Attention as a characteristic of nonclinical dissociation: an event-related potential study

Michiel B. de Ruiter, a,* R. Hans Phaf, a Dick J. Veltman, b Albert Kok, a and Richard van Dyck b

a Faculty of Social and Behavioral Sciences, Psychonomics Department, Universiteit van Amsterdam, Amsterdam, The Netherlands
b Department of Psychiatry, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands

Received 8 July 2002; accepted 18 December 2002

Abstract

Individual differences in dissociative style (which is generally considered a risk factor for dissociative pathology) were studied in a nonclinical sample. It was hypothesized that high-dissociative participants would show enhanced attentional abilities toward both relevant and irrelevant stimulus features. In the experiment, threatening and affectively neutral words were classified on their affective valence and the presence of the letter A. To facilitate the full deployment of dissociative abilities, a feature (i.e., negative valence) was included that would automatically attract attention but not interfere with the processing of the central feature. Both the behavioral measures (i.e., reaction time) and the central neural measures (i.e., event-related potentials) showed that the ability to direct attention to the central feature was enhanced in the high dissociators. The high dissociators, moreover, showed evidence of directing attention to both affective valence and the letter A in the letter detection task. It is concluded that dissociative style does not correspond to a damaged or disturbed function but to an enhanced ability to direct and divide attention.

© 2003 Elsevier Science (USA). All rights reserved.

Keywords: Dissociation; Attention; Affective processing; Event-related potentials

Attention appears to be such a central feature of human functioning that it would be astonishing if no individual differences in attentional processing occurred. We suggest here that dissociative style, which originates from the clinical literature (Kihlstrom et al., 1994; Ray, 1996; Waller et al., 1996), may be related to general differences in directing attention (see also DePrince and Freyd, 1999; Freyd et al., 1998). The relationship between dissociative style and the processing of emotional and neutral stimulus material with and without attention to the emotional content was investigated in a nonclinical group of university students. To include a feature with an intrinsic capacity to attract attention (e.g., Mathews and Mackintosh, 1998), half of the words had a negative emotional connotation. Because differences in attentional processing may be much harder to detect at a behavioral level than at a central, neural level, we have also investigated event-related potentials (ERPs) derived from the scalp.

Pathological dissociation—as defined by the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM IV, American Psychiatric Association, 1994)—is “a disruption in the usually integrated functions of consciousness, memory, identity, or perception of the environment.” The most widely known psychiatric disorders that have dissociation as a core feature are posttraumatic stress disorder and dissociative identity disorder. Dissociative experiences are a part of everyday life, however, and frequently occur outside any traumatic context (Kihlstrom et al., 1994; Ray, 1996; Waller et al., 1996). For example, car drivers may become so engrossed in daydreaming, a conversation with a passenger, or other mentation that the mental processes associated with driving are evidently dissociated from consciousness, yet the road is successfully navigated.
Although originally developed to screen for persons at risk for dissociative pathology, a number of questionnaires are nowadays used to determine to what extent individuals have a general tendency for dissociative experiences (e.g., DES: Bernstein and Putnam, 1986; Dis-Q: Vanderlinden et al., 1993). The Dis-Q, which has been developed in the Dutch language, is used in the present study. It has been argued that pathological dissociation is a categorically distinct entity from “normal” dissociative tendencies which can be found in the general population (Waller et al., 1996), whereas others emphasized the continuity between normal and pathological dissociative experiences (Kihlstrom et al., 1994). The idea that a dissociative disorder may develop, possibly after a traumatic experience, in individuals who already have strong dissociative tendencies is supported by twin studies showing a substantial shared genetic variance between normal and pathological dissociative experiences (e.g., Jang et al., 1998). The present research is, however, focused on memory processes in patient groups that are characterized in terms of general information processing activities. ERPs are scalp-recorded electrical potentials generated by neural activity associated with sensory, cognitive, and motor processes (e.g., Coles et al., 1995; DePrince and Freyd, 1999). Employing hybrid versions of a classical and an emotional Stroop task, Freyd et al. (1998) and DePrince and Freyd (1999) found that high-dissociative participants showed more classical (but not emotional) Stroop interference than low-dissociative participants. This increased interference disappeared when participants were instructed to perform dual tasking: besides naming the color of the words, the instruction was to also remember them. This led DePrince and Freyd (1999) to argue that high-dissociative persons are better at dual tasking than low-dissociative persons. In (classical) Stroop tasks, however, the two stimulus features are generally related in some respect. Participants are instructed, but are not very well able, to ignore the content of the word. The division of attention may, thus, be hindered by the relationship between the two features. This may not be very conducive to the deployment of dissociative abilities. In our experimental design the stimulus features did not interfere with one another, so that high dissociators would have a better opportunity to divide their attention between the two features.

