THE STARTLE PROBE RESPONSE AS AN INSTRUMENT FOR EVALUATING EXPOSURE EFFECTS IN SPIDER PHOBIA

Peter J. de Jong,* Arnoud Arntz,† and Harald Merckelbach*  

* Department of Mental Health Sciences, Limburg University, Maastricht, The Netherlands  
†Department of Medical Psychology, Limburg University, Maastricht, The Netherlands

Abstract — Before treatment, immediately after treatment and at one week followup, acoustic probes eliciting eyelink startles were presented to 37 female spider phobics during a behavioral approach test (BAT). To obtain control startles, the subjects also carried out a BAT with a block of wood (neutral foreground) and a BAT with tasty food items (positive foreground). During the pretreatment assessment eyelink startle magnitudes did not significantly differ among the three BAT conditions. For all conditions, startle responses were larger during the pre- than during the post-treatment and follow-up assessments. This possibly reflects a general fear-induced startle potentiation during the pretreatment session, due to subjects’ anticipating exposure to spiders. At one week follow up, the expected linear trend between affective valence (BAT conditions) and startle magnitude emerged, despite the fact that at this time spider startles were significantly smaller than those before treatment. The self-reported startles closely mimicked the pattern of eyelink startle responses. The present study indicates that the startle response might be a fruitful outcome variable, indexing aspects of phobia not covered by the more commonly used outcome measures. Yet, its prognostic properties remain to be established.

INTRODUCTION

The startle reflex refers to a diffuse skeletonmuscular response resulting from intense stimuli with rapid onset (e.g., a pistol shot). The eyelink is the first and most stable component of the startle pattern (Davis, 1984). Animal research has consistently found that the startle reflex is potentiated by fear. This startle potentiation can be enhanced by anxiogenic drugs and can be blocked by anxiolytic drugs like diazepam (Davis, Hitchcock, & Rosen, 1989).  

Recent studies of Lang and colleagues (Vrana & Lang, 1990; Bradley, Cuthbert & Lang (1990); Vrana, Spence & Lang (1988)) show that the human startle probe response is also modulated by emotional state. That is to say, positive foreground stimuli (e.g., slides depicting nudes) appear to inhibit the startle reflex, whereas the startle reflex is potentiated during a negative foreground stimulus (e.g., slides of mutilated bodies). Apparently, a match of the (negative) affective tone of the probe (i.e., a

Correspondence concerning this article should be addressed to Peter J. de Jong, Department of Mental Health Sciences, Limburg University, P.O. Box 616, 6200 MD Maastricht, The Netherlands.

JABR 15:1-8  

301
sudden loud noise) with the foreground stimulus leads to a potentiation, whereas a mismatch results in an inhibition of the response. The repeatedly documented linear relationship between affective tone of the foreground stimulus and the startle magnitude, led Vrana et al. (1988) to argue that "the startle probe would be useful in evaluating treatment methods and in the assessment of therapy prognosis of patients with pathological anxiety" (p.491; see also review by Lang, Bradley, & Cuthbert, 1990).

Results of a pilot study tentatively confirmed that the startle probe reflex has prognostic and evaluative properties in the treatment of spider phobia (de Jong, Merckelbach, & Arntz, 1991). In that study startle responses were found to be larger during a phobia relevant foreground (i.e., live spider) than during a positive foreground (i.e., basket with food items). In addition, this difference in magnitude decreased as a result of treatment. Furthermore, evidence was found to suggest that the pretreatment startle responses predict long-term therapy outcome defined in terms of self-reported spider fear at 18 months follow-up (de Jong, Arntz, & Merckelbach, 1991).

