Blood phobia and spider phobia: two specific phobias with different autonomic cardiac modulations

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Abstract

Cardiac reactions to two fear-related and one control film were compared in individuals high in spider or blood/injury fear. Twelve subjects in each phobic group were selected on the basis of their scores in the Spider or Mutilation Questionnaires and a semi-structured interview. Cardiac responses and self-reported affective ratings to the films were investigated. Sympathetic and parasympathetic cardiac influences were indexed by T-wave amplitude and respiratory sinus arrhythmia measured during film viewing. Basal parasympathetic cardiac control was also assessed during a paced breathing task. Results indicate differential autonomic modulation of cardiac responses for blood and spider phobics. Although each group reacted with marked cardiac activation to its feared stimulus, a sympathetic increase followed by withdrawal over time was found in blood phobics. Greater vagal tone at rest was present in blood phobics compared with spider phobics. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: Blood phobia; Film stimuli; Heart rate; T-wave amplitude; Respiratory sinus arrhythmia

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1. Introduction

Specific phobia is defined as a marked, persistent and unreasonable fear evoked by the presence or anticipation of clearly discernible objects or situations. Typically, the extreme anxiety reaction induced by exposure to the fear-related stimulus leads to avoidance behavior which significantly interferes with the individual's functioning (American Psychiatric Association, 1994).

The somatic and autonomic changes associated with this non-adaptive emotional reaction play a considerable role in assessment of the disorder and treatment outcomes (Lang, 1971; Hugdahl, 1989). As an extreme fear response, phobia involves a marked global increase in sympathetic activity, together with the subjective experience of heightened arousal. These psychophysiological changes are consistent with general mobilization for avoidance or escape behavior. In particular, in response to threat, heart rate is expected to increase, so that cardiac acceleration has frequently been employed as an index of the defense reaction or rejection of stimulation in normal subjects (Graham and Clifton, 1966; Turpin, 1986), as well as a measure of fearfulness of the phobic object in phobic patients (Sartory, 1986; Hugdahl, 1989). Indeed, a strong positive linear relationship between HR changes and subjective fear ratings has been found at intense fear levels (Sartory et al., 1977).

Animal phobia (especially toward spiders or snakes) has often been considered in the literature as a prototypical specific phobia. There is considerable evidence that this category of phobic individuals shows increased sympathetic activity both during exposure to the phobic stimulus and during phobic imagery (e.g. Lang et al., 1970; Prigatano and Johnson, 1974; Fredrikson, 1981). Autonomic changes include heart rate and blood pressure increases, cephalic and peripheral vasoconstriction associated with increases in skeletal muscle blood flow, and augmented phasic and tonic electrodermal activity. Self-report measures indicate high subjective tension, whereas behavioral variables, as indexed by viewing times of phobic pictures (Hamm et al., 1997) or by in vivo behavioral tests (Prigatano and Johnson, 1974) suggest a marked tendency for avoidance/withdrawal.

Most studies exploring the psychophysiological response patterns in animal phobics have employed slides as phobic objects (Prigatano and Johnson, 1974; Geer, 1966; Hare and Blevings, 1975; Hamm et al., 1997), whereas tonic visual stimulations (e.g. films or videotapes) have rarely been used (Fredrikson et al., 1995). For both stimulus conditions, the resulting autonomic response pattern is consistent with a defense response and supports clear aversive motivational disposition.

In striking contrast with this typical reaction in animal phobics, a different, unique psychophysiological response to the feared stimulus is often observed in blood–injection–injury phobia. Blood phobics directly or indirectly exposed to blood, injuries or wound situations, typically display a diphasic cardiovascular response pattern. A first phase, involving heart rate and blood pressure increases, is immediately followed by a marked and dramatic drop in both variables. This
response occurs to various extents and may eventually lead to emotional fainting (vasovagal syncope) due to the considerable reduction in cerebral blood flow (Graham et al., 1961; Öst et al., 1984; Kleinknecht, 1988; Steptoe and Wardle, 1988). Studies employing film stimuli or in vivo presentations of the phobic object indicate that the diphasic autonomic pattern is reliably displayed across time (Graham et al., 1961; Öst et al., 1984; Steptoe and Wardle, 1988).