The hypothesis that motivated this study was that high-dissociative persons are characterized by increased attentional abilities, compared to low-dissociative persons. Similar to a person with good eyesight, for instance, there may be no trade-off, but the perception of both central and peripheral details may be improved. In this experiment, attention was focused by the instruction on one of two stimulus dimensions of visually presented words. With affective classification participants had to indicate whether they thought the meaning of the presented word was negative or neutral. In the other task participants had to perform visual search (e.g., Luck and Hillyard, 1990). They were instructed to detect the letter A in the word presented.

Negative valence served as one of the two stimulus features because of its capacity to automatically attract attention which should facilitate the division of attention by high-dissociative individuals. Particularly negative valence, or more specifically threat value, of a stimulus has been hypothesized to be processed automatically at very early stages (LeDoux, 1996; Mathews and Mackintosh, 1998; Öhman and Mineka, 2001). Although the DSM IV definition of dissociation does not explicitly refer to affective processes, an affective component is also often implicated in dissociative phenomena and particularly in relation to possible traumatic experiences (e.g., Putnam et al., 1986). The prediction derived from this position, however, contrasts with our prediction. Whereas we would expect attention toward negative valence, the trauma-related position would predict avoidance by high dissociators (e.g., Cloitre et al., 1996).

Event-related brain potentials were recorded simultaneously with reaction time (RT) and error measures to assess the influence of dissociative style on attentional processing. The major advantage of ERP measures in this context is that they provide on-line assessments of information processing activities. ERPs are scalp-recorded electrical potentials generated by neural activity associated with specific sensory, cognitive, and motor processes (e.g., Coles et al., 1985; Donchin et al., 1986). One component of the ERP in particular, the late positive potential (LPP), is sensitive to both affective and nonaffective processing (e.g., Crites and Cacioppo, 1996; Ito and Cacioppo, 2000; Johnston et al., 1986; Naumann et al., 1992; Naumann et al., 1997), the amplitude of the LPP reflecting the allocation of attention and its onset latency reflecting temporal aspects of stimulus processing. Furthermore, LPP has been successfully utilized to assess individual differences in affective processing (e.g., Kiehl et al., 1999; Williamson et al., 1991).
It was expected that in the affective evaluation task (1) threat words would elicit faster responses than neutral words, (2) threat words would elicit larger LPP amplitudes than neutral words, and (3) these effects would be larger for high than for low dissociators. For the letter detection task, it was expected that (1) words containing the letter A would elicit faster responses than words not containing the letter A, (2) words containing the letter A would elicit larger LPP amplitudes than words not containing the letter A, (3) these effects would be larger for high than for low dissociators, and (4) the irrelevant stimulus feature (affective valence) would attract attention, particularly that of the high dissociators, and would aid the direction of attention to the relevant feature. To our knowledge, no consistent effects of valence on ERPs have been found when words are used as stimulus material and when attention is not directed to the meaning of the words. We speculated that, with a distinction based on individual differences, we would find an effect of stimulus valence for the high dissociators in the letter detection task.

Method

Participants

Approximately 120 students had previously filled out the Dis-Q in unrelated experiments and had consented to be contacted for participation in a following experiment. Eventually, 16 students with low (Dis-Q 1.32 ± 0.13; mean age 22.6 ± 5.5, 3 reported to be left handed, 6 male) and 16 with high (Dis-Q 2.19 ± 0.37; mean age 23.4 ± 3.72, 2 reported to be left-handed, 7 male) Dis-Q scores agreed to participate in the experiment. They were told that they were invited for the experiment because of their score on the questionnaire but were not told whether they had scored high or low on the questionnaire. The experimenter was unaware of the Dis-Q score of the participant. All participants had normal or corrected-to-normal vision, indicated not to be dyslexic and to have no history of mental or sustained physical illness, and had Dutch as their first language. Written informed consent was obtained from all participants.

