulties that individuals encounter following sleep deprivation are restricted attention and executive dysfunction (Fallone, Acebo, Seifer, and Carskadon 2005; Paavonen, Porkka-Heiskanen and Lahikainen 2009; Vriend, Davidson, Corkum, Rusak, Chambers, and McLaughlin 2013; Vriend, Davidson, Rusak, and Corkum 2015). As these abilities are compromised by sleep deprivation, those pragmatic abilities that hinge on them become impaired as well. For example, a person's attention is negatively influenced due to lack of sleep, which impacts on their coherence, organization of speech, turn-taking, and, consequently, on their overall pragmatic competence (Green et al. 2014). A wide range of studies suggest that a limited amount of sleep has an adverse influence on several attentional subfunctions, such as sustained, divided and alerting attention as well as on more demanding attention tasks (Fallone et al. 2001; Molfese et al. 2013; Sadeh 2007; Sadeh et al. 2002; Vriend et al. 2013; Waldon et al. 2015). For example, the sustained attention subfunction is crucial for the proper production of phrases, such as joint nouns (Jongman et al. 2015). Studies using sleep deprivation in typically developing children are rare, but children with sleep disturbances demonstrate increased levels of inattention and impulsivity (Paavonen, Rääkkönen, Lahti, Komsu, Heinonen et al., 2009). In addition, another index of attention performance, namely reaction time, has also been reported to increase following sleep loss (Peters et al. 2009; Sadeh 2007). A recent review (de Bruin et al. 2017) which summarizes the effect of sleep manipulation on the cognitive functions (i.e., attention and working memory) of pre-adolescents and adolescents (10-19 years old) has highlighted the decrement of performance in psychomotor vigilance tasks as the most consistent finding following insufficient sleep.

Executive functions (that is, self control, inhibition, flexibility, working memory and planning) play an important role in the quality of children's conversational behavior. It has been shown that executive functions contribute substantially to the formation of utterances free of repetitions or hesitation (Blain-Briere et al. 2014). Executive dysfunction appears to be reflected in an individual's conversational skills. For instance, difficulties with impulse control can be identified in a person's discourse as reduced coherence, excessive talking, or abrupt talking shifts (McDonald 1993). Several studies have revealed the existence of executive dysfunction, such as deficits in working memory and inhibitory abilities, in sleep-deprived children (i.e., Nelson et al. 2015; Nilsson et al. 2005). Similarly, children have been shown to score lower under sleep deprivation conditions on different tests of executive functioning, such as the Wisconsin Card Sorting Test, which assesses mental flexibility and planning, and the Stroop Test, a well-known inhibitory task (Molfese et al. 2013; Nelson et al. 2015; Randazzo et al. 1998). Working memory has been also found to be compromised after sleep deprivation (Chee and Choo 2004; Lei et al. 2015).

However, less is known about the effects of sleep deprivation on pragmatic abilities. Some studies have looked at the role of sleep duration in language acquisition and, more specifically, vocabulary development (Axelsson et al. 2016), but very few studies with healthy adults have focused on pragmatic abilities (i.e., sarcasm) following sleep deprivation (Deliens et al. 2015). The study demonstrated that participants made accurate interpretations, but displayed a slower reaction time, which implies a difficulty in understanding the other person's perspective rather than a sleep loss-induced vigilance deficit. The authors, therefore, concluded that inadequate sleep can influence the quality of social interactions. Likewise, interaction with peers and social skills were affected in another study with sleep-deprived children (Vaughn et al. 2015). The aforementioned study examined the effect of sleep loss on emotion perception, vocabulary and social engagement, yielding that adequate sleep is crucial for the development of social skills in children. However, no detailed linguistic and conversational criteria were applied. As the intricacies of linguistic and pragmatic impairments stemming from sleep deprivation are not well understood, the present study seeks to shed new light on their assessment.

More specifically, the current study aimed at (a) examining the impact of acute sleep deprivation on conversational behavior in two children, based on video-recorded and transcribed interviews with their mothers and (b) linking their possible difficulties at the conversational level to the cognitive processes that are involved according to the existing subject literature.

We hypothesized that the children's conversational skills would be affected after sleep-deprivation, in ways that would make the presence of deficits obvious during speech performance, i.e., reduced coherence and speech organization. We also assumed that executive dysfunction would result in problems with turn-taking agility, clarity, order of information presentation and self-correction. Conversational Analysis was used in order to assess the children's interaction with an investigator and a "trusted interlocutor", i.e., a Key Conversational Partner (KCP; Prutting and Kirschner 1983), who commonly regulates and facilitates communication. In this case, the children's mothers played the role of the KCP (hereafter MOT). Conversation Analysis has been used in various children assessment programs, targeting a broad range of psychiatric and developmental disorders (Fasulo 2015; Rendle-Short 2017). Mothers were here expected to play an integral part in the triadic interaction (i.e., child, mother, and the researcher) in terms of correcting the children's utterances and providing prompts so as to facilitate communication.

CASE STUDIES

Participants

Two boys, KM and ChI, both aged 11 years, participated in the study. They were admitted to the University Pediatrics Clinic of the Papageorgiou General Hospital

in Thessaloniki, Greece for electroencephalographic monitoring in order to be medically tested for possible epileptic seizures following a doctor's referral. Hence, they were already scheduled to spend a night at the hospital under the conditions of acute (one-night) sleep deprivation. No seizures appeared to result from sleep deprivation, according to the post-sleep deprivation EEG records.

KM's symptoms included frequent headaches and involuntary head movements, whereas ChI's symptom profile included reduced movement coordination and somatognosia, gait and balance problems (as reported by the healthcare professional), and difficulty in telling left from right. Both children were of average intelligence, had no neurological or psychiatric history, or history of neurodevelopmental disorders, as reported by their mothers. Neither of them took medication. The children were interviewed twice (before and after sleep deprivation) to assess the effect of sleep deprivation on their pragmatic ability. Their mothers also took part in the interview both in the pre- and post-sleep deprivation conditions. Ethical approval was granted by Papageorgiou General Hospital and the participants gave informed consent to take part in the present study. All interviews with both KM and ChI were video recorded, transcribed verbatim, and analyzed using qualitative analysis. Details on the tool that we employed are provided below.