Significant increases in heart rate and blood pressure followed by pronounced decreases were observed in blood donors during venipuncture by Graham et al. (1961). After cardiac acceleration, marked deceleration and even fainting occurred in 5-min or even 30-min film presentation (Öst et al., 1984; Steptoe and Wardle, 1988), whereas no significant HR decrease was found by Lumley and Melamed (1992) who employed 1-min scenes. When slides were used as phobic stimuli (6 or 10 s in duration), overall cardiac acceleration emerged in high-fear subjects, and no reliable diphasic pattern was observed. Interestingly, a strong cardiac acceleration was apparent only in the first trial block and was followed by a deceleration in the later blocks (Klorman et al., 1977; Hamm et al., 1997).

Although these data consistently suggest that the autonomic dysfunctions (and eventually fainting) require tonic stimulations to be fully displayed, a specific detection of the temporal boundaries of the beginning and completion of the diphasic cardiac reaction is lacking, also considering the extreme variability found between individuals who eventually faint (Graham et al., 1961).

Such a puzzling autonomic phenomenon characterizing blood phobia as compared to other specific phobias, calls for both physiological and psychological interpretations. Engel (1978) suggested that this autonomic pattern is the result of circulatory preparation for action (namely, flight) in the face of threat when avoidance, in fact, is not possible. Increased muscle blood flow, produced by vasodilation in skeletal muscles and mediated by sympathetic vasomotor nerves, would persist in the face of decreased muscle tone and marked drops in blood pressure and cardiac output. These conflicting physiological responses would reflect the activation of both sympathetic (‘flight–fight’) and parasympathetic (‘conservation–withdrawal’) emergency systems, simultaneously or in rapid alternation. A psychological condition of unresolvable uncertainty, as to whether overt action or inhibition is the most appropriate response to an overwhelming threat, would parallel the above-mentioned cardiovascular instability (Engel, 1978).

An overcompensatory parasympathetic rebound to an hyperdynamic sympathetic response to threat is the alternative interpretation proposed by Graham et al. (1961). The first phase of the cardiac reaction would be a reflection of anxiety, involving a marked increase in sympathetic activity. The second phase would reflect the intervention of antagonistic parasympathetic reflex mechanisms, acting to prevent the heart rate and blood pressure from rising without control. The cessation of anxiety and the sudden withdrawal of the intense sympathetic stimulation would leave the vagal reflexes unopposed, leading to an exaggerated parasympathetic activation.
Based on these and on other similar interpretations (e.g. Sledge, 1978; Vingerhoets, 1984), it is clear that the notion of disruption of the autonomic balance, as well as the complex sympathetic/parasympathetic interrelationship, seems to play a central role in blood phobia. Moreover, the selective association of fainting with blood phobics rather than with other phobic individuals and the peculiarity of the cardiovascular symptoms support the hypothesis of autonomic specificity (Connolly et al., 1976; Friedman et al., 1993).

Basal autonomic dysfunction, specifically a parasympathetic predominance in cardiac chronotropic control, has been hypothesized to be present in blood phobics. Angrilli et al. (1997) showed larger respiratory sinus arrhythmia (RSA) at rest (an index of cardiac vagal activity) in blood phobics as compared with non-phobic controls. Friedman and Thayer (1998) recently reported a higher cardiac vagal tone in blood phobics compared with nonclinical panickers, even though the highest levels were found in control subjects, whereas Steptoe and Wardle (1988) reported no reliable difference between blood phobics and healthy participants in intrinsic parasympathetic control of the heart. These inconsistent findings may be partly due to the different methods used for subject selection and quantification of the dependent measure (e.g. clinical vs. nonclinical samples; time-domain vs. frequency-domain indices of cardiac autonomic control).

In association with the evidence that individual differences in fear do modulate the autonomic response pattern to the phobic stimulus, a large number of studies indicate that a prevailing HR deceleration is observed to the sight of blood-related stimuli even in non-fearful, unselected subjects (Klorman et al., 1977; Gross and Levenson, 1993; Lang et al., 1993; Palomba et al., 2000), suggesting a stimulus-response specificity. In line with these data, it has been hypothesized that some autonomic/constitutional specificity may predispose individuals who are extreme in this stimulus-specific cardiac response toward developing blood phobia (Connolly et al., 1976; Friedman et al., 1993).

In a previous study (Palomba et al., 2000), a complex, mixed autonomic response pattern has been shown in normal subjects passively exposed to a film-clip depicting a thoracic operation. HR slowing (by itself indexing either augmented parasympathetic activation, or reduced sympathetic activation, or both), was associated with increased T-wave amplitude (TWA) and skin conductance levels (indicating decreased β-adrenergic and increased cholinergic sympathetic activity, respectively). One explanation for such a mixed autonomic pattern was that blood stimulus induced a multiple affect state made up by disgust, surprise, fear and other emotional states. This is in line with the psychological conditions of conflict and uncertainty in blood phobics as the critical determinants of fainting (Engel, 1978).

