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Altered orientation of spatial attention in depersonalization disorder

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ABSTRACT

Difficulties with concentration are frequent complaints of patients with depersonalization disorder (DPD). Standard neuropsychological tests suggested alterations of the attentional and perceptual systems. To investigate this, the well-validated Spatial Cueing paradigm was used with two different tasks, consisting either in the detection or in the discrimination of visual stimuli. At the start of each trial a cue indicated either the correct (valid) or the incorrect (invalid) position of the upcoming stimulus or was uninformative (neutral). Only under the condition of increased task difficulty (discrimination task) differences between DPD patients and controls were observed. DPD patients showed a smaller total attention directing effect (RT in valid vs. invalid trials) compared to healthy controls only in the discrimination condition. RT costs (i.e., prolonged RT in neutral vs. invalid trials) mainly accounted for this difference. These results indicate that DPD is associated with altered attentional mechanisms, especially with a stronger responsiveness to unexpected events. From an evolutionary perspective this may be advantageous in a dangerous environment, in daily life it may be experienced as high distractibility.

1. Introduction

Depersonalization disorder (DPD) is characterized by persistent or recurrent feelings of depersonalization (i.e. experiences of unreality, detachment, or being an outside observer with respect to one's thoughts, feelings, sensations, body, etc.) and/or derealization (individuals or objects are experienced as unreal, dreamlike, foggy, lifeless, or visually distorted). During these experiences reality testing remains intact. The symptoms are not caused by direct physiological effects of drugs or other medical conditions and are not better accounted for by another mental disorder (e.g. panic disorder or depression). Finally, these symptoms cause clinically significant distress or impairment (Spiegel et al., 2011; American Psychiatric Association, 2013). The prevalence of DPD in the general population is around 1% (Lee et al., 2012). Both genders are equally affected (Simeon, 2004). The onset of the disorder is usually before age 25, the course is typically chronic (Baker et al., 2003; Simeon et al., 2003). DPD has a high comorbidity with depression and anxiety disorders, however, comorbidity does not explain the severity of depersonalization (Simeon, 2004; Medford et al., 2005; Sierra et al., 2012). Impairment of cognitive functions is among the main complaints of DPD patients: patients complain about mind emptiness, racing thoughts, memory impairments, impairment of visual imagery and concentration (Lambert et al., 2001; Hunter et al., 2003; American Psychiatric Association, 2013). With regard to functions in DPD patients two previous studies demonstrated subtle alterations of the attentional and perceptual systems, but only little cognitive disturbances (Giesbrecht et al., 2008). In their first study, Guralnik et al. (2000) found a worse performance of DPD patients as compared to healthy persons for measures of attention, short-term visual and verbal memory, and spatial reasoning (Guralnik et al., 2000). In their second study they found an intact general intelligence and working memory for DPD patients. However, subtle impairments in tasks of short-term memory and selective attention emerged, as severity of depersonalization was correlated with increased distractibility during recall. Important to note, these findings were not mediated by the severity of anxiety and/or depression. The authors concluded that DPD may be associated with disruptions in the early perceptual and attentional processes (Guralnik et al., 2007). Impairments of short-term memory tasks were attributed to problems in processing new information. However, due to

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methodological limitations of the applied standard neuropsychological tests, it was not possible to differentiate, whether these cognitive impairments were due to deficits of short-term memory or attention.

The aim of the present study was to test whether DPD affects attentional processing stages as hypothesized by Guralnik et al. (2007). More specifically, we investigated whether DPD is associated with altered mechanisms of selective spatial attention. Selective attention is defined as the ability to select the behavioral relevant information from the vast amount of internal and/or external information (enhancement of processing) and to ignore the rest (suppression of processing) (Posner, 1980; Hillyard et al., 1998). A common and well established experimental task for investigating selective attention is the "Spatial Cueing Paradigm" by Posner and Cohen (1984). In the Spatial Cueing paradigm participants are instructed to detect and to respond to targets presented on the left or right side of a fixation cross on a screen. Prior to the target, a centrally located cue indicates the most likely location for the subsequent target. In most of the trials the prediction of the cue is valid, i.e. it indicates the correct target location. However, in some of the trials invalid cues are given, indicating the incorrect location of the target. By testing the responses to targets following a non-directional (i.e. neutral) cue, a baseline score of the participants' reaction time can be measured. A common finding is that response times (RTs) to targets are shorter after valid cues as compared to targets after invalid cues (e.g. Eimer, 1996; Luck et al., 1994; Mangun and Buck, 1998). This effect is considered as the result of a covert shift of attention to the expected target location. This total attention directing effect can be caused either by enhanced target processing at cued location ("RT benefits") or by suppression of processing of targets at uncued location ("RT costs"). RT benefits of directing attention are reflected in faster RTs for valid as compared to neutral trials, whereas RT costs are reflected in increased RTs for invalid compared to neutral trials (see Fig. 1).