STIMULI AND PROCEDURE

Interviews included narrating and other tasks and were video recorded. We administered the Pragmatic Evaluation Protocol – Revised (PREP-R; Fernández Urquiza, Díaz Martínez, Moreno Campos, López-Villaseñor, and Simón López 2015; see Gallardo Paúls 2006; 2009) to examine pragmatic competence in conversation. Three broad levels of pragmatic ability were evaluated based on the recorded conversations, namely enunciative, textual, and interactional. The items of each level were rated with “yes”, “no”, or “not observed”.

The enunciative level includes speech acts (i.e., illocutionary and propositional), intentional acts (i.e., indirect and direct), compensatory behaviors (verbal; examples include the descriptions of words the person is not able to retrieve and non-verbal; examples are gestures or drawing), metapragmatic awareness, and the maxims that compose the Cooperative Principle (Grice 1975), including quality, quantity, manner, relevance, and particularized implicatures.

The textual level is comprised of narrative and argumentative coherence as well as lexical, semantic, morphological, and syntactic cohesion. This includes the individual's ability to provide sufficient information about place and time, the characters of a story, and the actions taking place in a logical and chronological order (narrative superstructure). Alternatively, it includes rational arguments when supporting a statement during a conversation (argumentative superstructure). The textual level of PREP-R also assesses the abilities to identify a topic shift, shift topics in a fluid manner (textual coherence), create semantic chains by means of co-reference devices (lexical and semantic cohesion), use morphological categories correctly (morphological cohesion), and produce turns according

to the syntax commonly used in spontaneous conversations (syntactic cohesion).

Finally, the interactional level represents turn-taking agility, relative conversational participation, predictability, preference, gesture, and eye contact. Using conversation transcripts it allows for the calculation of the Agility of Turn Taking and the Conversational Participation Indexes. In order to apply the PREP-R, the clinician provides an impressionistic estimation. Predictability is assessed positively when the individual demonstrates a balanced proportion of reactive and predictive turns. Predictive turns are related to reactive turns as first and second parts of adjacency pairs (see Sacks 1992; Schegloff 2007). Reactive turns produce the act required by predictive turns. Predictability is positively assessed when the participant's reactive turns realize the requirement established by their predictive turns. Predictability also includes the ability to produce relevant and adequate predictive turns (e.g., ask questions, or initiate conversation). Preference concerns the way utterances are designed to adhere to principles of politeness and cultural appropriateness in adjacency pairs.

Every item of the PREP-R was individually assessed, by examining its presence and proper use in the participants' utterances. An item was rated with "yes" when the participant exhibited the corresponding pragmatic ability at least once during the conversation. Contrarily, an item was rated with "no" when the component assessed by the specific item was often absent or misused. Finally, an item was rated as "not observed" when the participant did not have the chance to use the particular component in the conversation.

For the creation of the Greek version of PREP-R, we first used backward translation; the PREP-R checklist was translated by a researcher from Spanish to Greek. Then, another researcher translated the Greek checklist back into Spanish and the authors examined the compatibility of the two versions. Finally, a group of independent investigators approved the Greek version through a consensus study that we conducted. The investigator (INV), in collaboration with the mother (MOT) provided prompts and questions to the participant (PAR) as a way of monitoring the conversation. The inclusion of mothers as KCPs is thought to be crucial in order to investigate and analyze conversational behavior in a natural conversation environment. The interview was divided into two parts; the first part required participants to tell a story with a highly emotional content. The second part included the telling of a story or the description of a procedural task. More specifically, in the first part, conversational behavior was assessed under emotional distress. Both participants/mothers were asked about their stay at the hospital and the examination procedures they had undergone (phase 2, following sleep-deprivation), or would undergo (phase 1, prior to sleep deprivation). For the second part of the conversational exchange, individuals were requested to narrate a story and describe their daily routine. This method provided the necessary insight into the children's syntax and textual cohesion and, therefore, facilitated the assessment of possible grammatically-based or specific pragmatic impairments.

The following conversational data were transcribed using the CHAT conventions (MacWhinney 2000, see Appendix), taking account of conversational over-

laps, interruptions, different kinds of pauses, and non-verbal communication. The resulting collection of video recordings and real-time transcripts were uploaded to a data bank. After independent examiner observation, PREP-R ratings were applied to all four interviews, two before (files named chl1.cha for ChI, and prin.cha for KM), and two following sleep deprivation (files named chi2.cha for ChI, and meta.cha for KM). The conversation analysis stemming from the interviews is presented below.

RESULTS

Interrater reliability was estimated using Cohen’s kappa. For positive (“Yes”) and negative (“No”) ratings, Cohen’s kappa indicated substantial agreement (0.61 and 0.76, respectively). Nearly perfect agreement (0.98) was observed regarding the items that were rated as “not observed” in the conversations. This section provides the-scores of KM and ChI on PREP-R, comparing their performance before and following sleep deprivation and focusing separately on their Specific and Grammatically-Based Pragmatic Ability. Tables 1 to 4 summarize these results for each child separately.

Table 1. Ratings of Enunciative Pragmatics for both participants, speech acts sublevel

ENUNCIATIVE PRAGMATICS	KM		ChI	
	Before	After	Before	After
Speech Acts Sublevel				
1. Speech Acts				
1.1 <i>Utterance acts</i>	Yes	Yes	No	No
1.2 <i>Propositional Acts</i>	Yes	Yes	No	No
1.3 <i>Management of pauses and silence.</i>	Yes	No	Yes	No
2. Intentional speech acts				
2.1 <i>Direct and indirect conventional speech acts.</i>	Yes	Yes	Yes	Yes
2.2 <i>Indirect speech acts.</i>	N.O.	Yes	N.O.	N.O.
3. Editing Tasks				
3.1 <i>Utterance Acts</i>	Yes	Yes	Yes	Yes
3.2 <i>Draft Acts</i>	Yes	No	Yes	No
3.3 <i>Compensatory non-verbal acts</i>	Yes	N.O.	Yes	No
4. <i>Metapragmatic awareness</i>	Yes	Yes	Yes	No

Table 2. Ratings of Enunciative Pragmatics for both participants, inferences sublevel

Inferences Sublevel	KM		ChI	
	Before	After	Before	After
5. Cooperative Principle: conversational maxims and particularized implicatures				
5.1 <i>Maxim of Quality</i>	Yes	Yes	No	No
5.2 <i>Maxim of Quantity</i>	Yes	No	Yes	Yes
5.3 <i>Maxim of Manner</i>	Yes	Yes	Yes	No
5.4 <i>Maxim of Relevance</i>	Yes	Yes	Yes	Yes
5.5 <i>Implicatures</i>	Yes	Yes	N.O.	N.O.
6. <i>Lexicalised tropic inference</i>	Yes	Yes	N.O.	N.O.

