Dissociation, Resting EEG, and Subjective Sleep Experiences in Undergraduates

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Abstract: In this study, we explored whether individual differences in dissociation are related to certain resting electroencephalographic (EEG) parameters. Baseline EEG with eyes open and closed was recorded in an undergraduate sample ($N = 67$). Cortical power in the α range was inversely related to dissociative symptoms as measured by the Dissociative Experiences Scale, while both δ and θ power where positively related to dissociation. However, sleep experiences, as indexed with the Iowa Sleep Experiences Survey, were unrelated to resting EEG characteristics. We propose that suppression in the α band and raised levels of θ activity, which are typical for high dissociators, might help to explain why dissociative symptoms are accompanied by attentional and memory deficits.

Key Words: Dissociation, subjective sleep experiences, resting EEG.

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Dissociative experiences, like depersonalization, absorption, and derealization, appear to be quite common in the general population. Studies indicate that as much as 80% to 90% of the respondents report having these experiences at least some of the time (Gershuny and Thayer, 1999). Bernstein and Putnam (1986, p. 727) define dissociation as "a lack of normal integration of thoughts, feelings, and experiences into the stream of consciousness," emphasizing the role of memory and attentional deficits. Likewise, Freyd et al. (1998, p. S91) state that "it would seem that fundamental basic cognitive mechanisms of memory and attention are implicated for the involvement in the phenomenon of dissociation." Relatively few studies followed this lead and found that dissociation is, indeed, related to disruptions in memory and attention. For instance, Candel et al. (2003) noted that elevated scores on the Dissociative Experiences Scale (DES; Bernstein and Putnam, 1986) were related to the creation of commission errors in memory for a narrative. This finding is in line with a study by Merckelbach et al. (2000), who reported that dissociative symptoms were related to the creation of pseudo-memories. Their participants watched 40 slides. Twenty of them were photographs of common objects or situations, while 20 others were short paragraphs that described a scene or an object. After they had seen the slides, participants were subjected to a surprise old-new recognition task. Relative to control participants, participants with heightened levels of dissociative symptoms (i.e., high dissociators) were more likely to claim that they had seen the new slides (see also Hyman and Billings, 1998).

A related area of research has focused on the link between attention and dissociative symptoms. Studies in this field have consistently found that high dissociators exhibit minor disruptions in attention. For example, DePrince and Freyd (1999) reported that high levels of dissociation were accompanied by a slowing of reaction times on a selective attention Stroop (1935) task. Other studies found some tentative evidence that dissociative tendencies are related to subtle disruptions in executive functioning (Cima et al., 2001; Giesbrecht et al., 2004).

In sum, research indicates that dissociative experiences go along with cognitive disruptions (e.g., Freyd et al., 1998). One would expect that this would have led to attempts to relate dissociation to neurophysiological manifestations of cognitive functioning. However, to the best of our knowledge, no such attempts have so far been made (but see Russ et al., 1999). This is surprising, as there is an extensive literature on how, for example, tonic and phasic changes in electroencephalographic (EEG) power are linked to attention and memory (see review, Klimesch, 1999). As a case in point, studies suggest that α power is an indicator of speed of cognitive and memory performance in particular (Klimesch et al., 1996; Surwillo, 1961, 1963a, 1963b). As early as (1961), Surwillo noted that relative to controls, individuals with high α frequency exhibit faster reaction times (see also Klimesch et al., 1996). Klimesch (1999; see also Vogt et al., 1998) ascribed the superior reaction time performance of individuals with relatively high power in the α range and low power in the θ range to the ease with which they can retrieve memories. In addition, research indicates that various neurological deficits (e.g., Alzheimer disease) are related to a reduction in the α power range, while heightened levels of θ power are associated with poor performance during sustained

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attention tasks (Beatty et al., 1974). With this in mind, one would predict that that heightened levels of dissociation would be accompanied by increased (tonic) levels of θ and decreased levels of tonic α power.

Individual differences in EEG power might be the result of fatigue and deviations in circadian rhythms (Klimesch et al., 1999). The effects of these two factors on EEG power are well-documented. For example, since the pioneering study of Dement and Kleitman (1957), it has been known that during the transition from alert wakefulness to sleep onset (i.e., the hypnagogic state), α power decreases and θ and δ power increase. These findings have been replicated in a more recent study (Tanaka et al., 1997). In line with previous findings, Cajochen et al. (in Klimesch, 1999) have shown that administration of melatonin, which regulates waking and sleeping and increases sleepiness, leads to an increase in the θ band and a decrease in the α band.

