Neuroticism, preattentive and attentional biases towards threat, and anxiety before and after a severe stressor: a prospective study

Christianne M. Verhaak[a,*], Jesper M.J. Smeenk[b], Agnes van Minnen[c], Floris W. Kraaimaat[a]

[a]*Department of Medical Psychology, University Medical Center St. Radboud, PO Box 9101, 6500 HB Nijmegen, the Netherlands*
[b]*Department of Obstetrics and Gynaecology, University Medical Center St. Radboud, PO Box 9101, 6500 HB Nijmegen, the Netherlands*
[c]*Department of Clinical Psychology, University of Nijmegen, PO Box 9104, 6500 HE Nijmegen, the Netherlands*

Abstract

This study was designed to prospectively investigate the role of neuroticism, trait anxiety and attentional biases towards threat in the development of anxiety after a failed IVF or ICSI treatment. A subliminal and supraliminal Stroop task was administered to 49 women entering IVF or ICSI treatment as well as self-report measures of neuroticism, trait anxiety and state anxiety. The assessment of state anxiety was repeated after failed treatment. Results of concurrent analyses have indicated that there was no relationship between Stroop factors and state anxiety. As hypothesised, prospective analyses showed a significant effect for neuroticism and Stroop interference on anxiety response to failed IVF or ICSI treatment. This effect was only apparent for interference on stressor related words and not for words related to general threat. The effect of subliminal Stroop interference was more pronounced in a subsample of women showing an increase in anxiety as a result of failed treatment. It can be concluded that, in addition to neuroticism, subliminal Stroop interference is a predictor for emotional response to an aversive stressor, such as failed IVF or ICSI treatment.
© 2003 Elsevier Ltd. All rights reserved.

Keywords: Vulnerability; Preattentive bias; Attentional bias; Neuroticism; IVF/ICSI treatment

---

* Corresponding author. Tel.: +31-24-3613608; fax: +31-24-3613425.
E-mail address: c.verhaak@cukz.umcn.nl (C.M. Verhaak).

1. Introduction

Stress vulnerability models differ in their attention to factors supposed to be the main predictors of the development of anxiety disorders. Models of personality dimensions stress the importance of neuroticism and trait anxiety, whereas cognitive models stress the importance of information processing. Until now, studies have mainly focussed on one of these two models, as a result of which relatively less attention has been paid to the additional contribution of factors from both models in the development of anxiety disorders. Information about this would increase our understanding of how to identify which individuals are more vulnerable than others to developing anxiety. The object of the present study is to illuminate this by investigating the concurrent and prospective relationship between factors of both models and state anxiety, before and after the occurrence of an aversive stressor.

Personality theories have stressed the importance of negative affectivity and underlying constructs, such as neuroticism and trait anxiety. It is assumed that individuals vulnerable to developing anxiety disorders are characterised by enhanced sensitivity to aversive stimuli (Clark, Watson & Mineka, 1994; Eysenck, 1970, 1998; Watson & Clark, 1984). This enhanced sensitivity is the main characteristic of negative affectivity. Neuroticism can be defined as a general sensitivity to negative information, trait anxiety as an enhanced sensitivity to threatening information. Neuroticism and trait anxiety are generally assessed by self-report measures, like the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1975) and the Spielberger Trait and State Anxiety Inventory (Spielberger, 1983).

Cognitive theories have proposed that enhanced vulnerability is explained by the selective processing of threatening information (Williams, Mathews, & MacLeod, 1996; Mogg & Bradley, 1998). In anxiety, selective processing is shown as an attentional bias towards threatening information. Pathological fear occurs when a fear structure is activated without further processing of threatening information (Foa & Kozak, 1986). Further processing involves incorporation of new information that is incompatible with the fear structure and results in its modification. Activation of the fear structure causes an orientation towards threat in the initial phase of information processing. Relaxed subjects are better able to entirely process threatening information, whereas this entire processing takes too much effort when subjects are under stress (Foa & Kozak, 1986).

Foa and Kozak did not differentiate between preconscious and conscious activation of fear structures. Later theories, like those of Beck and Clark (1997) and Mogg and Bradley (1998), proposed that biases in the processing of threatening information take place on preattentive (preconscious) and attentional (conscious) levels.

Preattentive and attentional biases towards threatening information are most frequently identified with an emotional Stroop task. In the emotional Stroop task, subjects are asked to name the colour of a word as quickly as possible, while ignoring the meaning of the word. Colour-naming interference is positively related to the emotional valence of the word.