Table 3. Ratings of Textual Pragmatics for both participants

TEXTUAL PRAGMATICS	KM		ChI	
	Before	After	Before	After
7. Coherence: Textual Superstructures				
<i>7.1 Narrative superstructure</i>	Yes	No	N.O.	Yes
<i>7.2 Argumentative Superstructure</i>	Yes	Yes	N.O.	N.O.
8. Topic Management				
<i>8.1 Recognition of the introduction of a new topic</i>	Yes	Yes	Yes	Yes
<i>8.2 Fluid introduction of new topics</i>	Yes	Yes	Yes	Yes
Cohesion Level				
<i>9. Lexical Cohesion</i>	Yes	No	Yes	No
<i>10. Morphological Cohesion</i>	Yes	Yes	Yes	No
<i>11. Syntactic cohesion</i>	Yes	Yes	Yes	No

Table 4. Ratings of Interactional Pragmatics for both participants

INTERACTIONAL PRAGMATICS	KM		ChI	
	Before	After	Before	After
<i>12. Agility of turn taking</i>	Yes	No	Yes	Yes
<i>13. Turn taking at the right momento</i>	Yes	No	No	No
<i>14. Adequate conversational participation</i>	Yes	No	Yes	Yes
<i>15. Predictability</i>	No	No	Yes	Yes
<i>16. Preference</i>	Yes	Yes	Yes	No
<i>17. Natural Use of Gestures</i>	No	No	Yes	No
<i>18. Gazes for communicating</i>	Yes	No	Yes	Yes

KM

KM's pragmatic ability showed a decline after one night of sleep deprivation. As seen in Table 5, his General Pragmatic Ability was relatively high before sleep deprivation (89.66%), but following sleep deprivation, the performance on General Pragmatic Ability dropped to 58.62%. With respect to Specific Pragmatic Ability, his initial performance reached 85.71%, but following sleep deprivation he only scored 52.38%. His Grammatically-based Pragmatic Ability also declined dramatically; his pro-sleep deprivation reached the ceiling (100%), but his post-sleep deprivation performance was much poorer (75%).

Specific Pragmatic Ability

KM showed a deterioration in Specific Pragmatic Ability, failing in items 3.2, 5.2, 7.1, 12, 13, 14, and 18. Item 3.2 evaluates the use of strategies to gain time during conversation. The negative rating of item 5.2 implies a violation of the maxim of quantity. KM's utterances in the second recording did not meet the standard con-

Table 5. General Pragmatic Ability, Specific Pragmatic Ability, Gramatically-Based Pragmatic Ability for KM and ChI

	KM		ChI	
	Before	After	Before	After
General Pragmatic Ability	89.66%	58.62%	68.97%	34.48%
Specific Pragmatic Ability	85.71%	52.38%	71.43%	52.38%
Grammatically-Based Pragmatic Ability	100%	75%	62.5%	0%

textual requirements, as they consisted mostly of one- or two-word responses. This can be illustrated in Example 1:

(1) KM, After

- 194 *INV: υπάρχει κάποιο μέρος που δυσκολεύεται στα μαθηματικά?
194 *INV: Is there a section in Mathematics where you've got difficulties?
195 *INV: ας πούμε στον πολλαπλασιασμό.
195 *INV: Let's say in multiplication.
196 *KM: &εε.
196 *KM: &eh.
197 *INV: στη διαίρεση.
197 *INV: in division.
198 *KM: όχι.
198 *KM: No.
199 *INV: σ' όλα καλά ε?
199 *INV: Everything fine, &eh?
200 *KM: ναι.
200 *KM: Yes.
201 *INV: και κάνετε και κλάσματα?
201 *INV: And you do fractions, as well?
202 *KM: &εε ναι κάναμε κλάσματα.
202 *KM: &eh yes we did fractions.
203 *INV: διαιρέση με δεκαδικούς?
203 *INV: Divisions with decimals?
204 *KM: ναι.
204 *KM: Yes.

In the above example, the researcher asked KM closed-ended questions, but KM could also give longer answers if he wished. In lines 195 and 197, the researcher expanded the question originally formulated in 194 due to KM's lack of response, but still KM only provided minimal answers (lines 198, 200, 202 and 204). In contrast, his performance before sleep deprivation was much more successful as far as the maxim of quantity is concerned. This can be illustrated by the following segment of the conversation (Example 2):

(2) KM, Before

- 65 *INV: τί θα κάνετε?
65 *INV: What are you going to do?
66 *INV: με το παιδάκι θα [/]/ θα είστε φίλοι λογικά θα παίζετε.
66 *INV: With the child you [/]/ you are probably friends you play together.
67 *KM: &εε ναι είμαστε.
67 *KM: &eh yes we are.
68 *KM: θα παίξουμε με τα κινητά και τα τάμπλετ.
68 *KM: We are going to play with cell phones and tablets.
69 *KM: θα παίξουμε μονόπολυ.
69 *KM: We are going to play monopoly.
70 *KM: θα παίξουμε φιδάκι και γκρινιάρη.

70 *KM: We will play snakes and ladders and parchis.

71 *INV: έχεις μεγάλα σχέδια για το βράδυ [=! γελάει].

71 *INV: You have big plans for tonight [=! laughs].

Note that, while line 65 was an open-ended question, line 66 was formulated as a closed-ended question. KM could have chosen to give a convergent answer, but he gave a rather detailed description, as seen in lines 67-70 of Example 2.

Item 7.1 was also negatively rated following sleep deprivation due to KM's difficulty in narrating a story properly by providing the necessary information about people, space, and time. This difficulty can be interpreted as an impairment in the processing of the researcher's questions and possibly a deterioration in working memory. The reader can appreciate these difficulties below.

(3) KM, After

241 *INV: Μπορείς να μου περιγράψεις πως ήταν οι αγώνες οι τελευταίοι που πήγες?

241 *INV: Can you describe how was the last competition you attended?

242 *KM: ποιο?

242 *KM: What?

243 *INV: στην κο [/] στην κολύμβηση.

243 *INV: In sw [/] in swimming.

244 *KM: &εε.

244 *KM: &eh.

245 *INV: γενικά να μου το περιγράψεις όλο.

245 *INV: Generally describe me everything.

246 *KM: μμμ ναι.

246 *KM: hmm yeah.

247 *INV: πως πήγες, τι κάνατε.