The rationale of our study paradigm was based on the following assumption. If there are any alterations within the attentional systems in DPD patients, then they should manifest themselves especially when the attentional system is subjected to increased amounts of demand. Therefore the Spatial Cueing paradigm was used with two conditions differing in their demand on the attentional system: an easy task with low attentional demand in a detection condition and a difficult task with high attentional demand in a discrimination condition. Both conditions trigger spatial orientation of attention (i.e., to the left or to the right), the additional attentional challenge in the discrimination task concerns the attention to the orientation of the stimuli (target vs. non-target). We hypothesized altered attentional mechanisms in DPD patients, mainly in the challenging discrimination condition. Further, we analyzed whether the altered attentional mechanisms result from smaller processing benefits of stimuli on attended locations (RT benefits) or from a lack of suppression of stimulus processing on unattended locations (RT costs).

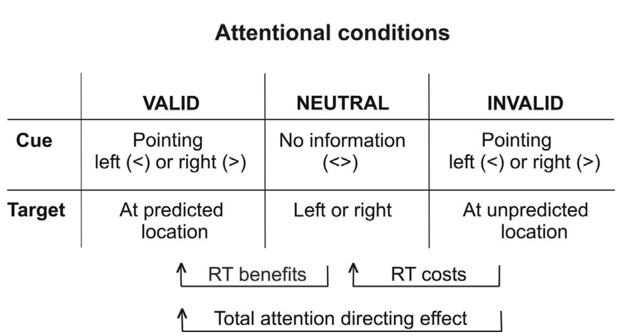

Fig. 1. Attentional conditions depending on cue validity and corresponding attention effects. Total attention directing effect (invalid minus valid trials), RT benefits (neutral minus valid trilas), RT costs (invalid minus neutral trials).

Table 1
Sample characteristics.

	DPD patients ($n=16$) Mean (S.D.)	Healthy controls ($n=17$) Mean (S.D.)	Test
Age in years	26.9 (4.7)	25.8 (2.4)	$p=0.87$
Sex, male	56%; 9 males	53%; 9 males	$p=0.85$
Years of education (at school)	12.4 (1.2)	13 (0)	$p=0.08$
CDS	128.7 (39.0)	11.9 (11.5)	$p<0.0001$
BDI-II	28.4 (10.1)	5.8 (5.4)	$p<0.0001$
STAI Trait	60.7 (10.2)	37.9 (11.0)	$p<0.0001$

t-Test for continuous variables, χ^2 test for categorical variables; years of education (without university or professional education); CDS, Cambridge Depersonalization Scale; BDI-II, Beck Depression Inventory; STAI, State-Trait Anxiety Inventory (Trait).

2. Participants and methods

2.1. Participants

The study was approved by the local ethics committee and all participants gave informed consent. The sample consisted of 16 patients with DPD (nine males) and 17 healthy controls (HC, nine males) with a mean age of 26 years (range 20–35 years). The DPD patients were recruited from our DPD clinic, healthy controls by research advertisements. The diagnosis of DPD was established by M.M. according to the German version of the Structured Clinical Interview for Dissociative Disorders (Gast et al., 2000). All patients met diagnostic criteria of depersonalization disorder according to DSM-IV (300.6) respectively depersonalization-derealization syndrome (ICD-10 F48.1). Diagnoses of comorbid conditions were based on DSM-IV diagnostic criteria. All participants were administered the German versions of the Cambridge Depersonalization Scale (Sierra and Berrios, 2000; Michal et al., 2004), the Beck Depression Inventory-II (BDI; Beck et al., 1996) and the State and Trait Anxiety Inventory (STAI; Spielberger et al., 1970). Participants with a lifetime history of any psychotic disorder, current substance abuse, major medical disorders, or history of head trauma were excluded. Table 1 characterizes the study participants. There was no difference between the groups concerning age, years of education and gender. Regarding years of schooling, all healthy controls had high-school graduation (13 years of schooling) compared to 10 from 13 years of schooling for the DPD patients. The mean age at onset of DPD was 16.0 ± 5.9 years (range 5–25 years), and the mean duration of DPD was 10.8 ± 8.1 years (range 1–24 years). In addition to the diagnosis of DPD the criteria of the following current diagnoses were fulfilled: $n=11$ diagnoses of major depression and/or dysthymia, $n=4$ panic disorder/agoraphobia, $n=4$ generalized anxiety disorder, $n=4$ social phobia, $n=3$ obsessive compulsive disorder, and $n=4$ personality disorders. Concerning medical disorders $n=2$ suffered from chronic tinnitus and $n=1$ from migraine without aura. With respect to current intake of medication, nine patients were taking psychotropic drugs: seven patients took antidepressants, two cases supplemented by lamotrigine and two by low dose atypical antipsychotics.