Given the potential importance of those findings, the major aim of the present study was to replicate and extend the pilot study. As in the pilot study, subjects were spider phobics who applied for treatment. Eye blink startles were elicited by means of acoustic probes during the behavioral approach test (BAT). During the BAT, subjects pulled a glass jar containing a live spider (negative foreground) as nearby as they could tolerate. To obtain contrast values of the startle responses, subjects also performed a "BAT" with a basket of tasty food items (positive foreground). To differentiate between negative foreground induced startle potentiation and positive foreground induced startle inhibition, a neutral "BAT" (i.e., block of wood) was added to the food "BAT" and spider BAT. In the present study, startle measurements were not only obtained before and immediately after a 2.5 h one-session exposure treatment, but also at the one week follow-up. In addition, it was explored in the present study whether subjective reported startles are sensitive to the same factors as are the eyelblink startle responses.

Another issue that was addressed in this study was the relationship between startle modulation and arousal. Previous research of Bradley et al. (1991) demonstrated that the skin conductance responses (i.e., physiological arousal) to positive and negative slides were of the same magnitude, while the responses to neutral slides were relatively small. Thus, whereas startle magnitudes show a linear increase from positive to negative slides, the relationship between arousal and slide valence appears to reflect a quadratic (U-shaped) function. In other words, within the context of slide presentations, affect induced startle modulation appears to be independent of arousal. To investigate whether in the present context
the startle reflex is likewise modulated by affect rather than by arousal, heart rate (HR) and self-reported arousal were measured during each BAT.

Given the findings of Bradley et al. (1991) it was anticipated that HR and self-reported arousal would show a U-shaped relationship with the affective valence of the BATs. The startle probe responses were expected to be strongest with a fear evoking foreground stimulus (i.e., spider) and weakest with a pleasant foreground stimulus (i.e., food), while an intermediate magnitude was expected when using the neutral foreground stimulus (i.e., wood). Additionally, it was predicted that the magnitude of the startles during the spider BAT would decrease as a result of treatment.

METHOD

Subjects

Subjects were 37 female spider phobics. They applied for therapy at the ongoing Spider Phobia Project of Limburg University. In return for “free” treatment (see below), subjects were invited to participate in research. The mean age was 25 years (range: 17–48). The mean score on the Spider Questionnaire (SPQ; Korman, Weerts, Hastings, Melamed, & Lang, 1974) was 22.1 (range 13–31). The original sample consisted of 42 phobics. However, five subjects were excluded from the analyses because (1) they did not show up at one week follow up (N = 2); or (2) no measurable startle responses were obtained (N = 3).

Assessment and apparatus

As a behavioral measure of phobic anxiety, subjects underwent a Behavioral Approach Test (BAT). This was conducted both before and after treatment and at a one week follow up. During this test subjects were seated in a chair located behind a large table (0.5 m x 3.0 m). At the far end of the table, a live spider (Tegenaria atrica) was kept in a closed glass jar. A guided string was fastened to the jar. Subjects were instructed to pull the spider as nearby as they could tolerate and to keep the spider in that position for 90 s. It was stressed that it was very important to really reach their limits. The BAT was scored on a 13-point scale ranging from 0 (spider at 300 cm) to 12 (spider on hand) (see Arntz, Levy, van den Berg, & van Rijnsoort, this issue, for more details concerning the BAT). On completion of the BAT, subjects were asked to indicate on 100 mm Visual Analog Scales (VASs) their fear during the test (0 = no fear, 100 = terrified).

Five pertinent startles were elicited during the final 90 s of each BAT
by presenting acoustic probes. The probes consisted of 50 ms, 100 dB white noise probes with instantaneous rise time delivered by headphones (binaurally). The mean interstimulus interval (ISI) was 20 s. To familiarize subjects with the acoustic probes, three test probes were delivered while the subjects were pulling the string.

During the pretreatment spider BAT, probes were given with the spider being in the final position for each subject. To provide the opportunity to evaluate the treatment effect on the startle probe responses, during the post-treatment and follow-up sessions, subjects were instructed to bring the spider in the same position as they did before treatment (this point was marked with a small bar) and to keep the spider in that position for 90 s. Thus, during all three assessments the subjects' distance to the spider was equal.