247 *INV: How did you go, what did you do.

248 *KM: (..) βγήκα πρώτος ναι.

248 *KM: (..) I finished first yes.

249 *KM: το πέρασα το άλλο παιδάκι που κάναμε αγώνες.

249 *KM: I defeated the other child with whom I competed.

250 *KM: &εε (.) αυτό (3.) πώς το λένε (4.) ε ναι ήταν ωραία γενικά οι αγώνες.

250 *KM: &eh (.) this (3.) how do we say (4.) eh yes it was nice generally the competition.

In lines 242, 244, and 246 of Example 3, KM only gave minimal answers, which suggests that he did not fully understand the researcher's questions. After multiple prompts, he explained that he had finished first in a competition (lines 248-9), and elaborated only briefly, saying that he enjoyed the competition (line 250). As a whole, the child failed to understand the questions and provide a structured and detailed narrative, in contrast to the pre-sleep deprivation performance:

(4) KM, Before

248 *INV: τί έχεις μάθει στον προσκοπισμό?

248 *INV: What have you learnt in scouting?

- 249 *KM: &εε πηγαίνουμε σε κατασκηνώσεις (.) σε σκηνές μένουμε.
249 *KM: &eh we go to camps (.)we stay in tents.
250 *INV: πολύ ωραία.
250 *INV: Very nice.
251 *KM: μαθαίνουμε να επιβιώνουμε στη φύση.
251 *KM: We learn how to survive in the wild.
252 *INV: πολύ ωραία.
252 *INV: Very nice.
253 *INV: ανάβετε φωτιές.
253 *INV: You learnt to light a fire.
254 *KM: ναι έχουμε ανάψει φωτιά μια φορά σε μια παραλία και παίζαμε κι θάρα.
254 *KM: Yes we have once lit a fire on a beach and we played the guitar.
255 *INV: και παίζατε [/] μη μου πεις ότι έπαιζες και κιθάρα [<1].
255 *INV: And you played [/] don't tell me you played the guitar, too? [<1].
256 *KM: όχι ένας έπαιξε [>1] [/] ένας [<2] έπαιξε κιθάρα.
256 *KM: N o, someone played [>1] [/] someone [<2] played the guitar.

The researcher's prompt in 248 instigates a structured listing of activities; when the researcher touched on another activity in 253, KM elaborated sufficiently, providing details on place and participants.

Item 12 was also rated with "no" following sleep deprivation, as turn taking was neither agile nor quick. In addition, KM did not take his turn at the right moment and, therefore, item 13 was also rated with "no". Item 14 was also negatively rated, since he very often gave only one-word answers. The conversation segment below is a representative example of these difficulties.

(5) KM, After

- 22 *INV: πόσες ώρες είστε ξύπνιοι?
22 *INV: How many hours are you awake?
23 *KM: (4.) πέντε?
23 *KM: (4.) Five?
24 *INV: πέντε ώρες?
24 *INV: Five hours?
25 *INV: από τί ώρα?
25 *INV: Since when?
26 *KM: από τις δύο.
26 *KM: Since two o'clock.
27 *INV: από τις δύο ωραία.
27 *INV: Since two nice.
28 *INV: και μέχρι τότε κοιμόσουνα?
28 *INV: And until then were you sleeping?
29 *KM: ναι.
29 *KM: Yes.

As shown in the excerpt above, there was a four second delay in line 23, a failure to answer the researcher's question in line 24, and a minimal response in

line 29. The resulting conversation rhythm is slow, with KM's collocutors having to patiently wait for him to complete his utterances. This stands in sharp contrast to the conversation flow before sleep deprivation, as shown below.

(6) KM, Before

- 354 *INV: σε ποια πόλη στην Ιταλία [<]?
354 *INV: In which city in Italy [<]?
355 *KM: στην Ιταλία [>]?
355 *KM: In Italy [>]?
356 *KM: στην Πάρμα και στην Βενετία.
356 *KM: in Parma and in Venice.
357 *INV: μη μου πεις ότι μιλάς και Ιταλικά.
357 *INV: Don't tell me that you also speak Italian.
358 *KM: ε ξέρω τους αριθμούς +/.
358 *KM: &eh I know the numbers +/.
359 *INV: θα τρελαθώ.
359 *INV: That's great!
360 *KM: +, ξέρω τους αριθμούς ως το πέντε.
360 *KM: +, I know the numbers up to five.

As seen in Example 6, the transition-relevance places begin and end normally, that is, the conversation progresses with minimal gaps between turns. Answers are also detailed and informatively relevant to the questions asked by the researcher.

KM's ability to use eye contact to communicate was also rated with "no" following sleep deprivation, as he stared at the ceiling or the floor and his body posture was rather passive for most of the interview.

Grammatically-based Pragmatic Ability

As far as Grammatically-based Pragmatic Ability is concerned, KM's performance declined for items 1.3 and 9. As seen in Table 5, his Grammatically-based Pragmatic Ability prior to sleep deprivation was better than following sleep deprivation. This is evident in Example 4 above (KM describes the activities he does in scouting, where his responses were more fluent, with intact cohesion and coherence). Item 1.3 is an example of adequately managing pauses within turns. KM's pauses in the interaction after sleep deprivation were too long (three or four seconds) and very frequent, resulting in a negative rating of this item (see Example 3, line 250 and Example 5, line 23). Such delays in response time were not found in KM's pre-sleep deprivation performance, in which his response times were faster, as seen in Example 2.

Lexical cohesion, as seen in item 9, was rated with "no" following sleep deprivation, since KM often encountered difficulties in locating and using the necessary words for the descriptions he was asked to give. A good example of these impairments is found in Example 3 above, where KM did not manage to provide a detailed description of a sports competition due to his compromised lexical retrieval. KM had not experienced Lexical Cohesion difficulties before sleep deprivation:

(7) KM, Before

- 486 *INV: &εε έκανες εγκεφαλογράφημα?
 486 *INV: &eh did you have EEG?
 487 *KM: εγκεφαλογράφημα το αγαπημένο μου.
 487 *KM: EEG my favourite.
 488 *INV: σ' άρεσε.
 488 *INV: You liked it.
 489 *INV: γιατί σου άρεσε?
 489 *INV: Why did you like it?
 490 *KM: γιατί δεν κατάλαβα τίποτα.
 490 *KM: Because I didn't know anything.
 491 *INV: ήτανε γρήγορο?
 491 *INV: Was it fast?
 492 *KM: δεν το λες και γρήγορο.
 492 *KM: Sure it was not fast.
 493 *KM: απλά δεν καταλάβαινα κάτι.
 493 *KM: I just did not feel anything.