Interestingly, Watson (2001, 2003) recently proposed that dissociative experiences possess dream-like properties, which might be fueled by a labile sleep-wake cycle. This would imply that individuals having frequent dissociative experiences more easily pass from normal waking mentation to dreamlike states. Support for this line of reasoning comes from studies showing that dissociative experiences, as measured with the DES (Bernstein and Putnam, 1986) are indeed related to various sleeping experiences, as measured with the Iowa Sleep Experiences Survey (ISES; Watson, 2001). In a recent study, we (Giesbrecht and Merckelbach, 2004) replicated this finding and demonstrated that the more pathological manifestations of dissociation, as measured with the Dissociative Experiences Scale Taxon (DES-T; Waller et al., 1996), are also related to sleep disturbances. That the relationship between sleep experiences and dissociation is not limited to this particular self-report scale of sleep experiences (i.e., ISES) was demonstrated by Levin and Fireman (2002) and Agargun et al. (2003), who noted a substantial overlap between dissociative experiences and nightmare frequency.

On the basis of the literature reviewed, we hypothesized that dissociation and subjective sleep experiences are related to heightened θ and lowered α power. The current study was a first attempt to test this idea.

METHODS

Participants

Participants were invited to take part in an electroencephalographic study on attention and memory. They were recruited through a bulletin board at the Faculty of Psychology, Maastricht University. Participants were 67 right-handed undergraduate students (59 women) at Maastricht University, with a mean age of 21.1 years (range: 18–31, $SD = 2.68$). Hand preference was determined on the basis of self-report. The study was approved by the local ethical committee, and all participants were naive as to the purpose of the study so as to minimize unwanted expectancy effects (Council, 1993). In return for their participation, they were given a small financial compensation.

Self-Report Measures

DES; Cronbach $\alpha = .90$

Bernstein and Putnam (1986, p. 727) developed the DES as "a means of reliably measuring dissociation in normal and clinical populations." This instrument consists of 28 items that ask the respondent to indicate the frequency of various dissociative experiences, such as derealization, depersonalization, and psychogenic amnesia, on 100-mm visual analogue scales (anchors: 0 = never; 100 = always). A sample item is, "Some people have the experience of looking in a mirror and not recognizing themselves. Mark the line to show what percentage of the time this happens to you." The DES possesses high internal consistency, and test-retest correlations range from 0.74 to 0.84. In a meta-analytic study, Van Ijzendoorn and Schuengel (1996) provided evidence for the sound psychometric properties of the DES.

A subset of eight DES items forms the DES-T (Waller et al., 1996; Cronbach $\alpha = .80$), which is thought to be especially sensitive to pathological manifestations of dissociation. DES-T total score can be obtained by averaging across DES items 3, 5, 7, 8, 12, 13, 22, and 27 (e.g., Eisen and Carlson, 1998). The DES-T was designed to offer an index of clinically relevant dissociation that is largely orthogonal of nonpathological dissociative experiences (i.e., absorption). However, recent research by Levin and Spei (2003) indicates that this effort was only partially successful. Employing the DES-T eliminates some but certainly not all of the overlap with imaginative involvement measures.

ISES; Cronbach $\alpha = .85$

The ISES (Watson, 2001) consists of 18 questions asking the respondent to rate the frequency of various sleep-related and dream-related experiences on a 7-point Likert scale (anchors: 1 = never; 7 = several times a week). The ISES consists of two separate subscales that measure general sleep experiences (Cronbach $\alpha = .83$, e.g., "I have recurring dreams") and lucid dreaming (Cronbach $\alpha = .79$, e.g., "I am aware that I am dreaming, even as I dream"), respectively. The general sleep experiences subscale taps symptoms of narcolepsy, vivid and unusual dreams, and other remarkable sleep experiences, whereas the lucid dreaming subscale consists of several items that refer to the situation that one is aware of dreaming while still being asleep. Previous research by Watson (2001) shows that these two subscales are moderately correlated with each other, r values being in the order of about 0.40, indicating that they measure distinct but related constructs. Watson (2001, 2003) obtained evidence for the convergent validity and internal consistency of the ISES.