In order to obtain contrast values, subjects not only carried out BATs with a spider but also with a basket containing tasty food items (e.g., bananas, chocolate, candies, cola, orange juice) and a block of wood. The order was balanced. Subjects were randomly assigned to one of the six groups. Thus, one third of the subjects started with the spider BAT, one third started with the food BAT and one third started with the wood BAT. For each subject the same order was maintained for all sessions. During both the post-treatment and the follow up sessions, subjects ended with the maximal approach task (spider BAT\textsubscript{max}). The BAT\textsubscript{max} was used as the behavioral index of treatment outcome.

Eyelblink startle responses were measured by recording EMG activity from the \textit{musculus orbicularis oculi} beneath the left eye, using Beckman miniature Ag–AgCl surface electrodes filled with Hewlett Packard Redux creme. The EMG signal was fed to a Beckman EMG Coupler (9852A). Frequencies were filtered 60 Hz high-pass (48 dB/octave), using a Krohn Hite filter (type 3341 with a Butterworth characteristic). The EMG signal was then rectified and integrated by a contour following integrator of the type recommended by Fridlund (1979). In order to optimize the sensitivity for momentary fluctuations of EMG activity, a short integration time constant was chosen (1/16 s). The transformed signals were fed to a Beckman polygraph using 3 different channels. To maintain optimal sensitivity for both incubating and habituating responses, each channel used a different amplification factor (0.5, 2 and 5, respectively). Magnitudes were scored by hand in arbitrary EMG units. During the food, wood and spider BATs, heart rate (HR) was measured via Beckman Ag–AgCl electrodes filled with Hewlett Packard Redux Creme. The electrodes were placed according to a lead II placement. Electrodes were connected with a Beckman Voltage/Pressure/Volume Coupler (type 9853A). Physiological signals were fed to a Beckman R 611 polygraph. A microcomputer controlled response registration and probe administration.
Immediately after each BAT, subjects were asked to report to what extent they were startled by the probes on a VAS ranging from 0 mm (not startled at all) to 100 mm (extremely startled). In addition they were asked to rate the foreground stimuli (i.e., spider, wood, & food) on the dimensions of affective valence and arousal by using a VAS.

**Procedure**

Upon arrival, subjects were introduced to the laboratory. Following this, subjects completed the SPQ. The SPQ is a 31-item self-report instrument that measures fear of spiders. It has been recommended as a therapy outcome measure (Fredrikson, 1983). Next, EMG and HR electrodes were attached. After the procedure had been explained, subjects carried the BATs. Before subjects were treated in the therapy room, electrodes were removed. The treatment consisted of exposure in vivo accompanied by modeling by the therapist and lasted exactly 150 min. The one-session treatment has been found to yield good immediate and long-term results (Öst, 1989; Merckelbach, Arntz, & de Jong, 1991; Öst & Salkovskis, 1992; Arntz & Lavy, 1993). Immediately after the one-session therapy and at one week follow up, subjects went through the BATs again. On both occasions, they also completed a SPQ. Finally, they received a booster session lasting approximately 1.5 h.

**Data reduction and analysis**

Changes scores of the BAT (0–12) and changes scores of the SPQ were used as indices for therapy success.

To check whether the manipulations of the foregrounds (the three BATs) were successful, subjects’ judgments of the foreground stimuli along the dimensions of affective valence and arousal were evaluated by using MANOVA trend analyses. A linear trend from spider to food BAT (that should be weakened as a result of treatment) was expected for the affective valence dimension. Reported arousal was expected to be relatively low for the wood BAT in comparison to the food and the spider BAT. In other words, quadratic trends were anticipated.

MANOVA trend analyses were performed on mean eyeblink startle magnitudes and subjective startle responses to evaluate (1) whether the startles linearly increased from the food via the wood to the spider BAT (before as well as after treatment and at one week follow up); and (2) whether the startle pattern among conditions was modulated by the treatment. Therefore, mean, linear and quadratic trends were inspected.
Heart rate (HR) data were also subjected to MANOVA trend analyses to test the hypothesis that HR follows (reported) arousal rather than (reported) affect (e.g., Lang et al., 1990), whereas the reverse was expected for the startle response. In other words, a quadratic trend was anticipated due to the relatively weak arousing properties of the wood BAT in comparison to the spider and food BAT.