In the example above, one can observe agility in turn taking and the use of technical terms (EEG) as well successful lexical retrieval.

KM's performance on Enunciative Pragmatics was relatively poorer following sleep deprivation; the initial score being 93.33% dropping to 73.33%. His initial score on Textual Pragmatics reached the ceiling (100%), but dropped to 71.43%, following sleep deprivation. His initial performance on Interactional pragmatics reached 71.43% but his post-sleep deprivation score amounted to only 14.29%. These findings are also summarized in Table 6.

Table 6. Total percentages for Enunciative, Textual, and Interactional pragmatics for KM and ChI

	KM		ChI	
	Before	After	Before	After
Enunciative Pragmatics	93.33%	73.33%	60%	26.67%
Textual Pragmatics	100%	71.43%	71.43%	28.57%
Interactional Pragmatics	71.43%	14.29%	85.71%	57.14%

ChI

ChI's ratings in PREP-R also point to a poorer performance following sleep deprivation. As seen in Table 5, his General Pragmatic Ability was rated with 68.97% before sleep deprivation and fell to 34.48% following sleep deprivation. His initial performance on Specific Pragmatic Ability (71.43%) was similar to his General Pragmatic Ability. Specific Pragmatic Ability dropped to 52.38% after sleep deprivation, as observed in Table 5. The most remarkable deterioration was observed in Grammatically-based Pragmatic Ability, with his performance reaching 62.5% before sleep deprivation, and dropping to 0% following sleep deprivation.

Specific Pragmatic Ability

Ten items were evaluated positively in both interactions: 2.1 (use of direct and non-direct speech acts), 3.1 (compensatory acts), 5.2 (maxim of quantity), 5.4 (maxim of relevance), 8.1 (recognizing the introduction of new topics), 8.2 (fluidly introducing new topics), 12 (agility in turn taking), 14 (conversational participation), 15 (predictability), and 18 (use of eye contact). Four items were assessed negatively both pre- and post-sleep deprivation: utterance acts (item 1.1), propositional acts (item 1.2), maxim of quality (item 5.1), and turn taking at the right moment (item 13).

The items in which deterioration was observed were 9 in total. Deterioration in Specific Pragmatic Ability was observed in items 3.2, 3.3, 4, 16, and 17. Item 3.2 was evaluated negatively after sleep deprivation due to ChI's failure to use strategies to gain time during the conversation. Before sleep deprivation, he was able to use strategies such as repeating the investigator's questions as a way of gaining time to construct his next utterance. Example 8 illustrates this finding; ChI used gestures in order to compensate when his utterance was underinformative:

(8) ChI, Before

339 *PAR: &εε όταν βγω από το νοσοκομείο?

339 *PAR: &eh when I get out of the hospital?

340 *INV: &μχμ.

340 *INV: &mhm.

341 *PAR: &εε δηλαδή από όλο το [=! σηκώνει το χέρι του και δείχνει όλο το δωμάτιο].

341 *PAR: &eh you mean the whole [=! raises his hand and points around the room].

342 *INV: Τελείως [/] τελείως.

342 *INV: Completely [/] completely.

In the post-sleep deprivation interview, ChI did not use any gestures throughout the interaction to compensate for his impaired verbal production and he kept his movements to a minimum. Consequently, he was given a negative rating of metapragmatic awareness (item 4). Before sleep deprivation, ChI adhered to social norms and politeness:

(9) ChI, Before

125 *CHI: Μπορώ να [<] πάω λίγο τουαλέτα?

125 *CHI: Can I [<] go to the toilet?

126 *INV: Σε λιγάκι.

126 *INV: In a moment.

127 *INV: Σε πέντε λεπτάκια.

127 *INV: In five minutes.

128*CHI: Εντάξει.

128*CHI: Ok.

A request to go to the toilet, formulated by a child to the convener of the interview in course, is a dispreferred first part; it interrupts the course of action to initiate a different activity under the auspices of the producer. The formula devised by ChI in (125) is conventional and complies with the principle of polite-

ness. His later acceptance of the researcher's decline is a preferred also produced in an appropriate format (positive, simple and minimal). Preference, as seen in ChI's interaction with the researcher, shows deterioration in verbal performance, such as in (211-212) of Example 10, of the interaction following sleep deprivation:

(10) ChI, After

211 *INV: Και ετοιμάζεσαι μόνος σου?

211 *INV: And you prepare yourself on your own?

212 *CHI: Τι?

212 *CHI: What?

ChI's utterance here could have been replaced with a politer expression (e.g., 'I beg your pardon?'). In a formal interaction with an unknown adult, a child would normally employ markers of distance and politeness. Finally, item 17 was also negatively assessed following sleep deprivation, since, as mentioned above, ChI demonstrated very little changes in posture, movement, and facial expressions. By contrast, a use of gestures was present, in the initial interaction as shown in Example 11:

(11) ChI, Before

64 *INV: Πώς νιώθεις για την κάμερα, δε νομίζω να έχεις άγχος?

64 *INV: How do you feel about the camera, I don't think you're nervous?

65 *CHI: &αα πάει αυτές τις καμ [//] αυτές εκεί έξω, ούτε κ [//] ούτε και

65 *CHI: &ah no these cam [//] those out there, nor th [//] nor

66 αυτή τώρα που μας τραβάει [=! points at the camera].

66 This one recording us now [=! points at the camera].

Grammatically-based Pragmatic Ability

ChI's Performance on Grammatically-based Pragmatic Ability showed deterioration in items 1.3., 5.3, 9, 10, and 11. ChI was rated negatively in item 1.2 (propositional acts) both before and following sleep deprivation. ChI was successful in using pauses within turns before but not following sleep deprivation. The ability to present information in an unambiguous and orderly manner was demonstrated before sleep deprivation, as shown in Example 14 (where ChI described his plans for the night in a fairly structured manner, lines 32-33). However, ChI had serious difficulties in this domain following sleep deprivation. Hence, item 5.3 was negatively assessed:

(12) ChI, After

215 *CHI: Λοιπόν, πρώτα, αν έχω κανένα μάθημα ξυπνάω στις εφτά,

215 *CHI: Well, firstly, if I have homework to do, I wake up at seven,

216 κάνω τα μαθ [//] το μάθημα: [>] άμα προλάβω να το κάνω +/.