Procedure

On arrival, participants were informed that EEG was to be measured. They were shown the control room with its equipment and the sound-attenuated testing room. After they gave informed consent, participants completed the DES (Bernstein and Putnam, 1986) and the ISES (Watson, 2001) while they were fitted with a stretch EEG cap. Next, participants were brought to a sound-attenuated laboratory room, where two periods of baseline resting EEG, one with eyes open and one with eyes closed, were recorded. During the eyes open condition, participants were instructed to fixate a cross in the middle of a computer screen so as to minimize eye movements. The order of these two conditions was counterbalanced across participants. Following this, participants completed an unrelated cognitive task, the result of which will be reported elsewhere. Finally, participants were thanked and fully debriefed.

EEG Recording

Using Neuroscan Synamps and Neuroscan Scan 4.3 software (Neurosoft Inc., Sterling, VA), EEG activity was recorded continuously during two periods of 3 minutes. Twenty-eight channels with a stretch-Lycra EEG cap (Quik-Cap, Neuromedical Supplies, Sterling, VA) containing tin electrodes placed according to the International 10-20 System. Electrical contact between electrodes and the participant's head was made with conducting gel, while positioning was achieved by using known anatomical landmarks. The montage included five midline sites (Fz, FCz, Cz, Pz, Oz) and 23 sites over each hemisphere (FP1/FP2, F3/F4, F7/F8, FC5/FC6, C3/C4, CP5/CP6, P3/P4, P7/P8, P9/P10, PO7/PO8, O1/O2, and the right mastoid). The left mastoid (A1) was used as the reference for all electrodes, and AFz served as ground electrode. To facilitate artifact-correction of the EEG, tin electrodes were used to record bipolarly the vertical (above and below the left eye) and horizontal (at outer canthi of both eyes) electrooculogram. The EEG electrodes were rereferenced offline to the average of right and left mastoids (Hagemann, 2004). All electrode impedances were kept below 5 kΩ. EEG and electrooculogram were digitally refiltered with a bandpass of 0.05 to 100 Hz. Digitization rate and gain were 500 Hz and 1000, respectively, and no notch filter was applied. Allen et al. (2004) pointed out that at least 2 minutes of continuous EEG recording is necessary, while longer periods add little to improve the internal consistency of the signal. Accordingly, we chose to record two periods of baseline EEG lasting 3 minutes.

Data Reduction and Analysis

Ocular activity was removed using a regression procedure (Semlitsch et al., 1986). Next, the continuous signal was epoched in chunks, 1024 samples in duration, that overlapped 75% to compensate for loss of data (Tomarken et al., 1992). Epochs with signals exceeding ± 100 μV were rejected. Artifact free epochs were subjected to a Fast Fourier Transformation. To eliminate interindividual variance in absolute EEG power, we normalized spectra by dividing each frequency step (of 0.5 Hz) by the mean power, thereby expressing them as a percentage of mean power (Vogt et al., 1998). Power spectra were normalized for each participant, condition (open versus closed), and lead.

RESULTS

Individual Differences Measures

Mean DES, DES-T, and ISES scores were 15.48 (SD = 9.41), 9.00 (SD = 10.02), and 2.81 (SD = 0.75), respectively. These values closely correspond to earlier findings in Dutch student populations (Giesbrecht and Merckelbach, 2004; Merckelbach et al., 2002). Table 1 shows the correlation between the DES and the ISES. Correlations between the subscales are also presented.

TABLE 1. Pearson Product-Moment Correlations Between DES, DES-T, ISES, the ISES General Sleep (ISES GS), and the ISES Lucid Dreaming (ISES LD) Subscale in an Undergraduate Sample (N = 67)

	DES	DES-T	ISES	ISES GS
DES	—			
DES-T	0.88*	—		
ISES	0.49*	0.41*	—	
ISES GS	0.55*	0.47*	0.97*	—
ISES LD	0.09	0.05	0.63*	0.41*

*Correlation is significant at the 0.01 level (two-tailed).

As can be seen, there was a significant correlation between DES and ISES. As well, the correlation between DES and the general sleep experiences subscale was significant. However, the correlation between the DES and the lucid dreaming subscale fell short of significance. The same pattern holds for the DES-T. This subscale correlated moderately with the ISES and its general sleep experiences subscale, but not with the lucid dreaming subscale.

