

Research Article

EVENT-RELATED POTENTIALS AND VISUAL AVOIDANCE IN BLOOD PHOBICS: IS THERE ANY ATTENTIONAL BIAS?[†]

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The possible presence of processing biases for threat-relevant information in blood-injection-injury phobia has been largely neglected in the literature. This issue was addressed by recording the late components (P300 and slow waves) of event-related potentials (ERPs) in the context of affective picture perception, as indicators of processing resources allocation. Blood phobics and healthy controls were shown threat-relevant, emotional threat-irrelevant, and neutral pictures. Free viewing time (VT) was measured as an index of voluntary visual avoidance, along with self-reports of pleasantness and arousal. No group differences as a function of picture content emerged for ERPs. Blood phobics spent less time viewing mutilations than did controls, but they did not show a clear-cut visual avoidance. As expected, individuals with phobias rated blood-related pictures as more unpleasant and arousing relative to controls. ERP results are in line with the limited behavioral data in the literature in demonstrating that blood phobics do not show an attentional bias toward threat-relevant stimuli. Depression and Anxiety 23:304–311, 2006. © 2006 Wiley-Liss, Inc.

Key words: blood phobia; event-related potentials; free viewing time; arousal; valence

INTRODUCTION

The ability to locate, attend to, and process dangerous cues effectively in the environment has an obvious evolutionary advantage. Threatening stimuli are particularly effective in capturing attention in that they represent a potential danger to the individual's survival and require an immediate adjustment to the situation's demands [see Öhman, 1997; Öhman and Mineka, 2001].

The assignment of processing priority to threats is particularly enhanced in individuals affected by anxiety disorders. In fact, an impressive body of behavioral investigations based on a cognitive-motivational approach to anxiety and pathological fears have shown that various anxiety disorders are associated with individuals' systematic attentional bias toward threat cues [i.e., their attention is automatically directed to threatening inputs in the external (or internal) environment; for a review, see Mogg and Bradley, 1998]. A hypervigilant processing mode, aimed at rapid detection of potential threats through continuous scanning of the environment, is considered to play a critical role

in the etiology and maintenance of pathological anxiety [Eysenck, 1992; Mathews, 1990]. A large amount of empirical research supports the existence of an anxiety-related preattentive bias that facilitates the initial automatic encoding of threat [e.g., Öhman, 1997]. However, it remains unclear whether avoidance or

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further maintenance of attention takes place after initial orienting.

According to the vigilance-avoidance hypothesis [e.g., Mogg et al., 1987], to reduce the anxious state, an individual's initial hypervigilance may be followed by an avoidant response pattern, interfering with subsequent detailed processing of threat. However, other studies have found evidence for a bias in the maintenance of attention toward threat information in anxious individuals, possibly reflecting a difficulty in attentional disengagement [see Beck, 1976; Bower, 1981].

Complementary to behavioral methods based on motor reaction times, event-related potential (ERP) recording is a well-acknowledged tool for examining the time course of information processing. Late ERP components (P300 and slow wave amplitude) are thought to reflect neural activity underlying allocation of attentional resources and memory consolidation [Elbert and Rockstroh, 1987; Polich and Kok, 1995; see also Cuthbert et al., 1998; Palomba et al., 1997]. The results of investigations on ERPs elicited by threat-relevant stimuli support the existence of an attentional bias, showing larger amplitude of P300 and slow waves in response to fear-related words or pictures in subjects with high trait anxiety or anxiety disorders compared with healthy controls [e.g., De Pascalis et al., 2004; Pauli et al., 1997; Stanford et al., 2001]. These findings have been interpreted as direct evidence that high anxiety is associated with the assignment of greater processing resources to threatening than to nonthreatening stimuli.

With regard to specific phobias, attentional biases toward fear-relevant information have been demonstrated in individuals with animal phobias in a variety of experimental paradigms in a large number of studies employing behavioral responses [e.g., Barker and Robertson, 1997; Öhman et al., 2001; Watts et al., 1986] and in the few studies measuring late ERP components [Gutberlet and Miltner, 1998; Miltner et al., 2000, 2005]. In these studies, individuals with spider and snake phobias showed significantly larger P300/slow wave amplitudes than healthy controls when exposed to pictures of their feared objects, indicating enhanced processing of stimuli that reflect critical fear concerns. Surprisingly, little attention has been devoted to the investigation of information-processing biases in individuals with blood phobia, although it is widely acknowledged that this disorder has distinct features that clearly differentiate it from other specific phobias.