216 I do my home [//] my homework: [>] if I have enough time +/.

217 *KEY: &=head:yes .

217 *KEY: &=head:yes .

218 *CHI: +, δεύτερον [//] πί [//] &εε πίνω το γά [//] μου κάνει η μαμά γάλα

218 *CHI: +, Secondly [//] I dr[//] &eh I drink mi [//] my mom makes milk

- 219 και το πίνω.
 219 and I drink it.
 220 *CHI: Μετ [//] δεύτερον, πάω και βουρτσίζω τα δόντια μου, γύρω
 220 *CHI: Aft [//] secondly, I go brush my teeth, all
 221 γύρω, παντού, ακόμα και στα σιδεράκ [//] &εε στις δαχτυλήθρες.
 221 over, everywhere, even on the brac [//] &eh on the braces.
 222 *INV: Ωραία.
 222 *INV: Nice.
 223 *CHI: Και μετά πηγαίνω και βάζω ρούχα, &εε πρέπει να έχω
 223 *CHI: And then I go and put on clothes, &eh I must have
 224 *CHI: ετοιμάσει την τσάντα μου πριν [/] πριν [//] πριν ξυπνήσει η μαμά,
 224 *CHI: prepared my bag before[/] bef [//] before my mom wakes up,
 225 *CHI: να ξυπνήσω πρώτος.
 225 *CHI: I must wake up first.

ChI is trying to describe an everyday activity using appropriate discourse markers; yet his mind goes blank and he has to start over repeatedly (in lines 216, 218, 220, 221 and 224). The resulting description is difficult to follow. Lexical cohesion (item 9 in PREP-R) was evaluated positively before sleep deprivation and negatively following sleep deprivation. Example 13 illustrates these difficulties.

(13) ChI, After

- 141 *INV: Σας είπαν πότε θα βγείτε?
 141 *INV: Did they tell you when you are leaving?
 142 *CHI: &εε δε μας είπαν οι γιατροί.
 142 *CHI: &eh the doctors did not tell us.
 143 *CHI: Μόνο όταν είχαμε [//]τελειώσαμε τη βόλτα μας και γυρίσαμε
 143 *CHI: Only when we had [//] we finished our walk and returned
 144 *CHI: πάλι πίσω, και αφού παραλίγο [//] πήγαινε να φύγει το [//] ο φίλος
 144 *CHI: back again, and after it almost [//] almost came off [//] my friend
 145 *CHI: που φοράει αυτό [//] που έχει κάνει εγκεφαλογράφημα [>].
 145 *CHI: who wears that [//] who has had an EEG examination [>].
 146 *INV: &μχμ [<].
 146 *INV: &mhm [<].
 147 *CHI: &εε μαγνητική.
 147 *CHI: &eh MRI.
 148 *CHI: Έχει βάλει εδώ ένα πράγμα εδώ πέρα [=! points at the back of
 148 *CHI: his hand], όλοι το φοράνε +/.
 148 *CHI: He has put a thing on over here [=! points at the back of his hand],
 everyone wears it +/.
 149 *INV: Την πεταλούδα, ναι.
 149 *INV: The butterfly, yes.
 150*PAR: +, &εε το [//] αλλά ξεκολλόταν [:: ξεκολλούσε] το [//] θα έβγαινε σε
 150*PAR: +, &eh it [//] but it came off [//] it would come off.

151*PAR: γι'αυτό πήγαμε να του βάλουμε λίγο σιλοτέηπ από πάνω.

151*PAR: so we went to get some tape for him to put on.

Several aspects of ChI's expression in this segment suggest lexical difficulties, as he made several attempts to use self-repair strategies (as in lines 143-144). On some occasions, these efforts fail and he produces grammatically incorrect (for example, "xekollótan" in line 150); and he resorts to deictic and imprecise words.

Morphological and syntactic cohesion were positively assessed in the interaction before sleep deprivation (see Example 14 below). However, morphological cohesion (item 10) was negatively assessed following sleep deprivation. Word construction was often incomplete and the use of nouns, verbs and articles was inadequate. Syntactic cohesion was also negatively assessed in the interaction following sleep deprivation due to ChI's difficulties in sentence construction. Example 14 includes a brief statement in which ChI employs additional syntactic and morphological options in his speech.

(14) ChI, Before

32 *CHI: Θα μείνω [/] θα ξυπνήσω στις δύο η ώρα τα μεσάνυχτα,

32 *CHI: I will stay [/] I will wake up at two in the midnight,

33 *CHI: και μετά θα κάνω ό,τι θέλω.

33 *CHI: and then I will do whatever I want.

Example 15 consists of a similarly brief utterance, but, on this occasion, the combination of lexical imprecision and lack of syntactic well-formedness results in absurd and unintelligible speech.

15) ChI, After

161 *CHI: Εγώ ήρθα εδώ [/] που ήταν εκεί πέρα και καθόταν

161 *CHI: I came here [/] who was over there and it was sitting

162 *CHI: εκεί μέσα.

162 *CHI: in there.

Example 15 reveals a violation of subject-verb agreement. There is a disagreement between the subject and the verb in line 161, although the reader should note that this is not reflected in the English translation. Cohesion is also lacking in the aforementioned line. The impairments in question could be alternatively attributed to an omission of an additional third-person subject in the utterance.

A substantial performance difference is observed when comparing ChI's scores on Enunciative Pragmatics pre- and post- sleep deprivation; his score dropped from 60%, to only 26.67%. ChI's score in Textual Pragmatics before sleep deprivation was relatively high (71.43%), but deteriorated remarkably following sleep deprivation (28.57%). His initial performance on Interactional Pragmatics (85.71%), dropped to 57.14% following sleep deprivation.

DISCUSSION

The present study explored the effect of sleep deprivation on the pragmatic abilities of two children aged 11 years, using the Pragmatic Evaluation Protocol – Revised (PREP-R; Fernández Urquiza, Díaz Martínez, Moreno Campos,

López-Villaseñor, and Simón López 2015; see Gallardo Paúls 2006; 2009). The excerpts provided illustrate a number of impairments in the boys' post-sleep deprivation performance. Both had difficulty in managing pauses and using strategies to gain extra time. In addition, the boys displayed deterioration in cohesion (lexical, morphological, and syntactic). They also encountered difficulties in turn-taking and ChI, more specifically, manifested a reduced use of gestures and less preferred utterances. Delay in speech initiation was also observed in KM's speech output. KM also experienced difficulties in using verbal compensatory acts. Inadequate use of verbal compensatory acts has been interpreted in previous studies as a deficit in behavior planning and self-monitoring, which is an important component of executive functions (Blain-Briere, Bouchard and Bigras 2014). KM's answers were, at times, short, thus violating Grice's (1975) Maxim of Quantity. This is in line with previous evidence that suggests that impairments in fluency following sleep deprivation are common (Vartanian et al. 2014).