Four backward regression analyses were carried out in order to investigate the prognostic properties of the pretreatment startle response, subjective startle, SPQ, BAT, subjective reported fear during the BAT (VAS) and HR for treatment outcome as indexed by change scores of the BAT as well as indexed by change scores on the SPQ. Because there are large differences in EMG responding among individuals, ratios of startle magnitude (i.e., mean magnitude spider-BAT/foodBAT) were preferred in the regression analyses.

Finally, Pearson's $r_m$ correlations were computed to investigate the interrelationship between the pretreatment subjective and eyeblink startle ratio and other more commonly used outcome measures; namely, the behavioral approach task (BAT), SPQ and heart rate acceleration during the BAT.

RESULTS

Due to apparatus failure, the post-treatment startle data of one subject was not available. For the same reason, startle data from the follow-up assessment for two other subjects were missing. Because of technical problems, HR of one subject could not be obtained during the follow-up session. This is reflected in the degrees of freedom for the relevant comparisons. In the overall MANOVAs listwise deletion was preferred.

Table 1. Mean Scores of the Behavioral Approach Test (BAT), the Spider Phobia Questionnaire (SPQ), Self-reported Fear During BAT (VAS), Before (pre) and After (post) One-session Treatment, and at the One Week Follow Up (f.u.).

<table>
<thead>
<tr>
<th>Phase</th>
<th>Pre</th>
<th>Post</th>
<th>f.u.</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAT (0-12)</td>
<td>4.0</td>
<td>9.7</td>
<td></td>
<td>13.4</td>
<td>36</td>
<td>&lt;.00</td>
</tr>
<tr>
<td>BAT (0-12)</td>
<td>4.0</td>
<td>8.4</td>
<td>9.1</td>
<td>36</td>
<td>&lt;.00</td>
<td></td>
</tr>
<tr>
<td>VAS (0-100)</td>
<td>61.9</td>
<td>35.8</td>
<td></td>
<td>-5.2</td>
<td>36</td>
<td>&lt;.00</td>
</tr>
<tr>
<td>VAS (0-100)</td>
<td>61.9</td>
<td>52.9</td>
<td>1.9</td>
<td>36</td>
<td>.06</td>
<td></td>
</tr>
<tr>
<td>SPQ (0-31)</td>
<td>22.1</td>
<td>21.7</td>
<td></td>
<td>-11.9</td>
<td>36</td>
<td>&lt;.00</td>
</tr>
<tr>
<td>SPQ (0-31)</td>
<td>22.1</td>
<td>13.8</td>
<td>-9.7</td>
<td>36</td>
<td>&lt;.00</td>
<td></td>
</tr>
</tbody>
</table>
The startle probe response

Treatment effects

In general, the one-session treatment yielded good immediate and short-term results (see Table 1). That is, BAT scores increased, SPQ scores decreased and self-reported fear during the BAT (VAS) decreased. As can be seen in Table 1, the treatment effect was maintained at the one week follow up.

Self-report ratings

Affective valence

Figure 1 depicts the self-report ratings of the three different foreground stimuli. As expected, there was a linear trend from spider to food at the pretreatment assessment, $F(1,36) = 190.1, p < .001$. This pattern of results was maintained at post-treatment and at one week follow-up, $F(1,36) = 92.5, p < .001$ and $F(1,35) = 123.2, p < .001$, respectively. The slope of the linear trend decreased as a result of treatment, $F(1,35) = 40.5, p < .001$ and $F(1,35) = 11.9, p < .01$, reflecting the change of affective valence of the spider after therapy.