EEG Power Spectrum

Klimesch (1999, p. 172) advocates the abolishment of traditional frequency bands and stated that the "use of fixed frequency bands does not seem justified," as it may masquerade effects. Following his recommendation, we calculated Pearson product moment correlations between DES, DES-T, ISES, and each frequency step of the normalized power averaged across all leads. Data were analyzed separately for eyes open and closed. Correlations are depicted in Figure 1.

These analyses indicate that, especially in the eyes open condition, both DES and DES-T are related to reduced power in the α range and heightened power in both the θ and the δ range. That these correlations are not limited to a certain area of the cortex is shown by the fact that a similar pattern of results evolved for all three areas (i.e., frontal, central, posterior), separately. That is, we calculated correlations between DES and normalized power for each frequency step in the three regions, frontal (Fp1, Fp2, F7, F3, Fz, F4, F8), central (C3, Cz, C4, FCz, FC5, FC6, CP5, CP6), and posterior (P9, P7, P3, Pz, P4, P8, P10, PO7, O1, Oz, O2, PO8), but the basic pattern is similar. It is unlikely that the current results were systematically biased by eye movements. Firstly, participants were instructed to fixate a cross during the eyes open condition. Secondly, and more importantly, artifacts caused by eye movements follow a distinct pattern, such that one would expect EEG effects due to eye movements to be most pronounced at frontal sites while being weakest at posterior sites. Our results, however, do not follow this pattern.

We found no significant correlations between sleep experiences, as indexed with the ISES, and normalized power of the EEG.