Material

The stimuli consisted of 304 Dutch words. Half of the words were neutral words, and the other half were threat words, selected from a pool of words validated in a perceptual clarification task (Ter Laak, 1992, unpublished Master’s thesis), in which these words were recognized most consistently and rapidly as neutral and threat words under conditions of minimal stimulus visibility. This resulted in a collection of neutral and threat words that were relatively high frequent and very representative for each category. Half of the words contained the letter A, and the other half did not. Words were selected that varied in length between 5 and 10 letters. Neutral and threat words were matched on word length, word type (verbs, adjectives and nouns), and frequency of usage. A subset of 45 neutral and 45 threat words was randomly selected and ordered for the affective evaluation task. Another subset of 45 neutral and 45 threat words was randomly selected and ordered for the letter detection task. Approximately half of the neutral and half of the threat words contained the letter A. Each stimulus consisted of a single word that appeared in white lowercase letters against a black background in the center of a 17” monitor positioned at 80 cm from the participants’ eyes. Words were presented for 1 s, with an interstimulus interval randomly varying between 2 and 3 s. Each word subtended a vertical angle of 1.43° and a horizontal visual angle varying between 4.55 and 8.58°. A small fixation cross was continuously present, except during presentation of the stimulus. Stimulus presentation and response registration was performed with in-house software of the Department of Psychonomics, University of Amsterdam, run on a Pentium personal computer.

Procedure

Participants were tested individually in a dimly lit, sound-attenuated room. They were comfortably seated in an easy chair, and two response buttons were both positioned either on the left or on the right armrest, depending on the participant’s handedness. In these tasks the participants were instructed to look at the fixation cross continuously and respond as quickly and accurately as possible. After filling out an informed consent and some personal details, participants were seated in a chair. Subsequently, the electrode cap, electrooculogram (EOG), and ground and reference electrodes were attached. The order of the two tasks was counterbalanced across participants within each participant group. During all task blocks, participants had to respond in a forced choice fashion by pushing a button with either the index or the middle finger of the preferred hand.

In the letter detection task, participants had to decide whether the letter A was present in the presented word. The button that could be pushed by the index finger was labeled “wel A” (“with A”); the button that could be pushed by the middle finger was labeled “geen A” (“without A”). In the affective evaluation task, participants had to decide whether the presented word was affectively neutral or negative. One button was labeled “neutraal” (neutral), and the other was labeled “negatief” (negative). The response button was counterbalanced across participants within each group.

ERP recording

EEG was continuously recorded from 58 tin electrodes embedded in an elasticized cap (Electro-cap International). The locations used were FPz, AFz, Fz, Cz, Pz, Oz, FP1, FP2, AF3, AF4, AF7, AF8, F3, F4, F5, F6, F7, F8, F9, F10, FC1, FC2, FC3, FC4, FC5, FC6, FT9, FT10, C1, C2, C3,
C4, T7, T8, T9, T10, CP1, CP2, CP5, CP6, TP9, TP10, P3, P4, P7, P8, P9, P10, PO3, PO4, PO7, PO8, PO9, PO10, O1, O2, O9, and O10. EEG recordings were referenced to a left mastoid electrode. Horizontal eye movements were measured by deriving the EOG from two electrodes placed at the outer canthi of the participants’ eyes. Vertical eye movements and eye blinks were detected by deriving an EOG from two electrodes placed approximately 1 cm above and below the participants’ right eye. Impedance of all channels was kept below 10 kOhm. Signals were amplified with a bandpass of 0.16 to 100 Hz and digitized and stored at 250 Hz.

During off-line analysis, data were segmented into epochs of 300 ms before to 1744 ms after stimulus onset and subsequently scanned for A/D saturation and flat lines. Ocular artifacts were controlled according to Woestenburg et al. (1983). All epochs containing artifacts (change in amplitude of more than 100 µV per five consecutive samples) or electrical drifts (change in amplitude of more than 200 µV per epoch) in one or more channels were omitted from further analysis. A 100-ms prestimulus interval was used as a baseline. The grand average ERPs were smoothed using a four-point binomially weighted filter (Wastell, 1979).

Topographic mapping of the scalp potentials was performed with the brain electric source analysis (BESA) software package (Scherg and Berg, 1995). The waveforms were rereferenced to the average reference and interpolated for mapping by means of a spherical surface spline method (Perrin et al., 1989).

Results

Behavioral data

The overall proportion of correct classifications and mean RT of correct classifications for each of the two tasks and for each word type (Fig. 1) were first subjected to ANOVAs in omnibus 2 (group) \( \times 2 \) (task) \( \times 2 \) (valence) \( \times 2 \) (A in word) designs and subsequently to separate ANOVAs for the two tasks.