Arousal

In line with the a priori predictions, there was a quadratic trend of the self-reported arousal from spider to food during all assessments, $F(1,36), p < .001, F(1,36) = 46.2, p < .001$ and $F(1,35) = 44.3, p < .001$, respectively. The quadratic trend between foreground stimulus and arousal was not affected by treatment, both $Fs(1,35) < 1$. Only during the pre-treatment assessment was there also a significant linear trend, indicating that the pretreatment spider BAT was more arousing than the pretreatment food BAT, $F(1,36) = 8.9, p < .005$.

Heart rate

In line with the hypothesis, pretreatment HR showed a quadratic trend between the three foreground stimuli, $F(1,36) = 13.8, p < .01$. This reflects the fact that HR was higher during the spider and food BAT as compared to the wood BAT. In addition, a linear trend emerged, $F(1,36) = 11.1, p < .01$, indicating that at the pretreatment assessments, HR was higher during the spider BAT than during the food BAT. This linear trend disappeared immediately after treatment, $F(1,36) < 1$. There was still some evidence for the presence of a quadratic trend, although the univariate F-tests did not reach the conventional level of significance, $F(1,36) = 2.6, p = .11$. At one week follow-up there was neither a linear nor a quadratic trend
left $F_{s}(1,35) < 1$. In other words, during the follow-up session, there were no differences in HR between the food, wood and spider BAT (see Figure 2).

The MANOVA revealed a multivariate effect of treatment $F_{6,30} = 3.64, p < .01$. Univariate $F$ tests indicated that there was no difference between the mean trends from the pre to post-treatment assessment $F_{s}(1,35) < 1$. Thus, there was no general decrease of HR after treatment.
In the meantime, both the linear and the quadratic trends decreased immediately after treatment, $F(1,35) = 13.4, p < .01$ and $F(1,35) = 9.7, p < .01$, respectively. A similar pattern of results was evident at one week follow-up, $F(1,35) = 12.5, p < .01$ and $F(1,35) = 12.7, p < .01$, respectively.

**Eyeblink startle responses**

Eyeblink startle responses are shown in Figure 3. During the pretreatment assessment, a linear trend from spider to food was anticipated. Although the absence of a quadratic component $F(1,36) < 1$ indicated that the startle responses during the three different foreground stimuli did not significantly deviate from the hypothesized linear relationship between affective valence and startle magnitude, the linear trend did not attain significance, $F(1,36) = 1.06, p = .30$.

During the assessment immediately after the treatment session, neither a linear nor a quadratic trend was found, $F(6,35) < 1$. Thus, there were no differences in startle magnitude between the spider, wood, and food BATs.

At one week follow up, a linear trend was evident from spider to food, $F(1,34) = 4.1, p < .05$. In other words, the startle magnitude during the spider BAT was larger than that during the food BAT. The absence of a quadratic trend ($F(1,34) < 1$) indicated that there was no deviation from a linear relationship between startle magnitude and emotional valence.
FIG. 3. Mean magnitudes of the eyeblink startle responses during the spider, wood and food BAT, before treatment, after treatment and at one week follow up. Note that the distance to the spider was fixed for each subject and determined by subjects’ pretreatment achievement.

Overall, there was a significant multivariate effect of treatment, $F(6,28) = 3.34$, $p < .05$. Univariate F-tests indicated that this effect was carried by a difference in mean trends between the pretreatment assessment and both post-treatment assessments, $F(1,33) = 14.9$, $p < .01$ and $F(1,33) = 12.1$, $p < .01$, respectively. That is, in general, startle magnitudes were smaller immediately after treatment and at one week follow up than during the pretreatment assessment. Both the linear and the quadratic trends were not significantly affected by treatment, $F(1,33) < 1$.

**Subjective startle response**

During the pretreatment assessment a linear trend from spider to food BAT was evident $F(1,36) = 32.0$, $p < .001$. In addition, a significant quadratic trend emerged, $F(1,36) = 5.1$, $p = .03$, reflecting the finding that the difference between the spider and wood startles were larger than the difference between the food and wood startles (see Figure 4).