2.2. Test of selective attention

The Spatial Cueing paradigm (Posner and Cohen, 1984), described in Section 1, was used as a detection and as a discrimination condition. These two task conditions were presented consecutively; the order of the two conditions was balanced across participants. Figs. 2 and 3 show the schematic description of the experimental task.

In both task conditions the participants sat in front of a computer screen. They were instructed to fixate a cross in the center of the screen. Both task conditions, detection and discrimination, had identical stimulation: in 448 of 520 trials (per task condition, divided in four blocks) one of two types of event stimuli (Gabor patches, see Fig. 2) occurred left or right from the fixation cross, for 100 ms. The Gabor patches differed with respect to their orientation (296 trials with 0° orientation and 152 trials with 45° orientation). In the discrimination condition, participants were instructed to discriminate between these two types of events and to respond only to stimulus defined as the target (Gabor patch with 0° orientation) and to ignore the non-target stimulus (Gabor patch with 45° orientation). In the detection condition, however, both types of event stimuli were defined as targets and had to be detected without discrimination (see Fig. 3). Responses were made

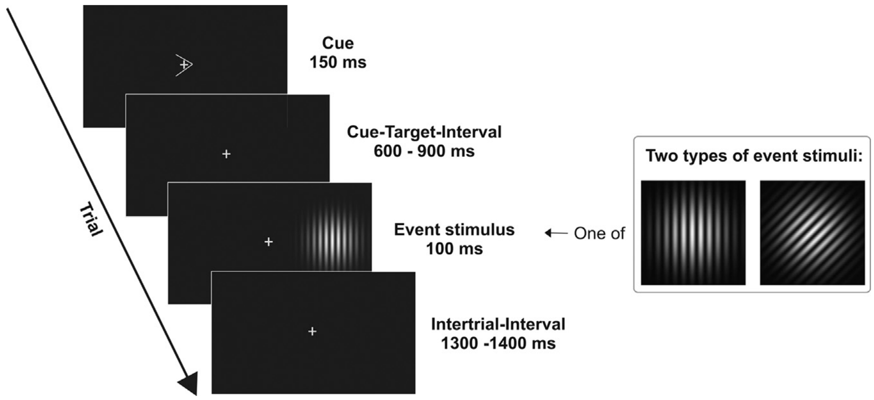

Fig. 2. Schematical depiction of the task under the condition of a valid cued target at the right side.

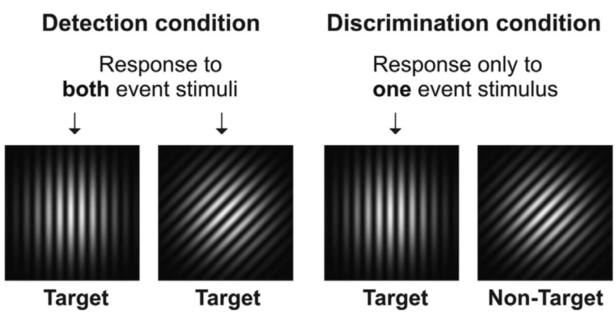

Fig. 3. Schematical depiction of target and non-target stimuli in the detection condition and in the discrimination condition.

by pressing a response button using the index finger of the dominant hand during the intertrial-interval of 1300 ms–1400 ms following the event stimulus; participants were instructed to respond as fast as possible.

Event stimuli (targets or non-targets) were preceded by a centrally depicted cue for 150 ms with a randomized time interval of 700–900 ms. In about 70% of the trials the cue prediction was valid (valid trials), in 15% of the trials invalid cues were given (invalid trials) and in the remaining 15% of the trial non-directional cues preceded the event stimuli (neutral trials). Cues were defined as arrows, pointing in the left or right direction ($<$, $>$) or in both directions ($<>$, neutral trials). The attentional conditions depending on cue validity are illustrated in Fig. 1. Further, in 72 trials per task condition no event stimuli were delivered after the cue. These trials served as “Catch-Trials” in order to prevent automatic responses in the detection condition.