After a night of sleep deprivation, ChI was unable to successfully manage pauses. That is, a slower reaction time was observed, indicating problems in alertness (Chengyang et al. 2016; Doran, Van Dongen and Dinges 2001; Killgore 2010). ChI's metapragmatic awareness was also compromised. This can be attributed –to some extent– to self-monitoring difficulties, which have been found to decline following sleep deprivation (Tsai, Young, Hsieh and Lee 2005).

ChI's working memory problems following sleep deprivation corroborate previous findings (Chee and Choo 2004; Lei et al. 2015). These working memory problems can, in turn, account for additional negative effects on conversational skills in the two children, in line with previous research (Blain-Briere, Bouchard and Bigras 2014).

The post-sleep deprivation impairments that were observed in the present study should still be interpreted with caution, as it is hard to disentangle the effects of different cognitive abilities on conversational skills. Nevertheless, the tool that we employed afforded us the possibility to look at detailed aspects of pragmatic abilities and their post-sleep deprivation decline. It also provided evidence on unique patterns of previously unexplored pragmatic abilities. Future research is warranted in order for the relation between cognitive functioning and pragmatic performance to be better understood.

The full adaptation and validation of the Greek PREP-R is still in progress. Administering standardized cognitive tasks in combination with PREP-R in future work can shed more light on the relationship between sleep deprivation and specific patterns of pragmatic impairments. The narratives of our participants, the presence of familiar persons in the interaction, and video recording analysis constitute a powerful way of examining what otherwise could be overlooked when evaluating conversational performance. It would also be of interest to apply brain imaging in order to examine how pragmatic competence is instantiated in the brain and how it can be compromised after sleep deprivation, thus providing further clinical and theoretical implications.

REFERENCES

- Axelsson, Emma L., Sophie E. Williams & Jessica S. Horst. 2016. The effect on children's word retention and generalization. *Frontiers in Psychology* 7: 1192.
- Blain-Brière, Bénédicte, Caroline Bouchard & Nathalie Bigras. 2014. The role of executive functions in the pragmatic skills of children age 4–5. *Frontiers in Psychology* 5: 240.
- Chee, Michael W. L. & Wei Chieh Choo. 2004. Functional imaging of working memory after 24 hr of total sleep deprivation. *Journal of Neuroscience* 24(19): 4560-4567.
- Chengyang, Li, Huang Daqing, Qi Jianlin, Chang Haisheng, Meng Qingqing, Wang Jin, Liu Jiajia, Ye Enmao, Shao Yongcong & Zhang Xi. 2016. Short-term memory deficits correlate with hippocampal-thalamic functional connectivity alterations following acute sleep restriction. *Brain Imaging and Behavior* 11(4): 1-10.
- De Bruin, Eduard J., Chris van Run, Janneke Staaks & Anne Marie Meijer. 2017. Effects of sleep manipulation on cognitive functioning of adolescents: A systematic review. *Sleep Medicine Reviews* 32: 45-57.
- Deliens, Gáetane, Fanny Stercq, Alison Mary, Hichem Slama, Axel Cleeremans, Philippe Peigneux & Mikhail Kissine. 2015. Impact of acute sleep deprivation on sarcasm detection. *PloS one* 10(11): e0140527.
- Doran, Scott M., Hans P. A. Van Dongen & David F. Dinges. 2001. Sustained attention performance during sleep deprivation: evidence of state instability. *Archives Italiennes de Biologie* 139(3): 253-267.
- Fallone, Gahan, Christine Acebo, Todd Arnedt, Ronald Seifer & Mary A. Carskadon. 2001. Effects of acute sleep restriction on behavior, sustained attention, and response inhibition in children. *Perceptual and Motor Skills* 93(1): 213-229.
- Fallone, Gahan, Christine Acebo, Ronald Seifer & Mary A. Carskadon. 2005. Experimental restriction of sleep opportunity in children: effects on teacher ratings. *Sleep* 28(12): 1561-1567.
- Fasulo, Alessandra. 2015. The value of conversation analysis for the study of children's mental health. In M. O'Reilly & J. N. Lester (Eds.), *The Palgrave handbook of child mental health: Discourse and conversation studies* (pp. 3–24). London: Palgrave Macmillan.
- Fernández Urquiza, Maite, Félix Díaz Martínez, Verónica Moreno Campos, Miguel Lázaro López-Villaseñor & Teresa Simón López. 2015. *Protocolo Rápido de Evaluación Pragmática – Revisado*. Valencia: Guada Impresores.
- Green, Benita C., Katherine A. Johnson & Lesley Bretherton. 2014. Pragmatic language difficulties in children with hyperactivity and attention problems: An integrated review. *International Journal of Language & Communication Disorders* 49(1): 15-29.
- Grice, H. P. 1975. Logic and Conversation. In P. Cole and J. L. Morgan (Eds.), *Syntax and Semantics 3: Speech Acts*, New York: Academic Press.
- Jongman, Suzanne R., Antje S. Meyer & Ard Roelofs. 2015. The role of sustained attention in the production of conjoined noun phrases: An individual differences study. *PloS one* 10(9): e0137557.
- Killgore, William D. S. 2010. Effects of sleep deprivation on cognition. *Progress in Brain Research* 185: 105-129.
- Kouki, Evgenia Peristera, Mary Helen Kosmidis, Félix Díaz-Martínez & Hariklia Proios. 2018. *Πρωτόκολλο Εκτίμησης Πραγματολογίας Post-grad thesis (in progress)*, Aristotle University of Thessaloniki.
- Lei, Yu, Yongcong Shao, Lubin Wang, Tianye Zhai, Feng Zou, Enmao Ye, Xiao Jin, Wujun Li, Jianlin Qi & Zheng Yang. 2015. Large-scale brain network coupling predicts total sleep deprivation effects on cognitive capacity. *PloS one* 10(7): e0133959.
- McDonald, Skye. 1993. Pragmatic language skills after closed head injury: Ability to meet the informational needs of the listener. *Brain and Language* 44: 28–46.
- MacWhinney, B. 2000. *The CHILDES Project: Tools for Analyzing Talk*. 3rd Edition. Lawrence Erlbaum Associates, Mahwah, NJ.
- Molfese, Dennis L., Anna Ivanenko, Alexandra Fonaryova Key, Andrienne Roman, Victoria J., Molfese, Louise M. O'Brien ... & Caitline M. Hudac. 2013. A one-hour sleep restriction impacts brain processing in young children across tasks: evidence from event-related potentials. *Developmental Neuropsychology* 38(5): 317-336.
- Nelson, Timothy D., Jennifer Mize Nelson, Katherine M. Kidwell, Tiffany D. James & Kimberly Andrews Espy. 2015. Preschool sleep problems and differential associations with specific aspects of executive control in early elementary school. *Developmental Neuropsychology*, 40(3): 167-180.