In contrast with other individuals with phobias, those with blood phobias do not show clear-cut defensive avoidant behavior during exposure to the object of the phobia. Indeed, whereas a marked enhancement in individuals' sympathetic activity is commonly observed in other specific phobias, indicating a tendency for avoidance/withdrawal [e.g., Hamm et al., 1997], blood phobia is associated with a complex autonomic control that may eventually result in individuals' fainting [e.g.,

Öst, 1992] and that is obviously not consistent with readiness to overt defensive behavior (namely, escape).

Direct investigation of visual avoidant behavior in individuals with blood phobia by means of free viewing time (VT), an index of interest-overt avoidance, yielded inconsistent findings. Tolin et al. [1999] found that individuals with blood phobia exposed to phobia-related pictures in a free-viewing context showed shorter VT compared with controls, whereas Hamm et al. [1997] did not find any significant difference between individuals with blood phobia and control subjects in VT for mutilation pictures. In contrast, a clear-cut visual avoidance, indicated by shorter VT than controls to threat-related pictures, was obtained for individuals with animal phobias in both studies. Thus, it is not clear to what extent blood phobia is associated with visual avoidance of threat-relevant stimuli.

To our knowledge, only one study has investigated information-processing biases in individuals with blood phobia [Sawchuk et al., 1999]. The results failed to demonstrate delayed color-naming latencies on phobia-related words in individuals with blood phobia compared with controls on a Stroop task, indicating a lack of attentional bias. These findings are in striking contrast with previous research showing processing biases in other specific phobias [e.g., Barker and Robertson, 1997; Watts et al., 1986], suggesting that information processing might be qualitatively different in blood phobia compared with other anxiety disorders. According to Sawchuk et al. [1999], the prevalence of an emotional response of disgust over fear is thought to play a role in the lack of attentional biases toward threat information in these subjects. In fact, disgust rather than fear is reported as the main subjective emotional reaction in individuals with blood phobia exposed to phobia-related stimuli [Tolin et al., 1997].

In our study, individuals with blood phobia and healthy controls were shown emotionally intense pictures depicting mutilated bodies (unpleasant, threat-relevant), attacking humans (unpleasant, threat-irrelevant), and erotic couples and sport/adventure (pleasant). Household objects and neutral people were included as neutral contents. In contrast with the majority of investigations on cognitive biases for threat in anxiety disorders, where lexical material was employed (e.g., words in Stroop tasks), standardized emotional pictures were used for their greater ecological validity.

The main goal of this study was the investigation of the emotional processing of threat-relevant material in individuals with blood phobia by means of ERP recordings. Moreover, a further measure of visual avoidance in individuals with blood phobia, free VT, was employed to examine voluntary suppression of exposure to phobia-related material. To the best of our knowledge, no studies have measured ERPs in individuals with blood phobia exposed to phobia-related cues. Late ERP components (P300 and slow

waves) are particularly suitable for investigating the allocation of processing resources in the context of affective picture perception [e.g., Cuthbert et al., 1998], thus allowing us to test whether blood phobia is associated with a bias in attentional resource allocation toward threat information. Based on the relevant empirical literature about attentional biases in anxiety disorders [e.g., Pauli et al., 1997; Stanford et al., 2001], it might be hypothesized that individuals with blood phobia would also show an enhanced processing of threat-relevant stimuli compared with controls (namely, larger P300 and slow wave amplitudes). Along the same line, voluntary visual avoidance (namely, reduced viewing time) of the phobia object might be expected for individuals with blood phobia, as observed in other specific phobias [Hamm et al., 1997; Tolin et al., 1999]. Conversely, based on the limited available data indicating a lack of attentional bias in blood phobia [Sawchuk et al., 1999], along with the absence of a clear-cut visual avoidance [Hamm et al., 1997], no difference in ERP late components and viewing time would therefore be hypothesized. Our study was meant to test these conflicting predictions.