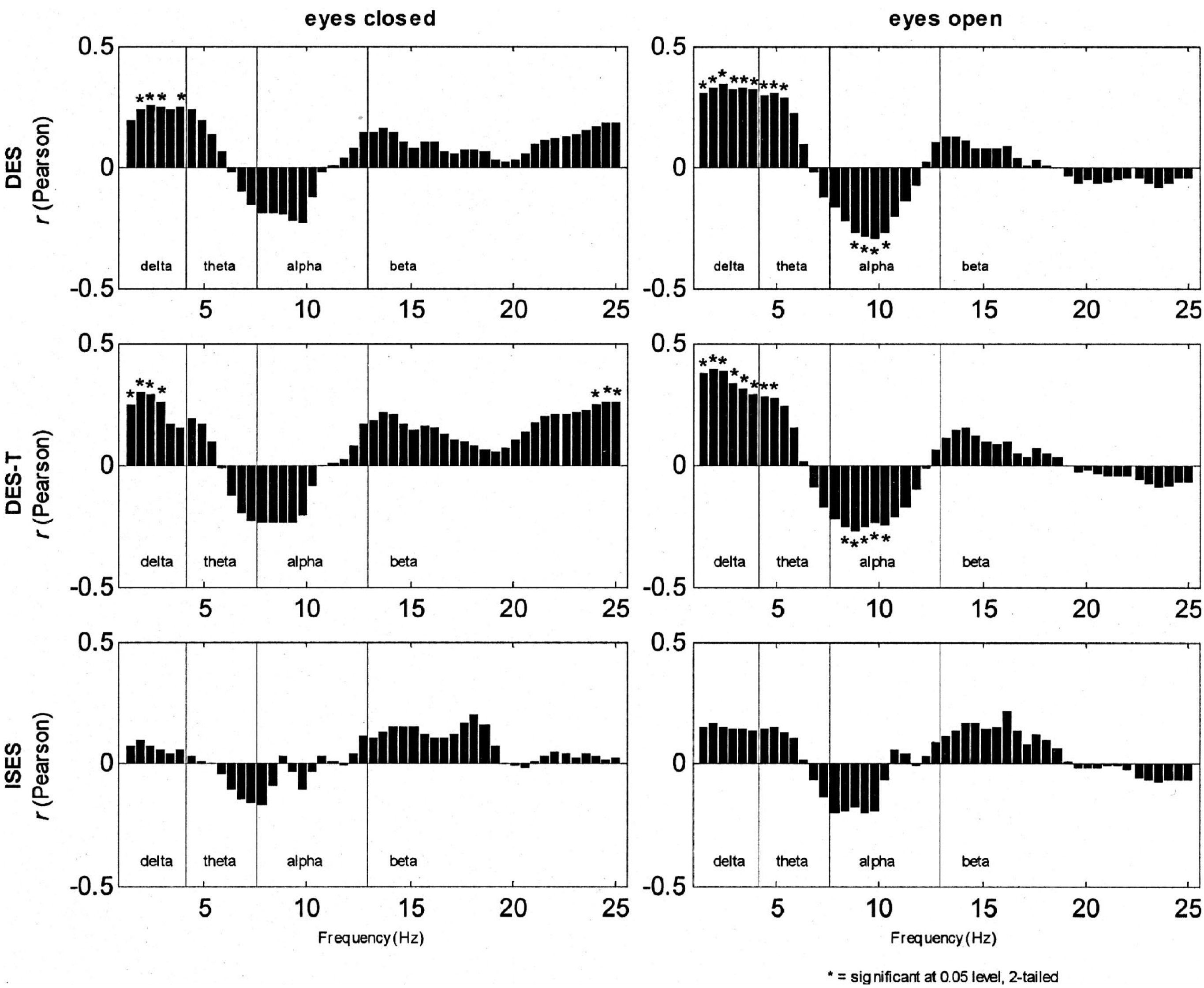

FIGURE 1. Bars represent Pearson correlation coefficients between DES, DES-T, and ISES and the normalized power averaged across all leads for each 0.50-Hz frequency step in the resting EEG in an undergraduate sample (N = 67).

DISCUSSION

To our knowledge, our study was the first attempt to relate dissociative experiences and sleep experiences to a measure that is independent of self-report. In line with previous research (Giesbrecht and Merckelbach, 2004; Watson, 2001, 2003), we found individual differences in dissociative experiences to be related to self-reports of sleep-related experiences, but not of lucid dreaming. The DES-T followed a similar pattern. While DES and DES-T were related to suppression in the α power range and heightened levels in the slow wave power range (i.e., δ and θ), the ISES was unrelated to cortical activity. The relationship between dissociation on the one hand, and both α power suppression and θ power increase on the other hand, was evident for all three areas of interest.

Dissociative experiences were related to general sleep-related experiences, but not to lucid dreaming. Apparently, the link between dissociation and general sleep experiences is quite specific, which argues against the idea that the administration of these two measures within a single session might have led to spurious expectancy effects (Council, 1993). In addition, in a recent study (Giesbrecht and Merckelbach, In press), we ruled out report bias as another potential explanation for the link between dissociative symptoms and unusual sleep experiences.

Our finding that dissociative experiences were unrelated to lucid dreaming is consistent with other research employing the ISES (Watson, 2001). Although more research is needed, we believe that the most plausible interpretation of the link between dissociative symptoms and general sleep experiences is that dissociative individuals have "thin boundaries" between the various stages of the sleep-wake cycle, allowing them to alternate between these stages effortlessly, which could be the origin of various dissociative symptoms (Watson, 2001). Lucid dreaming, however, is not affected by these "thin boundaries." Rather, this phenomenon represents "a cognitive skill that can be increased by attentional and mnemonic techniques learned when awake" (Blagrove and Hartnell, 2000, p. 42).

In the present study, we failed to find supportive evidence for the idea that sleep experiences, as indexed by the ISES, are linked to baseline cortical activity. However, this null-finding has to be interpreted with caution given of our limited sample size. Furthermore, our study relied on a rather homogenous student sample and, therefore, comparing patient and healthy samples with and without prominent sleep disruptions would provide a more powerful test of the idea that dissociation, sleep disturbances, and cortical activity are intimately related. Likewise, inducing sleep disturbance artificially by means of sleep deprivation and studying its influence on state dissociation might also yield important insights.

Our finding that dissociation was related to suppression of power in the α range to some extent differs from the only other study (Russ et al., 1999) that looked at how dissociation relates to cortical activity. This study examined dissociation and background EEG during a cold pressor task in a sample of female borderline personality disorder patients, depressed patients, and controls. The author found dissociative experiences to be positively related only to θ power. While we were able to replicate this particular aspect, at least in our undergraduate sample, dissociation was also related to lowered α power and raised δ power. This discrepancy might have to do with the specific sample characteristics in the Russ et al. (1999) study, notably their reliance on a mixed clinical sample. Another and more technical point is their use of fixed frequency bands, which might have blurred the negative association between α power and dissociation (Klimesch, 1999).