2.3. Statistical analysis

Only button presses between 200 and 1000 ms after target onset were considered as correct responses. In the detection condition response accuracy was defined as the sum of all correct responses to target stimuli. In the discrimination condition the accuracy was calculated as the sum of all correct responses to target stimuli and correctly ignored non-target stimuli. Possible differences in response accuracy were tested with repeated-measures ANOVA comprising the factor *task condition* (detection vs. discrimination condition) and *group* (DPD patients vs. healthy controls) as between subject factor. In case of a significant effect, partial eta squares (η^2_p) is reported as a measure of the effect size. For further analysis response times (RTs) of correct responses to target stimuli were used. The total attention directing effect was obtained by subtracting RTs on valid trials from RTs on invalid trials, RT benefits were obtained by subtracting RTs on valid trials from RTs on neutral trials and RT costs were obtained by subtracting RTs on neutral trials from RTs on invalid trials. Each attentional effect was addressed to repeated-measures ANOVA comprising the factor *task condition* (detection condition vs. discrimination condition) and *group* (DPD patients vs. healthy controls) as between subject factor. For each repeated-measures ANOVA Greenhouse–Geisser adjustments for non-sphericity were applied whenever appropriate. Pair wise post hoc Bonferroni-test were calculated where necessary. Furthermore we tested whether the sequence of task administration (detection–discrimination, discrimination–detection) had any impact (as an additional between-subject variable in a repeated-measures ANOVA). As it failed to reach statistical significance, and given the small sample size, we decided to report the analyses without this additional variable (the corresponding results will be given on request).

3. Results

3.1. Response accuracy

The response accuracy was 96% (± 5) for DPD patients compared to 94% (± 7) for healthy controls in the detection condition, respectively 93% (± 5) and 94% (± 2) in the discrimination condition.[1] Overall response accuracy was marginally better in the detection condition than in the discrimination condition, with no differences between DPD patients and healthy controls (main effect of the factor *task condition* F (1,31)=3.14, p=0.09; $\eta^2_{Part}=0.09$).

3.2. Reaction times

For both groups of participants RTs to target stimuli were shorter in the detection condition than in the discrimination condition (Table 2). In both task conditions RTs differed as a function of the cued condition (valid vs. neutral vs. invalid) with smallest RTs to targets with valid cues, longest RTs on invalid cues, and intermediate RTs on neutral cues. Comprehensive statistical analysis of the reaction times is presented in the supplementary online material.

3.3. Attentional effects

For the total attention directing effects, depicted in Fig. 4, a significant interaction of *task condition* $\times$ *group*, $F(1,31)=6.60$, $p=0.015$; $\eta^2_{Part}=0.18$ was observed. As confirmed by post hoc tests, DPD patients had a smaller total attention directing effect ($p=0.047$) compared to healthy controls only in the discrimination condition. For healthy controls the magnitude of the total attention directing effect was greater in the discrimination condition than in the detection condition ($p<0.0001$), absent for the DPD patients ($p=0.22$). No difference between the DPD patients and healthy controls was present in the detection condition ($p=0.56$).

As depression and anxiety might also influence attention, a multiple regression analysis was conducted for the whole sample to test for potential mediating effects. It revealed that neither depression (BDI) nor anxiety (STAI) influenced the attention directing effect in the task conditions (detection and discrimination) or the difference score between both task conditions.

[1] The accuracy indices are negatively skewed, however, with values around 2.0–2.2, therefore well below the critical value of 3.0 suggested by Kline (1998) functioning as cut-off between 'tolerable' and 'extreme' skew. Even though the cut-off value is a rule of thumb for structural equation models it should be generalizable to repeated-measures ANOVAs, as the latter can be considered as a restricted version of the former.

Table 2
Reaction times.