- Nilsson, Jens P., Marie Söderström, Andreas U. Karlsson, Mats Lekander, Torbjörn Åkerstedt, Nina Erixon Lindroth & John Axelsson. 2005. Less effective executive functioning after one night's sleep deprivation. *Journal of Sleep Research* 14(1): 1-6.
- Paavonen, E. Juulia, Tarja Porkka-Heiskanen & Anja Riita Lahikainen. 2009. Sleep quality, duration and behavioral symptoms among 5–6-year-old children. *European Child & Adolescent Psychiatry* 18(12): 747.
- Paavonen, E. Juulia, Katri Räikkönen, Jari Lahti, Niina Komsa, Kati Heinonen, Anu-Katriina Pesonen, ... & Tarja Porkka-Heiskanen. 2009. Short sleep duration and behavioral symptoms of attention-deficit/hyperactivity disorder in healthy 7-to 8-year-old children. *Pediatrics* 123(5): e857-e864.
- Peters, Jacqueline D., Sarah N. Biggs, Katie M. M. Bauer, Kurt Lushington, Declan Kennedy, James Martin & Jillian Dorrian. 2009. The sensitivity of a PDA-based psychomotor vigilance task to sleep restriction in 10-year-old girls. *Journal of Sleep Research* 18(2): 173-177.
- Poh, Jia Hou & Michael W. L. Chee. 2017. Degradation of cortical representations during encoding following sleep deprivation. *Neuroimage* 153: 131-138.
- Prutting, Carol A. & Diane M. Kirchner. 1983. Applied pragmatics. In T. Gallagher and C. A. Prutting (Eds) *Pragmatic Assessment and Intervention Issues in Language*, 29-64. San Diego, CA: College Hill Press.
- Randazzo, Angela C., Mark J. Muehlbach, Paul K. Schweitzer & James K. Waish. 1998. Cognitive function following acute sleep restriction in children ages 10–14. *Sleep* 21(8): 861-868.
- Rendle-Short, Johanna. 2017. Conversation Analysis: A Tool for Analysing Interactional Difficulties Faced by Children with Asperger's Syndrome. In *A Practical Guide to Social Interaction Research in Autism Spectrum Disorders* (pp. 297-323). Palgrave Macmillan, London.
- Sacks, H. 1992. *Lectures on Conversation*. Oxford: Blackwell Publishing Ltd.
- Sadeh, Avi. 2007. Consequences of sleep loss or sleep disruption in children. *Sleep Medicine Clinics* 2(3): 513-520.
- Sadeh, Avi, Reut Gruber & Amiran Ravi. 2002. Sleep, neurobehavioral functioning, and behavior problems in school age children. *Child Development* 73(2): 405-417.
- Schegloff, Emanuel A. 2007. *Sequence organization in interaction: Volume 1: A primer in conversation analysis* (Vol. 1). Cambridge: Cambridge University Press.
- Tsai, Ling Ling, Hung Yu Young, Shulan Hsieh & Chia Shun Lee. 2005. Impairment of error monitoring following sleep deprivation. *Sleep* 28(6): 707-713.
- Tucker, Andrienne M., Paul Whitney, Gregory Belenky, John M. Hinson & Hans P. A. Van Dongen. 2010. Effects of sleep deprivation on dissociated components of executive functioning. *Sleep* 33(1): 47-57.
- Vartanian, Oshin, Fethi Bouak, J. L. Caldwell, Bob Cheung, Gerald Cupchik, Marie-Eve Jobidon, Quan Lam, Ann Nakashima, Michel Paul, Henry Peng, Paul J. Silvia & Ingrid Smith. 2014. The effects of a single night of sleep deprivation on fluency and prefrontal cortex function during divergent thinking. *Frontiers in Human Neuroscience* 8.
- Vaughn, Brian E., Lori Elmore-Staton, Nana Shin & Mona El-Sheikh. 2015. Sleep as a support for social competence, peer relations, and cognitive functioning in preschool children. *Behavioral Sleep Medicine* 13(2): 92-106.
- Vriend, Jennifer L., Fiona D. Davidson, Penny V. Corkum, Benjamin Rusak, Christine T. Chambers & Elisabeth N. McLaughlin. 2013. Manipulating sleep duration alters emotional functioning and cognitive performance in children. *Journal of Pediatric Psychology* 38(10): 1058-1069.
- Vriend, Jennifer L., Fiona D. Davidson, Benjamin Rusak & Penny V. Corkum. 2015. Emotional and cognitive impact of sleep restriction in children. *Sleep Medicine Clinics* 10(2): 107-115.
- Waldon, Jessica, Jennifer L. Vriend, Fiona D. Davidson & Penny V. Corkum. 2015. Sleep and attention in children with ADHD and typically developing peers. *Journal of Attention Disorders* 1087054715575064.

Corresponding Author:

Hariklia Proios,
Department of Education & Social Policy,
The University of Macedonia,
156 Egnatia Avenue, 54636, Thessaloniki, Greece
e-mail: hproios@uom.gr

Appendix 1

CHAT conventions used in the cited excerpts:

1. [>]: overlap of utterance follows
2. [<]: overlap of utterance precedes
3. [>1], [<1], [>2], [<2] : numbered overlaps within a single utterance
4. &εε (&eh), &αα (&ah), &μχμ (&mhm) : exclamations
5. [/] : repetition
6. [//] : self-correction
7. [=! Text] : comment describing paralinguistic material
8. (.), (..) : small pauses; full stops indicate the number of seconds
9. (3.), (4.) : pauses; the numbers in brackets indicate the number of seconds
10. [:: text] : replacement of a real word
11. &=head:yes : positively nodding with the head
12. +/. : interruption
13. +, : interruption, continued