A number of limitations of our study deserve some comment. To begin with, dissociation overlaps with personality traits, such as absorption (Eisen and Carlson, 1998), fantasy proneness (Merckelbach et al., 2000, 2005), suggestibility (Wolfradt and Meyer, 1998), schizotypy (Watson, 2001), hypnotizability (Putnam et al., 1995), and self-reported history of trauma (Gast et al., 2001). In the current study, we did not assess these personality traits. Thus, we cannot rule out the possibility that these traits contribute in an important way to the dissociation-EEG pattern found in the current study. Clearly, this issue warrants further study. Secondly, our sample consisted primarily of females, which precluded a separate analysis for males and females. Thirdly, all participants were well adjusted undergraduates. While our participants differed widely in their self-reported frequency of dissociative experience, with DES scores ranging from 0 to 45, Waller et al. (1996) suggest that one has to distinguish between two qualitatively different types of dissociation. These authors emphasize that nonpathological dissociative experiences, such as absorption, are quite common in the general population, while pathological manifestations of dissociation, like depersonalization and derealization, have a lower prevalence. Although we employed the DES-T to tap the pathological aspects of dissociation, one has to acknowledge that this index overlaps with nonpathological manifestations of dissociation (Levin and Spei, 2003). Therefore, it remains possible that our sample exhibits a qualitatively different type of dissociative experiences in comparison to clinical samples. Hence, replication and extension of our findings, especially in clinical samples suffering from severe dissociative symptoms, while controlling for the aforementioned factors, would be highly informative.

Nevertheless, the fact that we found that dissociative experiences were linked to lowered α power and raised δ and θ power might broaden our understanding of the nature of dissociative experiences. Germane to this issue are studies on how individual differences in tonic α and θ power affect memory performance. For example, some studies noted a decrease in power in the upper α range in elderly participants (Klimesch et al., 2000), notably patients with Alzheimer disease (Besthorn et al., 1997). Similarly, a reduction in α power is characteristic for preschool age children with neurological deficits (Schmid et al., 1997) and patients with brain diseases that are known to impair memory performance (Klimesch, 1996).

The association between memory performance and α and θ power might shed some light on a number of curious phenomena that covary with dissociation. To begin with, dissociation predicts susceptibility to cognitive failures, as indexed by Broadbent's Cognitive Failures Questionnaire (Broadbent et al., 1982; Merckelbach et al., 2002). This self-report questionnaire measures the frequency of everyday lapses, such as forgetting names or being easily distracted unwillingly, features that have a raised prevalence in neurological disorders.

Secondly, high dissociators show disruptions in executive functioning (Cima et al., 2001; Giesbrecht et al., 2004) and a slowing of reaction times on the Stroop task (Freyd et al., 1998). These findings fit nicely with the statement by Klimesch et al. (1996, p. 511) that "alpha frequency is significantly correlated with the speed of information processing."

Thirdly, various studies found dissociation to be related to commission errors (i.e., confabulations) in memory. For example, Candel et al. (2003) examined commission errors during free-recall in undergraduate students scoring high and low on the DES. They found that such commission errors were related to dissociation, with high DES-scores going hand in hand with more commission errors. Clearly, the links between such memory errors and lowered α and raised θ power require further study.

Our finding that dissociation was related to lowered α power might hint at a possible source of depersonalization and derealization phenomena. While the classical view is that α rhythms reflect cortical idling, more recent theories stress that the α rhythm is instrumental in increasing the signal-to-noise ratio within the cortex by inhibiting conflicting processes to the task at hand (Cooper et al., 2003). Thus, it might well be the case that depersonalization experiences reflect a dysfunctional inhibitory process, leading to the influx of inappropriate information, thereby inducing depersonalization or derealization experiences.

This interpretation is in line with a case report by Raimo et al. (1999), who found reduced anterior and posterior mean α frequencies during alcohol-induced depersonalization (but see Simeon, 2004, for an overview of the neurobiology of depersonalization disorder).

Taken together, these findings suggest that the study of how cortical activity relates to dissociative experiences might be a fruitful research area.

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