Immediately after the one-session treatment and at one week follow up, only linear trends reached significance, $F(1,35) = 7.8$, $p < .01$ and $F(1,34) = 9.5$, $p < .01$, respectively. This result reflects a linear relationship between self-reported startle and affective valence of the foreground stimuli.

Overall, there was a multivariate effect of treatment $F(6,28) = 7.2$, $p < .001$. Univariate F-tests indicated that there was a significant difference
The startle probe response

Subjective startle

<table>
<thead>
<tr>
<th>Spider</th>
<th>Wood</th>
<th>Food</th>
</tr>
</thead>
</table>

FIG. 4. Self-reported startle responses during the pre- and post-treatment assessments and at one week follow up. Note that the distance to the spider was fixed for each subject and determined by subjects' pretreatment achievement.

in the mean trend from the pre- to the first post-treatment assessment, indicating a general decrease of the self-reported startle, $F(1,33) = 31.9$, $p < .001$. Yet, the mean trends of the pretreatment and the second post-treatment assessments (at one week follow up) did not differ significantly, $F(1,33) = 3.1$, $p > .05$. For both post-treatment assessments, the slope of the linear trend was smaller than that of the pretreatment assessment $F(1,33), p < .01$ and $F(1,33) = 8.6$, $p < .01$, respectively. In other words, the differential responding between the spider and the food BAT decreased after treatment.

Pretreatment startle response and treatment effects

Four (backward) regression analyses were carried out to investigate the predictive power of the startle response for immediate and short-term treatment success. The first regression analysis was performed with the BAT difference score ($\text{BAT}_{\text{pre}}$ minus $\text{BAT}_{\text{post}}$) being the dependent variable and the pretreatment startle response ratio, subjective startle, VAS, HR, SPQ, and pretreatment BAT being the predictor variables. The equation that included all variables did not reach significance, $F(6,28) < 1$ and none of the predictor variables remained in the final equation. The second regression analysis tested the association of the behavioral improvement at one week follow up ($\text{BAT}_{\text{pre}}$ minus $\text{BAT}_{\text{fin}}$) and the pretreatment startle ratios, VAS, HR, SPQ, and pretreatment BAT. Only 20% of the short-term behavioral improvement could be explained by
all independent variables operating jointly ($F(6,28) = 1.2, p = .34$). In the backward analyses, none of the above mentioned predictor variables remained in the final equation. Consequently, it can be concluded that the startle ratios, VAS, HR, SPQ and BAT cannot satisfactorily predict behavioral improvement neither immediately after treatment nor at one week follow-up.

To explore the relationship between the improvement on the self-reported fear of spiders (i.e., SPQ) on the one hand and the pretreatment startle ratios, BAT, VAS, HR and SPQ on the other hand, two other (backward) multiple regression analyses were carried out. Dependent variables were the SPQs immediately after treatment (SPQpost) and at one week follow up (SPQpost). The proportion of variance ($R^2$) in SPQ scores explained by the dependent variables was only .08 for the immediate post-treatment assessment and .15 for the assessment at one week follow up. Neither of the two regression equations reached significance, $F(6,28) < 1$. All in all, treatment success appeared to be highly independent of all baseline measures in the present study.

Table 2. Pearson p–m Correlations between Pretreatment Startle Ratio, Subjective Startle, the Spider Phobia Questionnaire (SPQ), the Behavioral Approach Task (BAT), Reported Fear During BAT (VAS), and Heart Rate During BAT (dHR)

<table>
<thead>
<tr>
<th>Startle ratio</th>
<th>Subj. startle</th>
<th>VAS</th>
<th>BAT</th>
<th>SPQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subj. Startle</td>
<td>0.33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAS</td>
<td>0.25</td>
<td>0.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAT</td>
<td>−0.27</td>
<td>−0.22</td>
<td>−0.48</td>
<td></td>
</tr>
<tr>
<td>SPQ</td>
<td>0.08</td>
<td>0.02</td>
<td>0.45</td>
<td>−0.67</td>
</tr>
<tr>
<td>dHR</td>
<td>0.01</td>
<td>−0.06</td>
<td>0.49</td>
<td>−0.41</td>
</tr>
</tbody>
</table>

$^1 p<0.005$; $^2 p<0.05$.