	Detection condition			Discrimination condition		
	Valid Mean (S.D.)	Neutral Mean (S.D.)	Invalid Mean (S.D.)	Valid Mean (S.D.)	Neutral Mean (S.D.)	Invalid Mean (S.D.)
DPD patients ($n=16$)	287 (25)	304 (26)	325 (21)	413 (45)	432 (48)	458 (42)
Healthy controls ($n=17$)	292 (24)	307 (26)	326 (31)	404 (33)	429 (40)	467 (41)
Mean across both groups of participants	290 (25)	306 (26)	326 (26)	408 (39)	430 (43)	462 (41)

Mean reaction times in ms to valid, neutral and invalid cued targets in ms and standard deviation in the detection condition and in the discrimination condition. Values are given for DPD patients and healthy controls and across both groups of participants. The predications of the paradigm (RT valid < RT neutral < RT invalid) were fulfilled, more pronounced in the discrimination condition than in detection condition. As no differences emerged in the absolute reaction times between both groups (DPD patients vs. healthy controls), we refrained from the integration of the statistical estimators in the article (but provide them in the online supplemental material).

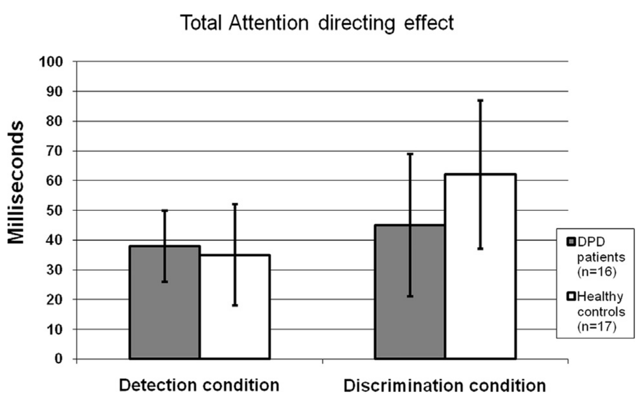

Fig. 4. Mean total attention directing effect (invalid minus valid trials) with corresponding standard deviations for DPD patients and healthy controls in the detection condition and in the discrimination condition.

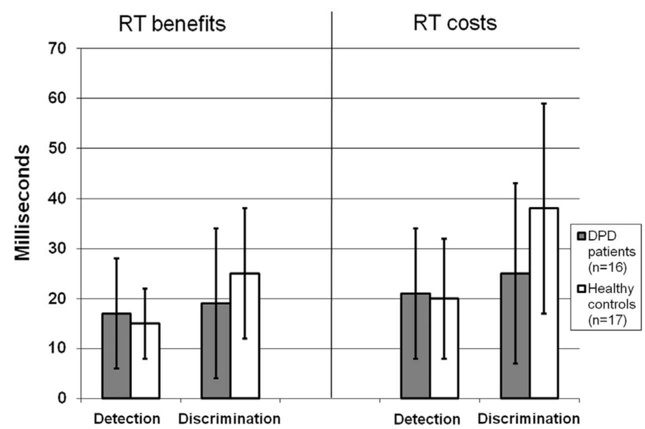

Fig. 5. Mean RT benefits (neutral minus valid trials) and mean RT costs (invalid minus neutral trials) with corresponding standard deviations for DPD patients and healthy controls in the detection condition and in the discrimination condition.

As depicted in Fig. 5, there were greater RT benefits in the discrimination condition than in the detection condition (main effect of *task condition* $F(1,31)=5.37$, $p=0.027$; $\eta^2_{\mathrm{Part}}=0.15$). No interaction was observed for *task condition* × *group* for RT benefits. For RT costs also the main effect of *task condition* reached significance ($F(1,31)=11.13$, $p=0.002$; $\eta^2_{\mathrm{Part}}=0.26$). Furthermore, for RT costs the interaction of *task condition* × *group* marginally significant effect, $F(1,31)=3.93$, $p=0.056$; $\eta^2_{\mathrm{Part}}=0.11$. Healthy controls revealed greater RT costs in the discrimination condition as compared to the detection condition ($p=0.001$), whereas for DPD patients RT costs did not differ between the task conditions ($p=0.35$). In the detection condition no differences in RT costs were found between DPD patients and healthy controls ($p=0.79$). In the discrimination condition, however, a trend to greater RT costs for healthy controls as compared to DPD patients ($p=0.077$) was observed.

4. Discussion

The main results of our study on attentional mechanisms were: in accordance with the predictions of the Spatial Cueing paradigm (Posner and Cohen, 1984), all participants showed a total attention directing effect, i.e. they responded faster to targets, preceded by valid cues relative to invalid cues. Differences between DPD patients and healthy controls were observed only in the discrimination condition. The magnitude of the total attention directing effect was smaller for DPD patients compared to healthy controls. RT costs accounted mainly for the difference of the total attention directing effect. This difference was only found in the condition with the increased demand on the attentional system (Lavie, 1995; Handy and Mangun, 2000). This indicates that the manifestation of attentional alterations in DPD patients depends on the processing load of the given situation.