Participants overall classified more words correctly in the letter detection task (\( M = 0.97, SD = 0.04 \)) than in the affective evaluation task (\( M = 0.90, SD = 0.09, F(1,30) = 35.41, P < 0.001 \)). This is not surprising because classification of words as either neutral or negative seems more subjective than detecting the letter A. Responses were also made faster in the letter detection task (\( M = 641 \) ms, SD =...
Affective evaluation

In the affective evaluation task, more neutral words ($M = 0.96$, $SD = 0.06$) were classified correctly than threat words ($M = 0.85$, $SD = 0.11$, $F(1,30) = 25.51$, $P < 0.001$). This may reflect the difficulty in selecting unambiguously negative words. The correct responses to threat words ($M = 754$ ms, $SD = 107$) were faster than to neutral words ($M = 771$ ms, $SD = 121$). Low dissociators made more correct responses to negative words with A than high dissociators. ($M = 0.89$; $SD = 0.08$ and $M = 0.81$, $SD = 0.12$, respectively) which resulted in a group $\times$ valence $\times$ A interaction ($F(1,30) = 7.89$, $P < 0.01$) and also qualified the group $\times$ A interaction ($F(1,30) = 4.75$, $P < 0.05$). The valence effect was somewhat larger for high dissociators (threat: $M = 739$ ms, $SD = 81$, neutral: $M = 758$ ms, $SD = 106$) than for low dissociators (threat: $M = 770$ ms, $SD = 134$, neutral: $M = 785$ ms, $SD = 135$). The effects of valence and group $\times$ valence, however, failed to reach statistical significance ($F(1,30) = 1.54$, NS; $F(1,30) < 1$, NS, respectively). No further main or interaction effects reached significance in the analysis of the affective evaluation task.

Letter detection

In the letter detection task, neutral words containing the letter A yielded fewer correct responses than the other three word categories, resulting in valence $\times$ A interaction ($F(1,30) = 9.86$, $P < 0.05$). This also accounted for the fact that words containing the letter A were less often classified correctly overall than words not containing the letter A ($M = 0.95$, $SD = 0.06$; $M = 0.98$, $SD = 0.03$, respectively, $F(1,30) = 14.00$, $P < 0.001$) and that negative words yielded more correct responses than neutral words ($M = 0.96$, $SD = 0.06$; $M = 0.97$, $SD = 0.03$, respectively, $F(1,30) = 6.73$, $P < 0.05$). Participants responded faster to words with the letter A ($M = 625$ ms, $SD = 73$) than to words without the letter A ($M = 657$ ms, $SD = 84$, $F(1,30) = 15.63$, $P < 0.001$). This probably arises from the fact that on average the search can be ended earlier when the letter is present than when it is not (e.g., Luck and Hillyard, 1990). In addition, letter detection responses were faster to threat words ($M = 637$ ms, $SD = 83$) than to neutral words ($M = 644$ ms, $SD = 75$), which resulted in a marginally significant main effect of valence ($F(1,30) = 3.19$, $P = 0.084$).

The effect of A on RT was larger for high dissociators (words containing the letter A: $M = 627$ ms, $SD = 66$; words not containing the letter A: $M = 672$ ms, $SD = 81$) than for low dissociators (words containing the letter A: $M = 623$ ms, $SD = 80$; words not containing the letter A: $M = 641$ ms, $SD = 88$), although the interaction between group and A was not significant ($F(1,30) = 2.68$, NS). Separate analyses of RT for the two groups, however, showed that the high dissociators were mainly responsible for the effect of A (high dissociators: $F(1,15) = 14.98$, $P < 0.005$; low dissociators: $F(1,15) = 2.80$, NS). The detection of the letter A was facilitated by a negative valence only for the high dissociators (interaction between group, valence and A: $F(1,30) = 5.31$, $P < 0.05$; valence $\times$ A interaction for low dissociators: $F(1,15) = 1 < 1$; for high dissociators: $F(1,15) = 5.73$, $P < 0.05$). Whereas the detection of A by the high dissociators was aided most by the threat words ($F(1,15) = 13.95$, $P < 0.005$), the effect of A was also significant for the neutral words ($F(1,15) = 8.77$, $P < 0.01$). No more main or interaction effects were significant in the analysis of letter detection.