The autonomic response pattern reliably developed across the 2’12” of film presentation, and clearly differentiated the surgery film from a threatening scene, the latter inducing cardiac acceleration throughout the film presentation. Moreover, the observed HR decrease to the surgery scene was found to be accentuated in individuals high in parasympathetic cardiac control measured at rest, indicating
that basal differences in vagal tone influenced the cardiac emotional response to this specific stimulus condition.

The present study was designed to extend the previous work and investigate the cardiac response induced by the sight of blood in individuals high in blood/injury fear, with a special reference to the role of the complex sympathetic/parasympathetic interrelationship in determining the emerging emotional response. In particular, it was hypothesized that blood phobics would show a diphase cardiac reaction in the face of the feared stimulus. In order to investigate the autonomic basis of the expected cardiac response pattern, two measures of autonomic influences on the heart were employed: TWA and RSA. The former is considered to be inversely related to myocardial β-adrenergic sympathetic activity (Furedy and Heslegrave, 1983; Rau, 1991), whereas the latter has been widely proposed as a non-invasive index of parasympathetic cardiac control (McCabe et al., 1984; Grossman and Svebak, 1987). During the first, acceleratory phase the sympathetic cardiac control was expected to be augmented. Accordingly, TWA was expected to be reduced. The role played by each of the autonomic branches in the second phase of the response is less clearcut. Therefore, either a withdrawal of sympathetic activity (increased TWA) associated with increased parasympathetic activity (increased RSA) or a conflicting activation of both systems (decreased TWA and increased RSA), simultaneously or in rapid alternation, were hypothesized during the second phase.

The second related issue concerns the autonomic basal predisposition which could be associated with blood phobia. It was hypothesized that blood phobics would have greater intrinsic parasympathetic control of the heart, as compared with other specific phobics, and that this difference could be related to their specific autonomic cardiac response pattern. This prediction was tested by measuring RSA during a paced respiration task before the experimental session as an index of vagal tone at rest.

It was interesting to assess within a single study the resting cardiac autonomic control and the autonomic reactions in blood phobics and spider phobics during exposure to both fear-related and fear-unrelated material. Indeed, in the literature, direct, systematic comparison of blood with other specific phobics has largely been neglected.

Spider phobia, a prototypical animal phobia, was thus selected as a control phobic condition. A coherent increase in heart rate accompanied by TWA decrease was hypothesized for spider phobics in the face of the feared stimulus. Few studies have addressed the comparison between blood and animal phobics (e.g. Hamm et al., 1997), but neither employing tonic stimulations nor including measures of cardiac autonomic control.

Two film clips were selected as phobic stimuli for each type of specific phobia. Based on our previous study (Palomba et al., 2000), film stimuli lasting 2 min and 12 s were employed in order to obtain continued exposure and to allow temporal examination of the development of the autonomic responses. Subjective and cardiac autonomic responses were investigated to evaluate differences between the two phobic groups in responding to fear-related stimuli.
2. Method

2.1. Participants

Given the higher prevalence of specific phobias in females (Öst, 1992), only women were selected for the present study. Twenty-four women (aged 19–27 years; $M = 22.7$, S.D. = 1.9) at the University of Padova were selected from a screening of 206 female students. They completed the Italian version of the Spider Questionnaire (SPQ) and the Mutilation Questionnaire (MQ) (Klorman et al., 1974; Kleinknecht and Thorndike, 1990). Subjects were included in the study if their scores were 21 on the SPQ or 23 on the MQ, respectively, i.e. with scores above the 95th percentile of the gender distribution of the questionnaires (mean scores $\pm$ S.D.s = 22.75 ± 1.05 and 23.5 ± 0.67 on the SPQ and MQ, respectively). Individuals who scored above the cut-off on both questionnaires were discarded. In order to be included in the study, subjects also had to fulfill the DSM-IV criteria for specific phobia, as assessed by means of a semi-structured interview adapted from the Anxiety Disorders Interview Schedule for DSM-IV (ADIS-IV) (Brown et al., 1994). The selection was subsequently restricted by asking subjects to complete a 17-item reduced form of the Fear-Survey Schedule (FSS-III) (Wolpe and Lang, 1964) in order to discard highly fearful subjects other than blood or spider phobics. Subjects were excluded from the study if their scores were 3 on items concerning contents other than blood or spider. Table 1 shows the group means of the SPQ, MQ and FSS-III for the participants.