Attentional biases towards general threat words are most frequently identified in clinical samples (see for reviews: Mathews & MacLeod, 1994; Mogg & Bradley, 1998; Williams et al. 1996). A few studies have also reported a *preattentive* bias towards threatening information in clinical samples (Lundh, Wikstrom, Westerlund, & Ost, 1999; Mogg, Kentish, & Bradley, 1993).

In non-clinical samples, there is less evidence of a relationship between anxiety and attentional biases towards threatening information. MacLeod and Ruthenford (1992) proposed that this

could be due to the fact that highly anxious subjects in non-clinical samples are able to strategically override a possible processing bias for threatening information. This capacity is assumed to be lacking in patients with anxiety disorders. This might explain why an attentional bias towards threat-related words is indicated most consistently in clinical groups. However, it is possible that, while non-clinical subjects strategically override a processing bias on the supraliminal level, they are not able to do this on the subliminal level. Thus non-clinical subjects with high levels of trait anxiety could show a preattentive bias towards threat. Indeed, there is evidence for a relationship between preattentive biases towards threat and trait anxiety in non-clinical groups (MacLeod & Ruthenford, 1992; Mogg, Kentish et al., 1993), but studies on this issue were based on small samples with high trait anxiety and revealed equivocal results.

Accordingly, in clinical samples, there seems to be support for a concurrent relationship between anxiety and preattentive and attentional biases towards threat. In non-clinical samples, however, the relationship between both of these factors has been insufficiently demonstrated. So, the question concerning the concurrent relationship between preattentive biases towards threat and anxiety in a normal sample with respect to their anxiety levels remains unanswered.

Up to now, prospective studies on the relationship between preattentive and attentional biases towards threat and anxiety have been rare. A prospective design is warranted in order to exclude the possibility of a preattentive or attentional bias being a consequence of anxiety, and not being a mediating factor in the course of anxiety. MacLeod and Hagan (1992) used a quasi prospective design in a sample of 32 gynaecological patients due for a colpescopy after a positive cervical test. Based on the results of their study, they concluded that the subliminal attentional bias before the stressor was a better predictor for emotional response to that stressor than self-report measures on state and trait anxiety. Supraliminal Stroop interference was not a predictor for emotional response. This supports the assumption of possible strategic overriding in non-clinical subjects with high trait anxiety. Caution in drawing firm conclusions should be exercised, however, because of the small sample size and the consequent limited power of their study. Until now, the prospective results of MacLeod and Hagan's study have only been partly replicated (Pury, 2002; Van den Hout, Tenney, Huygens, Merckelbach, & Kindt, 1995). Accordingly, the relative contribution of subliminal threat interference along with dispositional factors as assessed by self-report measures is still unclear.

The present study was carried out for two purposes: firstly, to explore the concurrent relationship between neuroticism, trait and state anxiety and attentional and preattentive biases to threat in a non-clinical sample. Secondly, it was conducted to investigate the relative contributions of neuroticism, trait anxiety and Stroop interference to anxiety response to an aversive stressor. The study sample consisted of women about to start in vitro fertilisation (IVF) or intracytoplasmic sperm injection (ICSI) treatment. Before the start of the treatment, IVF or ICSI patients showed trait and state anxiety levels comparable to sex and age specific norm groups (Verhaak, Smeenk, Eugster, Van Minnen, Kremer, & Kraaimaat, 2001). The nature of the IVF/ICSI treatment provides a good opportunity to prospectively study the predictive value of neuroticism and processing biases for the development and consolidation of anxiety in a natural setting with non-clinical subjects before and after experiencing a severe stressor. The success rate of an IVF treatment is low (first cycle only about 25%), while its emotional and physical strain is considerable (for a review see: Eugster & Vingerhoets, 1999). A treatment cycle takes about 6 weeks, in which women first inject themselves with hormones to stimulate follicle

growth. When follicles are sufficiently present, retrieval of oocytes takes place. Two days after fertilisation occurs, two embryos are replaced in the womb. A pregnancy test is performed two to three weeks after the embryo transfer. In the Netherlands, insurance companies pay for three treatment cycles. According to vulnerability models for the aetiology of clinical anxiety, a failed treatment cycle can be considered as a severe stressor able to trigger relatively high levels of anxiety in more vulnerable women.