MATERIALS AND METHODS

PARTICIPANTS

Because blood phobia is known to have a higher prevalence among females [Bienvenu and Eaton, 1998; Öst, 1992], only women were recruited for our study. The Italian version of the Mutilation Questionnaire [MQ; Klorman et al., 1974] was administered to 210 female undergraduates, and subjects scoring above the 85th percentile of the obtained scoring distribution (≥ 19) were preliminarily included in the phobic group ($N = 39$). They were then invited by telephone to the laboratory and screened with a semistructured interview by a clinical psychologist [Anxiety Disorders Interview Schedule for DSM-IV (ADIS-IV); Brown et al., 1994] to assess whether they fulfilled DSM-IV-TR criteria for specific phobia—blood-injection-injury type [American Psychiatric Association, 2000]. Subjects who met the DSM criteria were asked to participate in the study, and an appointment was arranged for those who gave preliminary informal consent. The final sample, matching as closely as possible analog samples to clinical populations, included 23 females (age range, 19–27 years; $M = 22.8$, $SD = 2.06$). The mean MQ score for the phobic group was 21.2 (range, 19–25; $SD = 2.23$).

Control subjects ($N = 26$; age range, 21–30 years; $M = 23.8$, $SD = 2.42$) were randomly selected from the initial pool of subjects. They were included in the sample if they scored below 19 on the MQ and had no specific fears, as assessed before the experimental session by a 17-item reduced form of the Fear Survey Schedule [FSS-III; Wolpe and Lang, 1964]. Given that none of the control subjects had specific fears, the

ADIS-IV interview was not administered. Their mean score on the MQ was 8.4 (range, 1–17; $SD = 4.4$).

The absence of clinically relevant physical and psychopathological disorders (other than for subjects with blood phobia) was ascertained for each subject by means of a general health questionnaire.

STIMULUS MATERIAL

Seventy-two pictures, varying in emotional pleasantness and arousal, were selected from the International Affective Picture System [IAPS; Center for the Study of Emotion and Attention, 1999].¹ They were divided into six categories according to their content (pleasant: erotic couples and sport/adventure; neutral: household objects and neutral people; unpleasant: attacking humans and mutilated bodies). Only highly arousing contents were selected for the pleasant and unpleasant picture categories, to obtain an effective emotion induction.

Pictures were presented on a digitized format via a 17" monitor on an IBM-compatible computer, positioned at a distance of about 1 m from the subject. Picture resolution was 1024×768 pixels.

Two orders of picture presentation were arranged (across subjects) to control for order effects.

PROCEDURE

Upon arrival at the laboratory, participants read and signed an informed consent form and filled out several questionnaires. Subjects were seated on a comfortable chair in a dimly lit, sound-attenuated room. After electrode attachment, they were instructed that a series of pictures would be shown, and that each picture should be viewed the entire duration it was on the screen. Each picture was presented for 6 s. A variable interval (12–20 s) occurred between trials. Two neutral pictures served as practice stimuli. At the end of the session, sensors were removed and pictures were shown again in a different order. Participants were allowed to view the pictures as long as they wanted to and were told that pressing the space bar on a computer keyboard could terminate each picture presentation. VT was recorded in milliseconds as a behavioral index of interest-avoidance [see Hamm et al., 1997]. After voluntary picture offset, participants performed picture ratings using a computerized version of the 1- to 9-point scales of Valence and Arousal [Self-Assessment Manikin (SAM); Bradley and Lang, 1994].

¹The IAPS picture numbers were as follows: Erotica: 4611, 4650, 4651, 4652, 4658, 4659, 4664, 4669, 4672, 4680, 4800, 4810; Sport: 8030, 8034, 8040, 8080, 8160, 8161, 8170, 8180, 8190, 8200, 8370, 8490; Objects: 7002, 7009, 7010, 7020, 7030, 7040, 7050, 7080, 7090, 7175, 7233, 7235; People: 2190, 2200, 2210, 2230, 2270, 2381, 2440, 2480, 2570, 2749, 2830, 9070; Threat: 6190, 6230, 6242, 6243, 6244, 6250, 6260, 6350, 6510, 6540, 6560, 3530; and Blood: 3000, 3010, 3053, 3060, 3071, 3080, 3102, 3110, 3130, 3150, 3400, 9405.