Twelve women were thus selected for each of the two groups (spider vs. blood/injury phobics), matching as closely as possible analogue samples to clinical populations. Subjects did not report any other particular kind of fears on the Fear-Survey Schedule; moreover, no significant difference in mean fear scores was found between the two groups ($t(22) = 0.41$). None of the participants reported health problems or were taking medications.

<table>
<thead>
<tr>
<th>Test</th>
<th>Spider phobics</th>
<th>Blood phobics</th>
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<td>$n$</td>
<td>12</td>
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<tr>
<td>Age (years)</td>
<td>19–27</td>
<td>19–25</td>
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<tr>
<td>Test</td>
<td>M (S.D.)</td>
<td>Range</td>
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<tr>
<td>SPQ</td>
<td>22.75 (1.05)</td>
<td>21–24</td>
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<tr>
<td>MQ</td>
<td>8.90 (2.61)</td>
<td>5–13</td>
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<tr>
<td>FSS-III</td>
<td>28.67 (5.35)</td>
<td>29.75 (7.30)</td>
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Note: The ranges of possible scores in these questionnaires were 0–30 for the MQ, 0–31 for the SPQ, and 0–68 for the FSS-III (0–4 score).
2.2. Stimuli

Three film-clips of 132 s duration each were selected and edited in order to preserve the integrity of the scenes (the scene continuity was maintained within the period of presentation). A second selection criterion required that only dialogue and no music score (to avoid music-related responses) were present in the clips. Each film clip was accompanied by a ‘documentary-like’ dialogue, rationalizing what was shown. Audio level was kept approximately equal across the films. The first fear-related film (spider) depicted a spider moving on a man’s arm. The second film clip (surgery) showed the early phases of a thoracic operation. As control situation, a film-clip (landscape) was drawn from a documentary depicting an urban area and some buildings of historical interest. The surgery and landscape clips had been previously used in the previous study on normal subjects (Palomba et al., 2000). Stimuli were presented on a 24-in. color TV monitor positioned 2 m in front of the subjects. Across subjects, films were viewed in one of three varied orders, according to a Latin square. A variable interval (4–6 min) lapsed between film presentations.

2.3. Apparatus and physiological recording

Electrocardiogram (ECG) was recorded using Ag/AgCl surface electrodes placed on the subject’s chest in a modified Lead II configuration. The signal was recorded with a time constant of 1 s (to avoid distortions of the T-wave) and a low pass filter set at 100 Hz.

DC recording of the respiration signal was obtained using a piezoelectric transducer placed on a belt stretched around the subject’s chest.

Physiological signals were amplified and filtered on a d/150 d/160 Digitimer LtD amplifier system, fed into an A/D board (NB MIO 16L-25; sampling rate: 500 Hz for ECG and 10 Hz for respiration), and stored on a Macintosh Quadra 700 computer. Data acquisition and analyses were implemented by LabVIEW 3 software (National Instruments, Austin, TX), according to Angrilli (1995).

2.4. Self-report measures

Based upon a dimensional model (e.g. Lang et al., 1993), emotion can be defined by the bipolar dimensions of affective valence and arousal, indicating feelings of pleasantness/unpleasantness and excitement/calm, respectively. Subjects’ emotional experience of each film-clip was rated using the paper-and-pencil version of the Self-Assessment Manikin (SAM) (Lang, 1980), which consists of a 9-point rating scale for each of the above-mentioned dimensions.

2.5. Procedure

Subjects meeting criteria for the study were asked to come to the laboratory. Upon arrival, they were given general information about the experiment, and their written informed consent was obtained. Each subject was then seated in a comfortable chair
in a dimly lit room and physiological sensors were attached. Following an initial 10-min adaptation period, subjects carried out 1 min of paced respiration at 8 cycles per min (cpm) with the aid of a rhythmic trace displayed on an oscilloscope.

Upon completion of the paced respiration task, subjects were asked to rest quietly for about 5 min, and then the three experimental films were shown. Subjects were instructed to watch each scene for its entire duration and to avoid looking away, although they were able to switch off the film whenever they wanted to. A videocamera allowed accurate monitoring of gaze direction and eye closing.