Event-related potentials

Grand average ERPs were calculated and analyzed separately for the affective evaluation task and the letter detection task. ERPs were quantified by computing the mean amplitude (relative to the 100-ms prestimulus baseline) for four latency regions: 200–300 ms, 300–400 ms, 400–600 ms and 600–1000 ms. Amplitude differences among the conditions were examined by conducting repeated-measures MANOVAs for each latency region from the five midline electrodes sites, resulting in $2 \times 5 \times 2 \times 2$ analyses that contained the between-participant factor group (low and high dissociators) and the within-participant factors electrode site (FPz, Fz, Cz, Pz, and Oz), valence (neutral words and threat words), and A (words containing the letter A and words not containing the letter A). Effects of electrode site are only reported if they interacted with the between-participant variable of group and/or one of the experimental within-participant factors. We also submitted a subset of lateral electrodes to MANOVAs (as shown in Figs. 2 and 3). However, after global normalization of the data as recommended by McCarthy and Wood (1985, second method), no laterality effects remained statistically significant. Other significant effects added nothing to the results of the midline analyses, so we do not report them here.

Affective evaluation

Grand average ERPs from selected lateral and midline sites for the affective evaluation task are shown, overlaid for stimulus type, in Fig. 2a and b for the low and high dissociators, respectively. The effect of valence was characterized by a large, widespread, and prolonged positivity that was elicited by negative relative to neutral words.

The 200- to 300-ms window

In the first time window, the expected effect of valence is already present: negative words yield a more positive ERP amplitude than neutral words ($F(1,30) = 11.36$, $P < 0.005$). This effect is larger for high- than for low-dissociative participants, which is reflected in a group $\times$ valence interaction ($F(1,30) = 4.79$, $P < 0.05$). Separate
post-hoc analyses for the low and high groups revealed that for low dissociators there was no effect of valence \((F(1,15) < 1)\), whereas for the high dissociators the effect is fully significant \((F(1,15) = 14.56, P < 0.005)\). Low dissociators showed some effect of A, with words containing the A eliciting a more positive ERP amplitude than words without A, resulting in a marginally significant group \(\times A\) interaction \((F(1,30) = 3.77, P = 0.062)\). Post hoc analyses revealed that there was no effect of A for the high dissociators \((F(1,15) < 1), \text{NS}\).
The 300- to 400-ms window

In the second time window, the effect of valence continued to be significant ($F(1,30) = 27.23, P < 0.001$). This effect is somewhat larger at posterior than anterior sites, which resulted in a marginally significant site × valence interaction ($F(4,27) = 2.57, P = 0.061$). Although group and valence did not interact significantly ($F(1,30) = 2.41, P = NS$), post hoc tests suggested that the effect of valence is larger for the high group ($F(1,15) = 19.01, P < 0.001$) than for the low group ($F(1,15) = 8.46, P < 0.05$). For the low group, words containing the letter A yield a more positive ERP amplitude than words without A, whereas this is not the case for the high group, which resulted in a significant group × A interaction ($F(1,30) = 6.14, P < 0.05$). This was confirmed by post hoc tests (effect of A for low group: $F(1,15) = 13.70, P < 0.001$, high group: $F(1,15) = 8.46, P < 0.05$).
In the third time window, effects were similar to the 300- to 400-ms window: the valence effect reached its maximal amplitude \((F(1,30) = 81.81, P < 0.001)\) and was larger at posterior sites, which resulted in a fully significant site \(\times\) valence interaction \((F(4,27) = 8.75, P < 0.001)\). The group \(\times\) A interaction remained significant \((F(1,30) = 4.64, P < 0.05)\). Post hoc tests again confirmed that the effect of A was only significant for the low group \((F(1,15) = 6.73, P < 0.05)\), high group: \((F(1,15) < 1, NS)\). Conform the previous window, group and valence did not interact significantly.
(\(F(1,30) < 1\), NS), but post hoc tests again suggested that the effect of valence was larger for the high group (\(F(1,15) = 53.01, P < 0.001\)) than for the low group (\(F(1,15) = 31.82, P < 0.001\)).

The 600- to 1000-ms window

In this late time window, the effect of valence is wearing off, but still resulted in a significant effect (\(F(1,30) = 14.51, P < 0.001\)). Conforming with the previous window, group and valence did not interact significantly (\(F(1,30) < 1\), NS), but post hoc tests revealed that the effect of valence was larger for the high group (\(F(1,15) = 53.01, P < 0.001\)) than for the low group (\(F(1,15) = 10.48, P < 0.01\)). A marginally significant group \(\times\) A interaction (\(F(1,30) = 2.93, P = 0.097\)) indicated that for the low group there was an effect of A (\(F(1,15) = 4.87, P < 0.05\)), whereas this was not the case for the high group (\(F(1,15) < 1\), NS).
Letter detection

Grand average ERPs from selected lateral and midline sites for the affective evaluation task are shown overlaid for stimulus type in Fig. 3a and b for the low and high dissociators, respectively. Similar to the effect of valence in the affective evaluation task, the effect of A is characterized by a large and sustained positivity that is elicited by words containing the letter A compared to words not containing the letter A.

