Declarative and procedural memory consolidation during sleep in patients with borderline personality disorder

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Abstract

Borderline personality disorder (BPD) is characterized by changes in subjective and objective measures of sleep quality. As recent findings point to the importance of sleep in memory consolidation, sleep-related memory consolidation was investigated in 15 female BPD patients (mean age 26.1 ± 6.1 years) and 15 female healthy controls (mean age 25.6 ± 6.8 years). Before and after the study night, declarative and procedural memory performance was tested by a paired associate list and a mirror tracing task. Subjective sleep quality was assessed by a sleep questionnaire, objective sleep quality was measured by a portable sleep recording device. During the study night the restorative value of sleep was significantly reduced in BPD patients ($p < 0.001$), while objective sleep quality showed a trend for longer REM sleep duration ($p = 0.054$). No significant differences were found regarding overnight performance improvement in the declarative and procedural memory tasks. Present findings suggest that declarative and procedural memory consolidation during sleep is intact in BPD patients.

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1. Introduction

Sleep in patients with borderline personality disorder (BPD) is characterized by changes in sleep architecture and sleep continuity parameters. With regard to sleep architecture, changes in rapid eye movement (REM) sleep such as shortening of REM latency, increases in REM density and longer durations of REM sleep have been observed repeatedly in BPD patients (Battaglia et al., 1993, 1999; Asaad et al., 2002). Moreover, prolonged sleep onset latency, reduced total sleep time and sleep efficiency, greater percentages of wake after sleep onset as well as reduced amounts of stage 2 non-REM (NREM) sleep and slow wave sleep (SWS) have been reported for BPD patients (De la Fuente et al., 2001, 2004; Philipsen et al.,

2005). Finally, subjective sleep quality has been found to be markedly impaired in patients with BPD (Philipsen et al., 2005).

Declarative memory, i.e., memory for facts and events, critically depends on the integrity of the hippocampus, while procedural memory, i.e., memory for skills and habits, relies primarily on the striatum (Squire and Zola, 1996). Previous research in healthy young adults indicates that declarative memory benefits from early nocturnal sleep, when slow wave sleep predominates, whereas procedural memory is enhanced through late nocturnal sleep, when REM sleep prevails (Plihal and Born, 1997; Plihal et al., 1999). Similarly, selective REM sleep deprivation was found to impair procedural memory consolidation compared to selective deprivation of SWS in healthy young adults (Karni et al., 1994). Other findings suggest that an optimal level of memory consolidation is only reached if SWS precedes REM sleep during the course of sleep (Gais

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et al., 2000; Stickgold et al., 2000). In this context, it is of interest to note that patients with BPD are known to exhibit cognitive dysfunctions, which can be related to altered brain activities (Beblo et al., 2006; Fertuck et al., 2006; Lange et al., 2005; Ruocco, 2005). These neurocognitive deficits could possibly interact with processes of sleep-related memory consolidation in BPD patients, which has not yet been investigated.

In the present study, declarative and procedural memory consolidation during sleep was investigated in female BPD patients and healthy controls. The study protocol was restricted to female participants, because about 76% of BPD patients are female (Widiger and Weissman, 1991). It was hypothesized that sleep-related memory consolidation in BPD patients differs from that of healthy controls based on the changes in sleep characteristics observed in this patient group. More specifically, it was expected that the increase in REM sleep observed in BPD patients would lead to a significant improvement in overnight procedural memory consolidation compared to healthy controls. Based on the reductions of SWS reported for BPD patients, it was hypothesized that overnight declarative memory consolidation would be significantly impaired. To our knowledge, this is the first study to investigate sleep-related memory consolidation in patients with BPD.

2. Methods

2.1. Participants

Fifteen female BPD patients and fifteen healthy controls, matched for age, sex and years of education, were included in the study. All BPD patients fulfilled the DSM-IV diagnostic criteria for BPD and were recruited as inpatients from the Department of Psychiatry and Psychotherapy, Charité-University Medicine Berlin, Campus Benjamin Franklin. Intake of any medication known to affect sleep characteristics was stopped at least three days prior to study participation. Healthy controls were mainly recruited by newspaper advertisements and were paid for their participation. A telephone screening was conducted

to exclude any volunteers with psychiatric disorders, psychiatric or psychotherapeutic treatment, sleep disorders or substance abuse. Written informed consent was obtained prior to the study. The present study was conducted in accordance with the Declaration of Helsinki and the study protocol was approved by the ethics committee of the Charité-University Medicine Berlin, Campus Benjamin Franklin. For demographic data and descriptive results from self-report measures of depression, psychopathological symptoms and sleep quality see Table 1.

Please note that three of the fifteen patients had a comorbid diagnosis of major depression. Furthermore, nine patients had received antidepressant medication prior to study participation, including citalopram, paroxetine, sertraline, venlafaxine and trimipramine.

2.2. Study design

All participants took part in declarative and procedural memory tasks before and after the study night. The memory tasks were carried out between 8.30 PM and 9:00 PM the evening before the study night and between 7:30 AM and 8:00 AM the morning thereafter. All participants were asked to go to bed at their regular bedtimes after the evening testing. While BPD patients slept in the hospital, healthy controls spent the night at home and returned the following morning. All participants were requested not to smoke at least one hour before the test sessions and not to consume any caffeine at least four hours ahead of testing. Prior to the study, all participants had been instructed on how to apply the portable sleep recording device. After the evening testing, a sleep questionnaire was handed out to the participants.

2.3. Measures of sleep

Subjective sleep quality was assessed by a standardized sleep questionnaire the morning after the study night (Hoffmann et al., 1997). Participants were asked to estimate the duration of sleep onset latency (time between bedtime and occurrence of first sleep stage different from stage 1 NREM

Table 1
Demographic data and descriptive results from self-report measures of depression, psychopathological symptoms and sleep quality ($M \pm SD$)

	BPD patients	Healthy controls	Statistics
Age (years)	$n = 15$	$n = 15$	$t(28) = 0.227$
	26.1 ± 6.1	25.6 ± 6.8	ns
Education (years)	$n = 15$	$n = 15$	$t(28) = 0.081$
	12.6 ± 1.3	12.5 ± 0.9	ns
MWT-A (IQ)	$n = 15$	$n = 15$	$t(28) = -0.050$
	110.1 ± 12.4	110.3 ± 9.3	ns
BDI (total score)	$n = 14$	$n = 15$	$t(27) = 6.477$
	24.7 ± 9.0	7.1 ± 5.2	$p < 0.001$
SCL-90 R (global severity index)	$n = 13$	$n = 15$	$t(26) = 5.811$
	76.3 ± 5.5	50.9 ± 14.9	$p < 0.001$
PSQI (sleep quality index)	$n = 14$	$n = 14$	$t(27) = 5.749$
	10.8 ± 3.9	4.4 ± 1.7	$p < 0.001$

MWT-A: "Mehrfachwahl-Wortschatz-Intelligenztest" Version A (premorbid intelligence); BDI: Beck Depression Inventory; SCL-90-R: Symptom Checklist-90-Revised, global severity index (t-values); PSQI: Pittsburgh Sleep Quality Index (0 = maximum sleep quality).