Heart rate, TWA, RSA, and respiration rate (RR) were recorded for the 30 s immediately prior to stimulus onset, and continued to be recorded during the subsequent 132-s scene. At the end of each clip, subjects were asked to assign valence and arousal ratings.

2.6. Data reduction and analysis

A digital trigger detecting R-waves was applied to the ECG signal to obtain interbeat intervals. Interbeat intervals were then converted to heart rate in half-second bins, as described by Graham (1978). The TWA was computed as the difference in microvolt between the maximum value included in a 100–300-ms window after the R-wave and the mean value of the 40-ms isoelectric line included between P- and Q-wave (Rau, 1991).

RR was quantified in cycles per min using a digital trigger detecting signal zero crossing. RSA was quantified as the difference in millisecond between the largest interbeat interval measured during expiration and the lowest measured during inspiration, according to the peak-valley estimation (e.g. Grossman et al., 1990). For all the physiological measures, the time course of each response was analyzed by dividing the 132-s stimulus period into four 33-s epochs. Change scores between each epoch and the 30-s baseline were analyzed. For each measure, mean values were entered into separate analyses of variance (ANOVAs) with Group as between-subjects, and Film (landscape, surgery, spider) and Time (four 33-s epochs) as within-subjects factors. In an attempt to further investigate relationships between variables, for each group HR changes during the viewing of the phobic stimulus were analyzed within each epoch by multiple regression, using TWA and RSA during film viewing as regressors.

In order to examine group differences in parasympathetic cardiac control, interbeat intervals recorded during the paced respiration task were used to estimate RSA at rest according to the above-mentioned criterion. One-tailed unpaired t-test was then performed on mean RSA values.

In order to test the influence of the basal autonomic characteristics on the response patterns, HR, TWA and RSA changes during film viewing were also analyzed by repeated measures analyses of covariance, using the basal parasympathetic activity as covariate.

The $P$-values for effects within variables having more than two levels are reported together with the Greenhouse-Geisser Epsilon ($e$). Post-hoc means comparisons
(Newman-Keuls) were employed to further examine significant effects (using a $P < 0.05$ criterion for significance).

3. Results

3.1. Physiological measures

3.1.1. Heart rate

A significant Group $\times$ Film interaction was obtained ($F(2, 44) = 3.32, P < 0.04, \eta^2 = 0.78$), indicating that each group responded with HR increases only to its fear-related stimulus. As assessed by post-hoc tests, no significant difference was found between groups in responding to their own phobic object. Interestingly, whereas blood phobics exhibited a large HR decrease to the spider film, spider phobics virtually showed no response to the surgery film.

The significant Group $\times$ Film $\times$ Time interaction ($F(6, 132) = 2.33, P < 0.04, \eta^2 = 0.65$) provides interesting information on the temporal development of the cardiac responses (Fig. 1). Blood phobics exposed to the surgery film exhibited marked relative HR increases from the first to the second epoch, followed by abrupt relative decreases from the second to subsequent epochs. Post-hoc tests showed significant differences between the second epoch and the first, third and fourth epochs. During the first, third and fourth epochs HR changes were not significantly different from each other.

In response to the feared stimulus, spider phobics showed a HR increase that was maintained despite the deceleration occurring at the third film-epoch. Post-hoc analyses indicated a significant difference between the second and third epochs only,

![Fig. 1. Mean heart rate changes across the four time epochs during film viewing in the two phobic groups. Epoch 1 = 1 – 33 s; 2 = 34 – 66 s; 3 = 67 – 99 s; 4 = 100 – 132 s.](image)
showing that during the first, second and fourth epochs comparable HR changes were produced.

HR analyses also yielded significant Film ($F(2, 44) = 5.05, P < 0.01, \varepsilon = 0.78$), Time ($F(3, 66) = 3.43, P < 0.02, \varepsilon = 0.59$) and Film × Time ($F(6, 132) = 4.04, P < 0.0009, \varepsilon = 0.65$) effects. Averaged across all subjects, larger HR increases emerged during the surgery than during the other films, particularly in the middle viewing stages.

None of the above-mentioned results changed when the analysis was repeated using the basal parasympathetic activity as covariate, suggesting that cardiac reactivity was not dependent on vagal tone measured at rest.

3.1.2. T-wave amplitude

A significant Group × Time interaction ($F(3, 66) = 4.54, P < 0.006, \varepsilon = 0.73$) revealed that, independently of films, blood phobics showed a TWA increase from epoch 1 to epochs 3 and 4, and from epoch 2 to epochs 3 and 4; furthermore, during the last two epochs, a significant difference in TWA was found between the two groups, with spider phobics showing no significant TWA changes across epochs (Fig. 2).