More detailed information concerning the startle response in relation to other commonly used outcome measures can be obtained from the correlation matrix (see Table 2). As can be seen in Table 2, the eyeblink startle was not significantly related to any of the outcome measures that were assessed in the present study.

**DISCUSSION**

The major aim of the present study was to explore whether the startle probe methodology provides a useful psychophysiological index of therapy outcome and therapy prognosis in pathological anxiety. A prerequisite for such an index would be that it can be modulated by...
fear or anxiety. Pertinent to this issue, a study of Cook, Hawk, Davis, and Stevenson (1991) demonstrated that startle responses were larger during fear imagery than during pleasant imagery. Moreover, this effect appeared to be enhanced among subjects scoring high on the Fear Survey Schedule (FSS; Arrindell, Emmelkamp, & van der Ende, 1984). A second criterion for a psychophysiological index of therapy outcome would be that the response is affected by successful treatment. Results from previous animal research strongly suggest that the startle probe response is affected by fear reduction. More specifically, Berg and Davis (1984) showed that fear induced startle potentiation can be blocked by anxiolytic drugs (i.e., diazepam).

In accordance with the animal research, the present study showed that the magnitude of the spider startles, indeed, decreased from the pretreatment to both the post-treatment and follow-up assessments. Yet, in contrast to what was expected, during the pretreatment assessment no significant difference in eyeblink magnitude could be detected between the spider and food BAT. The absence of the expected differential response before treatment might be attributed to potentiated startles during the food and wood BAT rather than to a lack of startle potentiation during the spider BAT. During the pretreatment measurements, phobic subjects were well aware of the fact that they would undergo exposure treatment. It is plausible to assume that this anticipation caused a general negative tone/anxious mood, which, in turn, facilitated startle responses under all BAT conditions. The fact that for all foreground stimuli (i.e., spider, wood, food) eyeblink startle responses were significantly smaller during both the post-treatment and follow-up assessments as compared to the pretreatment measurement underlines this line of reasoning. In addition, at one week follow-up the expected linear trend between startle magnitude and affective valence did emerge. This pattern was evident, despite the fact that the follow-up spider startle was significantly smaller than the pretreatment spider startle. This finding adds to the suggestion that the absence of such a linear trend during the pretreatment assessment was due to a general fear-induced startle potentiation rather than to a failure of the spider BAT to potentiate startle probe responses.

Another explanation for the absence of differential responding before treatment might be, that the very high prior level of emotional excitation during the pretreatment spider BAT, to some extent prevented foreground induced potentiation of the startle response to occur. Pertinent to this suggestion are Zillman’s (1983) studies on “excitation transfer” in which it was shown that physiological responses to emotional stimuli are larger when they are evoked in moderate states of emotional excitation than in intense states of excitation (see Lang et al., 1990, p. 389, for a similar line of reasoning). This potential relationship between affect intensity and startle
modulation, might also explain why in an earlier pilot study differential responding did occur during the pretreatment assessment (de Jong et al., 1991). In that study, subjects were instructed to pull the spider as nearby as they normally would tolerate. In contrast, subjects in the present study were instructed that they should reach their limits. The latter instruction not only resulted in a “better” performance on the BAT (4.0 vs. 3.2) but also in higher levels of self-reported fear (VAS) during the BAT (62 vs. 51). It might well be that the higher level of fear due to the latter instruction (to some extent) prevented foreground induced startle potentiation to occur during the spider BAT.