The 200- to 300-ms window

No significant effects were found in this latency interval.

The 300- to 400-ms window

The effect of A was significant \((F(1,30) = 11.67, P < 0.05)\) and larger for the high than for the low group, which was reflected in a marginally significant group \(\times A\) interaction \((F(1,30) = 2.92, P = 0.098)\). Post hoc tests confirmed this observation: for the low group the effect of A was not significant \((F(1,15) = 2.38, \text{NS})\), but it was fully significant for the high group \((F(1,15) = 9.46, P < 0.01)\). Based on visual inspection, it can be seen that the effect of A is amplified by stimulus valence for the high group, whereas this is not the case for the low group. Although no significant group \(\times\) valence \(\times A\) interaction was found \((F(1,30) = 2.36, \text{NS})\), post hoc tests demonstrated that there was no valence \(\times A\) interaction for the low group \((F(1,15) < 1, \text{NS})\), whereas the valence \(\times A\) interaction was nearly significant for the high group \((F(1,15) = 4.28, P = 0.056)\). Further tests revealed that, for the high group, the effect of A was larger for negative words \((F(1,15) = 9.31, P < 0.01)\) than for neutral words \((F(1,15) = 5.44, P < 0.05)\). A marginally significant site \(\times\) valence interaction \((F(4,27) = 2.30, P = 0.084)\) indicated that there was some effect of valence at anterior sites.

The 400- to 600-ms window

As in the previous time window, words containing the letter A elicited a more positive amplitude than words not containing the letter A \((F(1,30) = 7.36, P < 0.05)\). This effect was larger at anterior sites, which resulted in an almost significant site \(\times A\) interaction \((F(4,27) = 2.61, P = 0.058)\). Again, the effect of A is larger for the high than for the low group, which was reflected in a fully significant group \(\times A\) interaction \((F(1,30) = 5.94, P < 0.05)\). Post hoc tests again confirmed this (low group: \((F(1,15) < 1, \text{NS})\); high group: \((F(1,15) = 9.06, P < 0.01)\). The enhancement of the effect of A by valence for the high, but not the low, group now resulted in a significant group \(\times\) valence \(\times A\) interaction \((F(1,30) = 6.94, P < 0.05)\). This observation was again confirmed by post hoc tests (valence \(\times A\) for the low group: \((F(1,15) < 1, \text{NS})\), for the high group: \((F(1,15) = 8.62, P < 0.01)\). Further tests revealed that, for the high group, the effect of A was larger for negative words \((F(1,15) = 11.22, P < 0.005)\) than for neutral words \((F(1,15) = 4.76, P < 0.05)\), but that it was still present for neutral words.

The 600- to 1000-ms window

In the late window, the effect of A was still significant \((F(1,30) = 7.00, P < 0.05)\) and again stronger at anterior sites (site \(\times A\) interaction: \((F(4,27) = 4.99, P < 0.005)\)). Also, as in earlier windows, the high-dissociative participants were mainly responsible for the effect of A (group \(\times A\): \((F(1,30) = 3.42, P = 0.074)\); low group: effect A \((F(1,15) = 1.18, \text{NS})\); high group: \((F(1,15) = 5.84, P < 0.05)\). Furthermore, although the group \(\times\) valence \(\times A\) interaction did not reach statistical significance \((F(1,30) = 1.55, \text{NS})\), separate post hoc tests still revealed a significant valence \(\times A\) interaction for the high group \((F(1,15) = 4.61, P < 0.05)\), whereas this effect was absent for the low group \((F(1,15) < 1, \text{NS})\). Further tests revealed that, for the high group, the effect of A was larger for negative words \((F(1,15) = 7.07, P < 0.05)\) than for neutral words \((F(1,15) = 3.77, P = 0.071)\).

Scalp topographies

To elucidate topographical aspects of task and group effects, scalp potential maps were calculated using the BESA software package (Scherg and Berg, 1995). Maps were based on grand average ERP difference waves reflecting the relevant effects.

Affective evaluation

Scalp potential maps of the valence effect were calculated that were based on the difference waves obtained by subtracting ERPs to neutral stimuli from ERPs to negative stimuli (pooled for presence and absence of A). In Fig. 4, these scalp potential maps are shown for latencies that correspond to maximal amplitudes within time windows with significant effects. The scalp potential maps support the visual inspection of the grand average ERPs, which suggest a centrotemporal maximum for the valence effect.