An interesting, but marginally significant Group × Film × Time interaction ($F(6, 132) = 1.94, P < 0.079, \varepsilon = 0.69$) is also worth mentioning, showing a response pattern that mirrors the one observed for HR (Fig. 3).

Significant Time effect ($F(3, 66) = 5.3, P < 0.002, \varepsilon = 0.73$) and Film × Time interaction ($F(6, 132) = 2.21, P < 0.05, \varepsilon = 0.69$) were also obtained, indicating an overall progressive decrease in cardiac sympathetic activity, particularly during the landscape film.

![Fig. 2. Mean TWA changes across time during film viewing in blood and spider phobics. Epoch 1 = 1–33 s; 2 = 34–66 s; 3 = 67–99 s; 4 = 100–132 s.](image)
Again, similar results were obtained when the basal RSA was entered as covariate in the analysis, indicating that TWA changes during film viewing were not influenced by vagal tone measured at rest.

3.1.3. Respiratory sinus arrhythmia

RSA analysis during film viewing failed to reveal any significant effect or interaction for Group, Film and Time.

3.1.4. Respiration rate

No significant effects were found also for this measure, indicating similar breathing patterns for both groups during the three films across time. This result also indicated that HR changes were not affected by changes in RR.

3.1.5. Basal resting vagal tone

Mean RSA measured during the paced respiration task was significantly higher for blood than for spider phobics ($t(22) = 1.72$, $P < 0.05$-one tailed). Mean values were $215.42$ ms (S.D. = 59.15) and $167.67$ ms (S.D. = 75.74), respectively. No significant difference in heart period was found between the two groups during the same task ($t(22) = 0.12$).

3.1.6. Multiple regression analyses

In order to further explore the role of sympathetic and parasympathetic activity in producing HR changes during film viewing, separate multiple regression analyses were performed for each epoch of the surgery and the spider film in blood and spider phobics, respectively, using mean HR changes as dependent variable and mean TWA and RSA changes as regressors. The findings are reported in Table 2.
Table 2
TWA and RSA changes as predictors of heart rate changes in blood and spider phobics exposed to their own phobic stimulus: multiple regressions

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<th>Predictors</th>
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<td>Surgery in blood phobics</td>
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<tr>
<td>TWA</td>
<td>-4.67</td>
<td>-0.87</td>
<td>-3.54</td>
<td>-0.76</td>
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<td>-0.59</td>
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<td>RSA</td>
<td>0.082</td>
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<td>Spider in spider phobics</td>
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<td>TWA</td>
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<tr>
<td>RSA</td>
<td>0.32</td>
<td>0.09</td>
<td>0.72</td>
<td>0.22</td>
<td>-0.80</td>
<td>-0.30</td>
<td>1.07</td>
<td>0.27</td>
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<tr>
<td></td>
<td>P &lt; 0.75</td>
<td>P &lt; 0.49</td>
<td>P &lt; 0.44</td>
<td>P &lt; 0.31</td>
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<tr>
<td></td>
<td>R² = 0.45</td>
<td>F(2, 9) = 3.74</td>
<td>F(2, 9) = 4.99</td>
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<tr>
<td></td>
<td>P &lt; 0.06</td>
<td>P &lt; 0.03</td>
<td>P &lt; 0.40</td>
<td>P &lt; 0.03</td>
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For blood phobics, the regressors, taken together, explained a large and significant portion of variance at epoch 1 and 2. However, only the effects of TWA on HR were statistically significant: HR changes were negatively related to TWA, whereas the effects of RSA on HR were marginal and not significant. Interestingly, at epoch 3 the relationship between TWA and HR changes became weaker (although the effect was very close to significance, the Beta coefficient was lower than at the previous epoch, the overall relationship was not significant and the regression was a poor fit). The effect of RSA as predictor was still not significant. At epoch 4, TWA and HR changes were no longer significantly associated: the regression was a poor fit and not significant.

For spider phobics, the negative relationship between TWA and HR changes was maintained until the end of film presentation, despite the lack of association at epoch 3. As noted in blood phobics, RSA changes made no significant contribution to the prediction.