In the present study, the startle reflex was not only indexed by the eyeblink response, but also by subjects' self-reported startle. The subjective startles appeared to be sensitive to the same factors as the eyeblink startle responses. More specifically, the self-reported startle responses varied systematically with the valence of the foreground stimuli. In fact, the relationship between subjective startle and affective valence was even more pronounced than that between the eyeblink startle and valence. Whereas at the pretreatment assessment only a very weak linear relationship emerged between BAT valence and eye blink startles, a very strong linear relationship was found between BAT valence and self-reported startles. Apparently, affect-induced potentiation of self-reported startles is less affected by the level of emotional excitation than is the affect-induced potentiation of eyeblink startles. Furthermore, the subjective startle appeared to be more specifically affected by treatment than the eyeblink component of the startle reflex. That is, only the self-reported spider startle (but not the wood or food startle) significantly decreased as a result of treatment.

The finding that the self-reported startle closely follows affective valence may be of practical relevance for the startle probe methodology. Obviously, on the one hand, self reported startle lacks some of the advantages of the eyeblink startle because it demands reflection, is vulnerable to experimental demand and needs some explanation. On the other hand, subjective startles are easy to monitor, i.e., do not require technical facilities. In addition, it provides the opportunity to apply the startle probe methodology outside the laboratory (e.g., in a clinical setting).

To control for the possibility that the startle response (in the present BAT context) reflects arousal rather than affective valence, heart rate was measured as an index of autonomic arousal. In addition, subjects were asked to rate the foreground stimuli on the dimensions of affective valence and arousal. The pattern of the heart rate data were found to closely mimick the self-reported arousal. Subjects showed relatively low arousal during the wood BAT and relatively high arousal during the food and spider BAT, as indexed by both heart rate and self reporter
The startle probe response

arousal. Meanwhile, the eyeblink startle responses closely followed the self-reported affective valence rather than the arousal evoking properties of the three different foreground stimuli. In other words, the present results indicate that the startle response is especially sensitive to affective valence and relatively independent of arousal, whereas the reverse is true for heart rate responses. Thus, the present data can be considered as further evidence for the position of Hamm (1992) that potentiation of the startle response indicates an avoidance (e.g., flight/flight) disposition induced by the evaluation of affective valence, while autonomic responding reflects general activation processes. In other words, the present findings are consistent with the view that the startle probe response is an "arousal free" index of emotional valence (e.g., Lang et al., 1990).

Some remarks are in order as to the clinical significance of the current data. The present study shows that the modulation of the startle probe response according to the subjects' perception of positive and negative foreground stimuli is not restricted to the context of slide presentations and imagery. In addition, the startle response appeared to be relatively independent of other outcome measures (i.e., SPQ, BAT, HR). Furthermore, the present data suggest that the magnitude of the startle response is affected by treatment. Taken together, these findings suggest that the startle response might be a fruitful additional outcome variable, indexing aspects of phobia not covered by the more commonly used outcome measures. Yet, the present study could not replicate the earlier finding that pretreatment startles have prognostic power for therapy outcome (de Jong et al., 1991). Neither treatment outcome indexed by post-treatment SPQ, nor indexed by post-treatment BAT scores were related to the pretreatment startle response ratio. However, as said before, this absence of a relationship between the startle ratio and treatment outcome might be related to the relatively high level of prior emotional excitation during the pretreatment spider BAT. In other words, it might well be that optimal startle potentiation (resulting in a more sensitive differentiation between subjects) only occurs at more moderate affective intensities. In order to draw more firm conclusions in this respect, parametric studies are needed concerning the relationship between affect intensity and startle modulation.

To recapitulate, the present findings confirm that in the context of a behavioral approach task the startle response predominantly reflects affective valence rather than arousal. In addition, the pattern of self-reported startles closely mimicks the pattern of eyeblink startle responses. Furthermore, the present study suggests that fear-induced startle potentiation can be reduced by behavioral treatment. Finally, although the present results suggest that the startle response can be considered as a useful
contribution to commonly used outcome measures, its prognostic properties remain to be established.

Acknowledgements — The authors wish to thank the therapists Arie Dijkstra, Edith Lavy, Birgit Maier, and Anja Meijboom for treating the patients and Dorien Wolfs for taking care of the organizational aspects of this project. Finally we are grateful to Karel Elses who provided *Drosophila* for our spiders.

REFERENCES