At 256 ms, the effect of valence was not significant for low dissociators. For high dissociators, it can be seen as a very broad positivity that is stronger to the left. At the next latency (352 ms) the valence effect was significant for both groups. The maps indicated that, at this latency, the effect of valence is more anteriorly located for low than for high dissociators. At 544 ms, the valence effect was fully developed and took the form of a broad centrotemporal positivity. The maps indicate that the valence effect was stronger for high than for low dissociators. Although at this latency no significant interaction between group and valence was found, separate analyses of the two groups confirmed this conclusion. The valence effect was slightly lateralized to the left for low dissociators, whereas this was not the case for...
high dissociators. At 592 ms, the valence effect seemed to be lateralized to the left for low dissociators and lateralized to the right for high dissociators. Finally, at 916 ms the valence effect was totally absent for low dissociators whereas it was still present at the right posterior scalp for high dissociators.

Letter detection
Scalp potential maps for the effect of A (based on difference waves that were obtained by subtracting ERPs to words not containing the letter A from ERPs to words containing the letter A, pooled for affective valence) are shown in Fig. 5. Because the effect of A was never significant for the low dissociators, and visual inspection of the ERPs suggested the absence of any effect of A, the scalp maps for the low dissociators are best regarded as noise. For the high dissociators, however, the effect of A seemed to shift from a medial frontocentral to a left parietal distribution and back.

Fig. 6 reflects the valence × A interaction during the letter detection task. It can be seen that the effect of A is enhanced by stimulus valence for the high dissociators (cf. Fig. 3b).

Discussion
Individual differences in attentional abilities seem to be more readily visible in central measures, such as ERPs, than in behavioral measures, such as performance ratings and reaction times. The interpretation of the ERP effects, however, benefits from the more direct understanding of the behavioral effects. As predicted, high dissociators were characterized by heightened attentional abilities, in the affective evaluation as well as in the letter detection task. In absolute terms high dissociators showed a larger valence effect on RT than low dissociators in the affective evaluation task. This effect was mirrored by an ERP positivity that started significantly earlier and was numerically larger for the high than for the low group. Similarly, during letter detection, the group effects were more pronounced in the ERP results than in the reaction times. Particularly the high-dissociative participants responded faster to words containing the relevant feature A than to words not containing A. The accompanying ERP positivity was robust for almost the entire recording epoch for the high dissociators, reflecting increased focused attention to the relevant stimulus feature, whereas it was virtually absent for the low dissociators.

In addition, letter detection was enhanced by the presence of negative valence for the high group: detection of the relevant feature (A) was facilitated by negative relative to neutral words, which was accompanied by an enhanced ERP amplitude. The affective value of the word, thus, helped only the high dissociators to focus attention on the relevant stimulus feature, even when they were not instructed to do anything with word valence. These effects are
very reminiscent of a study by Stormark et al. (1995). In an emotional cueing paradigm, targets that were validly cued by negative words elicited faster responses than those validly cued by neutral words. Conversely, when serving as an invalid cue negative words tended to slow down the response, although this effect was not significant. Stormark et al. (1995) interpreted this effect in terms of negative words eliciting focused attention at the cued location. Contrary to our results, however, there was no cueing effect for neutral words which may be due to the fact that Stormark et al. did not distinguish between participants with different information processing characteristics. In our experiment, even when the words were neutral, the high dissociators were better at detecting the letter A than the low dissociators.

Unexpectedly, an effect of the irrelevant stimulus feature A was found for the low dissociators during affective evaluation. This probably represents an inertia effect in task switching between affective evaluation and letter detection blocks. In contrast to the results for the high dissociators, it could, moreover, only be observed in the ERP data and not in the behavioral data. At first sight, this effect resembles the valence effect in the letter detection task with high dissociators, but there is an essential difference. Attention to the irrelevant feature facilitated detection of the relevant feature in high dissociators, which was accompanied by an increase in ERP amplitude of the relevant feature (words with A). In the affective evaluation task, the irrelevant feature did not facilitate detection of the relevant feature but was manifested as a nonselective increase in ERP amplitude for the low dissociators. Although unexpected, these results seem to strengthen the hypothesis of enhanced attentional capabilities in high dissociators relative to low dissociators. High dissociators seem to have a higher ability to direct attention toward stimulus features to which they should respond (i.e., focused attention) and simultaneously a higher ability to attend to irrelevant features (i.e., divided attention).