3.2. Self-report measures

3.2.1. Valence and arousal ratings

Valence and arousal mean ratings were entered in ANOVAs containing Group as a between-subjects and Film as a within-subjects factor. As expected, each group rated its phobic stimulus as significantly more unpleasant and arousing than the other two conditions (Group × Film interactions: \( F(2, 44) = 12.06, P < 0.0001, \varepsilon = 0.92 \) and \( 8.63, P < 0.0007, \varepsilon = 0.91 \) for valence and arousal, respectively). Moreover, as assessed by post-hoc tests, for both variables, the significant Film effects (\( F(2, 44) = 81.21, P < 0.0001, \varepsilon = 0.92, \) and \( 48.29, P < 0.0001, \varepsilon = 0.91, \) for valence and arousal, respectively) indicated that the surgery film was rated as significantly more unpleasant and arousing than the other two conditions, and the spider film was rated as more unpleasant and arousing than the landscape. For arousal judgements, spider phobics assigned overall higher ratings than blood phobics did (Group effect: \( F(1, 22) = 7.91, P < 0.01 \)).

Mean scores and standard deviations are reported in Table 3.

4. Discussion

The present study was aimed at investigating the autonomic basal characteristics of blood–injection–injury phobics and the role of the two branches of the ANS in determining the cardiac reaction during exposure to the fear-related stimulus. A comparison with a typical category of specific phobia (namely, spider phobia) was performed to explore differences in phobic response patterns.

As indicated by the significant Group × Film interaction, similar heart rate increases were displayed by the two phobic groups when facing their own feared object. Nevertheless, analyses of HR changes over time revealed important
information on the different development of the cardiac responses in blood and spider phobics.

Contrary to expectations, a complete diphasic cardiac reaction was not observed in blood phobics when viewing the surgery film, due to a lack of a genuine bradycardic reaction during the second phase. Nevertheless, reliable HR increases were displayed during the first two epochs, followed by an abrupt reversal leading to relative decreases during the remaining stages, with HR falling below the baseline levels at the end of the film. The significant differences in HR changes found between epochs 1 and 2 and between epochs 2 and 3 support the existence of a diphasic-like development of the cardiac response, albeit not leading to a pronounced HR decrease.

The lack of a larger, bradycardic reaction in blood phobics is most probably due to the duration of the film, which may have been too brief to allow the complete development of the autonomic effects. As previously stated, the film-clips, and so their lengths, were selected based on our previous study with normal subjects (Palomba et al., 2000). Furthermore, information on the temporal development of the diphasic cardiac response as was available in the literature did not give specific information regarding the latency and completion of the second, deceleratory phase.

Interesting patterns emerged from the analysis of the role played by the two branches of the autonomic nervous system in determining the emerging cardiac response in blood phobics. Although the overall Group × Film × Time interaction did not reach statistical significance, TWA changes mirrored the corresponding HR changes across time. In particular, TWA decreased gradually at epoch 1 and 2, indicating an increased sympathetic activity, while marked TWA increases were found at epoch 3 and 4, indexing a withdrawal of sympathetic tone. Therefore, the prediction that the sympathetic cardiac control would be augmented during the first, acceleratory phase of the cardiac response was confirmed.

The strong negative association between TWA and HR changes during the first two epochs of film viewing was supported by the significant results of multiple regression analyses, suggesting that cardiac acceleration was determined exclusively by increased sympathetic activity. The ANOVA on RSA measured during film

<table>
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<th>Landscape</th>
<th>Surgery</th>
<th>Spider</th>
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<tr>
<td></td>
<td>M (S.D.)</td>
<td>M (S.D.)</td>
<td>M (S.D.)</td>
</tr>
<tr>
<td><strong>Blood phobics</strong></td>
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<tr>
<td>Valence</td>
<td>7.25 (1.55)</td>
<td>1.92 (0.90)</td>
<td>4.75 (1.55)</td>
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<tr>
<td>Arousal</td>
<td>1.25 (0.45)</td>
<td>6.92 (1.88)</td>
<td>3.42 (1.73)</td>
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<tr>
<td><strong>Spider phobics</strong></td>
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<tr>
<td>Valence</td>
<td>6.67 (1.37)</td>
<td>2.92 (1.73)</td>
<td>2.08 (1.31)</td>
</tr>
<tr>
<td>Arousal</td>
<td>1.75 (1.76)</td>
<td>6.00 (2.26)</td>
<td>6.75 (1.55)</td>
</tr>
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</table>

Table 3
Self-report measures of valence and arousal during the landscape, surgery and spider films for blood and spider phobics.
viewing did not reveal any significant effect. These results suggest that the autonomic cardiac regulation across epochs during the viewing of the feared stimulus was mainly under sympathetic control.