APPARATUS AND PHYSIOLOGICAL RECORDING²

The electroencephalogram (EEG) was recorded using a Grass 15 A54 Quad Amplifier (Model 15 RXi; Grass Instrument Co., W. Warwick, RI). The recording started 3 s before picture onset and stopped 3 s after picture offset. Ag/AgCl electrodes (8 mm diameter) were placed on Fz, Cz, and Pz sites according to the International 10-20 system [Jasper, 1958]. Electrodes were also placed on both mastoids. EEG signals were digitized on a G3 Power Macintosh computer with LabView software. All channels were recorded with a Cz reference and digitally converted off-line to a linked-mastoid reference. The time constant was set at 15 s, and the high-frequency cutoff was 30 Hz. Vertical and horizontal eye movements were recorded in the same frequency range as the EEG. The sampling rate was 125 Hz.

Stimulus timing and ERP data collection were implemented by VPM software program [Cook, 1997] on an IBM-compatible computer. Picture presentation and data collection for the viewing time task and the SAM ratings were accomplished with MEL v.2 software [Micro Experimental Laboratory; Schneider, 1988] on an IBM-compatible computer.

DATA REDUCTION AND ANALYSIS

Individual EEG trials that were off-scale at any time during the 12-s recording interval were discarded. Separate epochs of stimulus-synchronized EEG traces were extracted from the whole 12-s EEG recording, extending from 120 ms before until 1.5 s after picture onset. To correct for vertical and horizontal ocular artifacts, an eye movement artifact correction procedure [Gratton et al., 1983] was applied to single-trial ERPs during picture processing and 1 s pre- and post-picture. ERP grand average waveforms were calculated separately for each category and site, referenced to a 120-ms baseline before picture onset.

The P300 component of the ERP was scored by determining the base-to-peak amplitude on averaged waveforms for each participant, category, and electrode site within a window beginning at N200 latency and continuing until 504 ms [Cuthbert et al., 1998; Schupp et al., 1997]. Slow waves were analyzed by computing mean amplitudes in three time windows after picture onset (400–600 ms, 600–800 ms, and 800–1,000 ms).

VT and self-report data were analyzed with a mixed-model analysis of variance (ANOVA), with one between-subjects factor (Group: Blood Phobics, Controls) and one within-subjects variable as repeated measure (Category: Erotica, Sport, Objects, People, Threat, Blood); for ERPs, the Site (Fz, Cz, and Pz) within-subjects variable was also included in the design.

²Other physiological measures were recorded during picture viewing, for purposes that are not strictly related to the main focus of this article. Therefore, the data have not been reported here.

The uncorrected *P* values for effects within variables with more than two levels are reported together with the Geisser–Greenhouse ϵ . Significant main effects and interactions ($P < .05$) were followed by Tukey post hoc comparisons to identify specific differences.

RESULTS

EVENT-RELATED POTENTIALS

Grand average ERP waveforms at Pz in the two groups are presented in Figure 1. For Group, neither a significant main effect nor an interaction with Category was found for any of the considered components.

Independent of Group, P300 amplitude was largest for Erotica and Blood (Category main effect [$F(5, 235) = 19.09$; $P < .00001$, $\epsilon = 0.91$]). Main effects for Category, essentially replicating that observed for P300 amplitude, emerged for slow wave amplitude in the 800–1,000 ms intervals [$F(5, 235) = 21.75$; $P < .00001$, $\epsilon = 0.87$]. In the 400–600 ms and 600–800 ms time windows, the Category main effect showed a larger amplitude for Blood compared with Threat [$F(5, 235) = 28.87$; $P < .00001$, $\epsilon = 0.84$ and $F(5, 235) = 35.76$; $P < .0001$, $\epsilon = 0.91$, respectively].

For both P300 [$F(2, 94) = 193.13$; $P < .00001$, $\epsilon = 0.84$] and slow wave time windows [$F(2, 94) = 208.07$;