The widespread effects of experimental manipulations on ERP amplitude make it hard to draw any firm conclusions about brain regions responsible for the ERP effects. The main effects concerned the effect of valence and the effect of A on the LPC (late positive complex). Regarding the effect of negative valence, the statistical analysis of the ERP windows pointed at a centroparietal maximum, which was confirmed by the spline maps. This is in accordance with the literature. In addition, the spline maps point to a left hemispheric specialization in the experiment. For the high dissociators, the valence effect seemed to shift in time from a left to a right hemispheric maximum. Since these observations were not supported by statistics, we only mention this on a highly speculative note, however.

In the letter detection task, inspection of the spline maps indicated that the effect of A seemed to shift in time from a medial-frontal to a left-parietal maximum and back. Al-
Though laterality effects were not supported by statistics, analysis of the midline ERPs confirmed this anterior maximum. In Fig. 3b this can be discerned as a negative slow wave that is elicited by words that did not contain the relevant feature A. Frontal negative slow waves have been linked to inhibition processes (e.g., Fox et al., 2000). We may, therefore, speculate that this slow wave may reflect active inhibition by the high dissociators when the stimulus feature is absent.

Enhanced focused attention of high dissociators is found both for nonaffective features, such as the letter A, and for affective features, such as threat word valence, and, thus, does not appear to be driven by emotional influences. In addition, when attending to nonaffective stimulus features, the high dissociators’ attention is drawn to the valence resulting in faster A detection. Enhanced divided attention, thus, appears to affect specific, apparently supporting the notion that dissociation may be related to emotion and possibly even to trauma. The idea that these abilities then serve to avoid reexperiencing this painful emotion (e.g., Cloitre et al., 1996) is contradicted by the increased, instead of reduced, attention to negative valence (see also Elzinga et al., 2000).

An alternative explanation that can be used to account for part of our results is that dissociative style is confounded with trait anxiety (a number of studies have found positive associations, e.g., Cloitre et al., 1996; McNally et al., 1998; Elzinga et al., 2000) and that threatening material automatically attracts attention of highly anxious individuals (e.g., Mathews and Mackintosh, 1998; Öhman and Mineka, 2001). A number of arguments can be raised against this account, however. The students in our experiment were invited to participate on the basis of their extreme Dis-Q scores and not on the basis of their trait anxiety. Because the association of dissociative style and trait anxiety is only modest in nonclinical groups (Jang et al., 1998), the variance in dissociative style may have been much larger in our participants than the variance in trait anxiety. The high dissociators, moreover, also showed enhanced attention to nonaffective features of neutral words, which is not expected by the anxiety-based account. Higher memory performance by high dissociators has also been obtained for other word categories than threat words (e.g., sex words, Elzinga et al., 2000). A higher susceptibility (Bremner et al., 2000; Clancy et al., 2000) of high dissociators for “false” recognition (see also Hyman and Billings, 1998) of affectively neutral, critical lures (i.e., words that are semantically related to studied words, but were not previously presented) is also very hard to explain by emotional processes. The notion that dissociative style involves a general information processing mechanism is finally supported by the recent finding of a higher verbal working memory span in high...
than in low dissociators (Veltman et al., submitted). Because attention may not only specify the contents of working memory (e.g., Conway et al., 2001) but also these (concurrenly available) contents may subsequently serve to direct attention (e.g., Downing, 2000), this finding further strengthens the notion of enhanced general attentional abilities with high-dissociative tendencies.

In sum, our results argue in favor of a relative independence of dissociation and emotional processes. From a clinical perspective, it cannot be excluded that traumatic experience contributes to dissociative tendencies, but this independence, and the large genetic influence (Jang et al., 1998), supports the notion that dissociative pathology probably develops on top of preexisting dissociative tendencies. This view would be compatible with the finding of increased memory performance in high dissociators under some conditions (Cloitre, 1992; Elzinga et al., 2000; McNally, 1998; McNally et al., 1998). Dissociative patients would then be characterized by an inability to forget a traumatic experience and the employment of an alternative information processing strategy (i.e., dividing attention and dual tasking) to do their best to avoid the negative affect associated with the trauma (see Elzinga et al., in press.) This leads to the paradoxical conclusion, which of course requires further investigation, that dissociative disorders may not be related to a damaged or disturbed function, but actually to an enhanced ability, which can also be found in nonpathological individuals. More importantly, the individual difference of dissociative style may also serve to improve our insights in fundamental information processing mechanisms, such as those involved in attention.

References


Cloitre, M., Cancienne, J., Brodsky, B., Dutil, R., Perry, S.W., 1996. Memory performance among women with parental abuse histories: enhanced directed forgetting or directed remembering? J. Abnormal Psychol. 105, 204–211.