Two explanations are conceivable for the observed differences in RT costs between DPD patients and healthy controls. Firstly, as DPD is characterized by a feeling of detachment from one's self and one's body, its plausible to assume, that the reliance on sensory perceptions is also influenced. One might speculate that the weight attached to the sensory perception is also reduced in DPD patients compared to healthy controls. It has been shown that the magnitude of the total attention direction effect depends on the ratio of valid to invalid cues (Eriksen and Yeh, 1985; Madden, 1992; Riggio and Kirsner, 1997). High validity of the cue correlates with greater attention directing effects (Eriksen and Yeh, 1985; Madden, 1992; Riggio and Kirsner, 1997), as low validity is supposed to suppress the use of the spatial cue (Yu and Dayan, 2005). It may be assumed that DPD patients experience the cues as less reliable, as they generally complain that they feel insecure about relying on their perceptions because they perceive their surroundings and their self as “unreal and strange”. A lower validity of the cues leads especially to smaller RT costs (Madden, 1992) as we found for DPD patients as compared to healthy controls in the discrimination condition. However, a general mistrust regarding the accuracy of one's own perception should be evident in both task conditions it was, however, found only in the discrimination condition. Furthermore, if the observed differences between DPD patients and healthy controls are caused by a lack of reliance in their own perception in DPD patients, an additional effect on response accuracy would be expected, however, no such effect was found. Therefore it seems unplausible that the observed differences between DPD patients and healthy controls are due to differences in the reliance in sensory perception.

Therefore, an alternative explanation may be more appropriate: the smaller RT costs of DPD patients may indicate that they were faster in disengaging their attention from the predicted location and in reorienting to the target at the unpredicted location in the invalid condition. Selective attention relies on two separable neuronal attentional systems with distinct functions and anatomical locations (Corbetta and Shulman, 2002): attention can be controlled by cognitive ('top-down') or by stimulus driven ('bottom-up') factors. Cognitive factors are knowledge, expectation, and current goals; whereas stimulus driven factors reflect a reflexive shift of the attentional focus driven by the involuntary capture of attention by sudden events. Adaptive and coherent behavior strongly depends on a functional balance between the modes of top-down and bottom-up driven attention (Corbetta and Shulman, 2002; Berti and Schröger, 2003; Spalek et al., 2006; Adler et al., 2009). In the present Spatial Cueing paradigm the informative cue leads to a top-down guided attentional shift to the predicted location, whereas the invalid cued target induced a bottom-up, i.e. a sensory driven capturing of attention to the opposite side. Therefore smaller costs (difference invalid vs. neutral cued targets) as observed for DPD patients compared to healthy controls, suggest a stronger impact of the "bottom-up mode" of attention. Stronger responsiveness to sudden events can indicate increased distractibility as discussed for DPD patients by Guralnik et al. (2000, 2007), and it is in line with the complaints of DPD patients about severe concentration difficulties. One might argue that this stronger responsiveness in patients with DPD is linked to hyperarousal, as described by Sierra et al. (2002)). Higher arousal is typically associated with shorter RTs (Eason et al., 1969). As no such differences were found in the general RTs between DPD patients and healthy controls, it seems rather unlikely that the observed differences in the attentional effects are attributable to increased arousal. In conclusion, DPD may be associated with a functional imbalance between the modes of top-down and bottom-up driven attention, with a relative preponderance of the "bottom-up mode" responsible for a stronger responsiveness to sudden events. Interestingly, in a previous study DPD patients showed functional abnormalities in the temporo-parietal area (Simeon et al., 2000), an area which is part of the ventral fronto-parietal network associated with the bottom-up driven attentional mode (Corbetta and Shulman, 2002; Natale et al., 2010).

Limitations of the generalizability and the validity are limited by the small sample size. Furthermore changes in RTs may reflect a variety of processing aspects, such as the process of attending to, anticipating, and detecting environmental targets (Halliday, 1993). For a more precise differentiation between potential neuronal causes of the observed effects, further research is needed.

In sum, the present study gives further evidence for altered attentional mechanisms in DPD. The study extends previous findings, by showing that DPD patients may have a relative preponderance of the bottom-up mode of attentional regulation as reflected by increased responsiveness to unexpected events. From an evolutionary perspective this may sometimes be advantageous, for example in a dangerous environment. However, in daily life it may be experienced as a debilitating distractibility.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.psychres.2014.02.021.

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