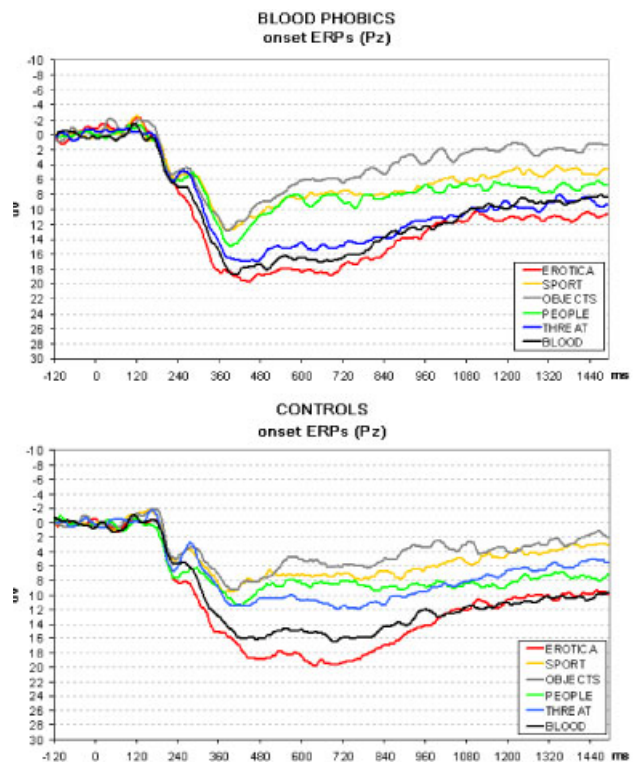


Figure 1. Grand average ERP waveforms in Pz during the viewing of affective pictures in Blood Phobics and Controls. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

$P < .00001$, $\varepsilon = 0.79$; $F(2, 94) = 154.46$; $P < .00001$, $\varepsilon = 0.74$; and $F(2, 94) = 84.31$; $P < .00001$, $\varepsilon = 0.64$], the largest positivity was found in Pz as compared with Fz and Cz.

A significant Site $\times$ Category interaction was also observed for P300 [$F(10, 470) = 9.11$; $P < .00001$, $\varepsilon = 0.71$] and slow wave amplitude in the three time windows [$F(10, 470) = 16.40$; $P < .00001$, $\varepsilon = 0.67$; $F(10, 470) = 16.75$; $P < .00001$, $\varepsilon = 0.64$; $F(10, 470) = 11.31$; $P < .00001$, $\varepsilon = 0.64$], showing that in Pz, Erotica and Blood prompted maximal amplitude and were significantly different from all other contents.

VIEWING TIME

As indicated by the significant Group main effect [$F(1, 47) = 4.53$; $P < .038$], picture viewing was overall shorter for Blood Phobics than for Controls. In addition, VT was significantly different in the two groups as a function of picture content [$F(5, 235) = 6.62$; $P < .00001$, $\varepsilon = 0.40$]: Blood Phobics spent less time than Controls watching Blood and Erotica, but not the other stimulus categories. Controls spent the same amount of time viewing Blood and Erotica, with Blood being viewed longer than all the other contents, and Erotica longer than Objects only. Interestingly, picture content did not modulate VT in individuals with blood phobia, in that no significant differences emerged among picture categories in this group (see Fig. 2).

The Category main effect [$F(5, 235) = 10.04$; $P < .00001$, $\varepsilon = 0.40$] showed that Blood and Erotica were viewed longer than all the other categories. The shortest viewing time was recorded for Objects.

AFFECTIVE JUDGMENTS

Means and standard deviations for valence and arousal ratings in Blood Phobics and Controls are presented in Table 1. Overall, pleasantness ratings were lower in Blood Phobics than in Controls [Group main effect: $F(1, 47) = 8.23$; $P < .006$]. The only significant difference emerging from the Group $\times$ Category

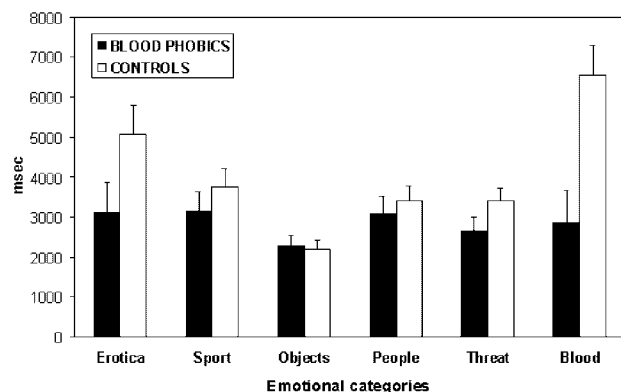


Figure 2. Mean viewing times (and standard error bars) in Blood Phobics and Controls.

interaction [$F(5, 235) = 2.96$; $P < .012$, $\varepsilon = 0.66$] concerned Blood, which was rated as more unpleasant by Blood Phobics than by Controls.