This pattern of results demonstrates that the first acceleratory phase of the diphasic cardiac response was reliably shown in blood phobics. Moreover, after the initial increase in sympathetic activity, a decrease occurred, possibly preluding the emerging of a parasympathetic predominance, but surely not coexisting with it. The inference of a sympathetic withdrawal across time in blood phobics is strongly supported by the significant Group × Time interaction obtained for TWA, which steadily increased over time in blood phobics only. A further effect, emerging from multiple regression analyses, indicates that during sympathetic withdrawal the association between TWA and HR changes became progressively weaker.

The prediction of greater intrinsic parasympathetic cardiac control in blood phobics was largely confirmed. This group showed higher RSA values at rest (during the paced breathing task) than spider phobics did. This is consistent with our previous finding demonstrating greater basal parasympathetic activity in blood phobics than in normal subjects (Angrilli et al., 1997). These remarkable results suggest that an altered autonomic control mechanism, namely, vagal predominance in cardiac chronotropic control, may sustain the cardiovascular lability commonly reported in blood phobics. Other studies have emphasized the usefulness of this approach in identifying autonomic/constitutional factors which may play roles in vulnerability to anxiety disorders (Connolly et al., 1976; Friedman et al., 1993).

Nevertheless, the autonomic response patterns obtained for blood phobics were not dependent on vagal tone measured at rest, as suggested by the unchanged results of the ANOVAs when entering basal RSA as covariate. This is not surprising, since basal parasympathetic activity was expected to exert its influence mainly on the second, bradycardic phase of the cardiac response, which was not observed in the present study.

The comparison of blood phobics with another category of specific phobics yielded interesting results. A different cardiac reaction was obtained for spider phobics, who showed sustained HR increases during exposure to their feared stimulus. Despite the cardiac deceleration observed from the second to the third film epoch, an increase toward previous HR levels was found during the last epoch. After a closer inspection of the film clip (spider), this unexpected HR decrease during the third epoch was thought to be related to a specific scene (about 30 s long) in which the phobic object was filmed from a greater distance than during all the other epochs. This event, containing less aversive elements as compared with the rest of the film, could have temporarily dampened the previous activation in spider phobics.

As expected, multiple regression analyses indicated that HR changes during the viewing of spider film were predicted by sympathetic activity (namely, TWA changes) whereas RSA made no significant contribution to the cardiac response. Moreover, no remarkable changes in the strength of association between HR and TWA measures were found in spider phobics. Unexpectedly, spider phobics confronted with the surgery film did not show the cardiac deceleration commonly observed in non-fearful, unselected subjects (e.g. Klorman et al., 1977), whereas
blood phobics displayed the normal deceleratory response to the spider stimulus (cf. Hamm et al., 1997). Unfortunately, comparable data are not available in other studies and further investigation is needed to clarify the functional significance of this response. As for the present study, we might speculate that spider phobics responded selectively to their feared stimulus, thus being less reactive to other phobic, highly unpleasant material (i.e. showing no HR decreases to the surgery film).

Regarding the subjective measures, as expected, subjects in each phobic group reported higher arousal and unpleasantness during their feared situation than during the other two conditions, confirming extreme ratings of fear along the basic affective dimensions. Moreover, the phobia-specific fear stimuli did produce equivalent levels of subjective negative arousal in the respective groups, suggesting that the distinct cardiac reactions were not attributable to emotions of different intensities.

In summary, the present study provided useful information in identifying the autonomic cardiac influences in two different phobic categories, both classified as specific phobias (American Psychiatric Association, 1994). Distinct cardiac autonomic modulations were found for blood and spider phobics when exposed to their feared stimulus. These differences did emerge already across the 2-min film presentation. The analyses of responses over time indicated that spider phobics displayed a pure sympathetic activation pattern, involving cardiac acceleration sustained by a negative association with TWA changes, whereas blood phobics showed a first phase of high sympathetic activation followed by relative HR decreases, sustained by sympathetic withdrawal. Film duration was long enough to show, in blood phobics, a reversal in HR and TWA responses toward a reduction in sympathetic control of the heart, whereas a change in parasympathetic activity was not displayed across film presentation. However, the hypothesis of autonomic specificity is strengthened by the finding that blood phobics had greater vagal cardiac activity at rest.

Acknowledgements

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References

American Psychiatric Association, 1994. Diagnostic and Statistical Manual of Mental Disorders, DSM-IV.