As shown by the Category main effect [$F(5, 235) = 277.02$; $P < .00001$, $\varepsilon = 0.66$], Erotica and Sport were evaluated as the most pleasant contents, followed by Objects and People. Blood, followed by Threat, obtained the lowest rating.

On average, arousal ratings were significantly higher in Blood Phobics than in Controls [Group main effect: $F(1, 47) = 13.86$; $P < .001$]. However, Blood Phobics attributed significantly higher arousal ratings to Blood and Threat compared with Controls [Group $\times$ Category interaction: $F(5, 235) = 5.48$; $P < .00001$, $\varepsilon = 0.61$]. Furthermore, Blood Phobics rated Blood as significantly more arousing than all the other contents, whereas Controls' arousal ratings for Blood did not differ significantly from ratings for Erotica.

Arousal reports also varied as a function of picture contents [Category main effect: $F(5, 235) = 84.68$; $P < .00001$, $\varepsilon = 0.61$], with Blood judged to be the most arousing, followed by Erotica, Sport, Threat and last, People and Objects.

DISCUSSION AND CONCLUSIONS

The results of our study do not provide evidence for an attentional bias toward threat-relevant stimuli in individuals with blood phobia during picture viewing.

To the best of our knowledge, this is the first study investigating emotional processing in blood phobia by means of ERPs. For none of the considered ERP's late components (i.e., P300 and slow waves) did the amplitudes in individuals with blood phobia differ significantly from controls. On the one hand, individuals with blood phobia did not show reduced ERP

TABLE 1. Means (and standard deviations) for valence and arousal ratings in Blood Phobics and Controls

	Blood Phobics	Controls
Valence ratings		
Erotica	6.85 (1.22)	7.12 (1.14)
Sport	7.00 (1.09)	7.05 (0.83)
Objects	5.23 (0.63)	5.16 (0.57)
People	5.22 (0.80)	5.42 (0.86)
Threat	2.85 (0.83)	3.50 (0.98)
Blood	1.23 (0.29)	2.32 (1.19)
Arousal ratings		
Erotica	5.82 (1.16)	4.69 (2.03)
Sport	5.36 (1.33)	4.31 (1.76)
Objects	2.24 (1.32)	1.88 (1.26)
People	3.30 (1.38)	2.92 (1.45)
Threat	5.78 (1.07)	4.14 (1.80)
Blood	7.77 (1.25)	5.26 (2.25)

Both scales ranged 1–9 (for Valence, 1 = lowest pleasantness, 9 = highest pleasantness; for Arousal, 1 = lowest activation, 9 = highest activation).

amplitudes to phobia-related information, which would suggest avoidance of detailed processing aimed at decreasing anxiety. On the other hand, they did not demonstrate increased ERP amplitudes, which would indicate a bias in the maintenance of attention. Therefore, individuals with and without phobias allocated similar amounts of attentional resources toward blood stimuli throughout emotional processing (up to 1000 ms). In both healthy individuals and those with phobias, blood-related stimuli commanded stronger attentional engagement compared with other unpleasant, high-arousal contents. A similar amount of processing resources was allocated toward erotic stimuli, demonstrating that erotica and mutilations are contents that prompt the highest affective engagement [Bradley et al., 2001; Buodo et al., 2002].

Our results complement the evidence provided by the only study investigating attentional biases in blood phobia, which failed to demonstrate an increased interference effect of threat-related information on a Stroop task [Sawchuk et al., 1999] and suggests that the lack of a bias found in selective attention also extends to resource allocation. Taken together, these findings contrast previous research demonstrating attentional biases toward threatening stimuli in individuals with animal phobia and other anxiety disorders [Barker and Robertson, 1997; De Pascalis et al., 2004; Gutberlet and Miltner, 1998; Öhman et al., 2001; Pauli et al., 1997; Stanford et al., 2001; Watts et al., 1986].

A possible interpretation of the absence of attentional bias in blood phobia might be related to the prevalence of an emotional response of disgust over fear. Fear and disgust might exert differential, conflicting influences over the emotional processing of blood-related information [Sawchuk et al., 1999]. Indeed, rapid detection and identification of potentially harmful stimuli, often described as fast and unpredictable, are critical for effective escape and avoidance. In contrast, the assignment of processing priority to “static” disgust stimuli that prompt avoidance of physical contact seems to be less influential for adaptive behavior [Sawchuk et al., 2002; Woody and Teachman, 2000]. From a different perspective, a physiological and psychological conflict between action and inhibition has been proposed as the determinant of the complex autonomic response pattern that characterizes blood phobia and can eventually lead to fainting [e.g., Engel, 1978]. Therefore, blood phobia represents a unique phenomenon among specific phobias, for which extreme experienced fear is commonly associated with clear physiological mobilization for effective escape and avoidance [Hamm et al., 1997].

In our study, individuals with phobias judged blood pictures as more unpleasant and arousing than did controls. In addition, they assigned the highest arousal and unpleasantness ratings to the phobia-relevant condition. Although expected, these data indicate that the affective picture paradigm employed in the study was effective in inducing a highly aversive emotional

state in individuals with blood phobia when confronted with pictures related to their own phobias.

Interesting results emerged from the analysis of VT data. In line with the findings reported by Tolin et al. [1999], individuals with blood phobias showed shorter VT for threat-relevant stimuli than did controls, indicating that when these individuals are placed in a free-viewing context, they engage in active visual avoidance of phobia-related material, with the possible intent of reducing the anxiety elicited by the threatening situation. This is also consistent with previous research investigating VT in other specific phobias [Hamm et al., 1997; Lang, 1995]. Although visual avoidance might serve to prevent fear and distress in the short term, its long-term effect is supposed to be highly dysfunctional, namely, the preservation of fear and avoidant behavior [Mogg and Bradley, 1998]. However, it is worth noting that, whereas reliably shorter than in controls, VT for threat-related pictures in individuals with blood phobias was not truly suppressed compared to all the other picture categories, suggesting a lack of a clear-cut avoidant response. Moreover, shorter VT was found in individuals with blood phobias than in controls also for one of the threat-irrelevant emotional categories (namely, erotica), which makes the obtained results even more ambiguous. Free VT of emotional pictures is known to covary reliably with experienced arousal, which, in turn, is affected by interest or attentional demands [Lang et al., 1993]; however, in individuals with phobias, VT of phobia-relevant material is considered to reflect mainly visual avoidance [Hamm et al., 1997; Lang, 1995]. Whereas VT reflected rated arousal in our nonfearful sample, in that the most arousal-evoking pictures were also viewed longer, the same effect was not observed in the phobic sample. In blood phobia, threat-relevant cues might evoke conflicting demands, resulting in a more complex emotional experience than in other specific phobias. Therefore, VT in individuals with blood phobias might reflect more the co-occurrence of multiple affective dimensions than a clear-cut avoidant behavior, as also suggested by the null effects reported by Hamm et al. [1997], who did not observe a significant difference in VT for blood-related pictures between individuals with and without phobias.

In summary, no evidence of a bias in the allocation of attentional resources toward phobia-relevant cues, as measured by ERP late components, was found in individuals with blood phobias. However, this finding does not completely exclude the possibility that attentional processes operate abnormally in these individuals. Preattentive/attentional biases that favor threat information might be detected at early stages of stimulus analysis in the early ERP components using suitable experimental contexts (e.g., facilitation, interference, and detection paradigms), and other measures (e.g., eye movement tracking) might be employed to probe the distribution of attention during

emotional processing, allowing a more refined analysis of visual avoidance [see Pflugshaupt et al., 2005]. In addition, the design used in our study could be improved by including a control group of individuals with other specific phobias (e.g., spider phobias) along with the presentation of non-phobia-related disgusting material (e.g., pictures of body products, rotting food, cockroaches), to better clarify the role of disgust in attentional processing.

Voluntary visual avoidance of blood-related pictures, as measured by free VT, was observed in individuals with blood phobias when compared with controls, but this response was not clear-cut and truly content-specific. Given also the inconsistent results in the relevant literature, visual avoidance in blood phobia remains a critical issue that needs to be addressed in future research.

As a final note, further studies including clinically referred individuals, instead of analogue samples to clinical populations, might clarify the characteristics of emotional processing in blood phobia and reveal possible biases in both attentional mechanisms and avoidance strategies.

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