This study was undertaken to investigate both the concurrent and prospective relationship between self report measures of personality characteristics, state anxiety and Stroop interference. The results of studies into the concurrent relationship between these self report measures and Stroop interference revealed equivocal results, partly due to differences in characteristics of the samples of the studies. In the present study, we explored this relationship in a non-clinical sample of women entering fertility treatment.

Theories on the processing of threatening information assume that preattentive and attentional biases towards threat is a determinant of enhanced vulnerability to develop an anxiety response as a result of a stressor (Mogg & Bradley, 1998; Williams et al., 1996). Empirical evidence has indicated that attentional biases towards threat in non-clinical samples, seem to be cognitively overridden (MacLeod & Ruthenford, 1992), but there appears to be evidence for preattentive biases towards stress as vulnerability factors in non-clinical groups (MacLeod & Hagan, 1992; Pury, 2002; Van den Hout et al., 1995). Accordingly, in the non-clinical sample of women with fertility problems, we expected a positive relationship between preattentive biases towards threat and change in anxiety after a failed treatment.

2. Method

2.1. Subjects

The sample consisted of a total of 49 women who entered the IVF programme at the University Medical Centre St. Radboud from January 1999 to June 2000 and did not get pregnant after their first treatment cycle. Three to seven days before the start of treatment, these women completed questionnaires (T1). In the same period, an emotional Stroop task was administered. Four weeks after the pregnancy test, a second set of questionnaires was administered (T2).

2.2. Materials

2.2.1. Self-report measures

Neuroticism was assessed with the Dutch version of the Eysenck Personality Questionnaire (Sanderman, Arrindell, Ranchor, Eysenck, & Eysenck, 1995). State and trait anxiety were measured using the Spielberger state and trait anxiety questionnaire (STAI, Spielberger, 1983; Dutch translation: Van der Ploeg, 2000). As a control factor, depression was measured with the Dutch version of the BDI (Beck, Ward, Mendelson, Mack, & Erlaugh, 1961; Bouman, Luteijn, Albersnagel, & Van der Ploeg, 1985). The state anxiety and depression questionnaires were repeated four weeks after the pregnancy test was administered in the first treatment cycle, at T2.

2.2.2. Stroop: equipment and procedure

We used a PC with a Pentium Processor motherboard and a high-resolution Trinitron colour monitor (Sony, multiscan 15 inch). One button was linked to the computer in order to enable the researchers to score incorrect responses. The test was administered in a room devoid of daylight, with a single light source located behind the monitor. Light intensity was constant throughout the sessions. Reaction time was recorded with a microphone placed 5 cm in front of patients' mouths.

We administered a single trial format of the Stroop, consisting of fifteen neutral words, fifteen general threat words (e.g. blood, torture, pain) and six threat words related to infertility, presented in three colours: blue, red and green. We used the same set of neutral and general threat words as Van den Hout et al. (1995). The threat words were related to physical and social threat (e.g. war, torture, lie, despair, accident, death). The selection of infertility-related threat words was based on a word valence study performed with 30 IVF or ICSI patients and 12 controls. The women in the control group were the same age as the IVF and ICSI women. Narratives on infertility problems were used to select 35 words of possible valence for women with fertility problems. These words were presented on paper with two 5-point Likert scales for each word. On the first scale, women could indicate the positive value of the various words, on the other they could indicate the negative value of the words. The following six words in English (followed by the Dutch translation between brackets) that scored highest on negative valence after subtracting the positive valence were selected for the use in the Stroop experiment: 'infertile' [onvruchtbaar], 'miscarriage' [miskraam], 'childless' [kinderloos], 'bleeding' [bloeding], 'bellyache' [buikpijn], and 'period' [ongesteld].

The general threat words and the neutral words were matched in terms of the same number of syllables and lexical frequency. The specific threat words could not be matched in terms of the number of syllables because there were no specific threat words available with one or four syllables. The mean number of syllables in the general threat and neutral words was 2.1 and in the specific threat words 2.5. Subliminal and supraliminal exposure conditions were employed. First, the words were presented subliminally for 12 ms. After 12 ms, a mask appeared in the same place where the word had appeared. The scale and colours of the mask were the same as those of the word. Seven seconds before presentation of the word with or without mask, a white dot was presented where the word was to appear. After the subliminal trials ($N = 108$), the supraliminal version was administered, also with a random sequence of words and colours. The supraliminal Stroop task was administered in a consecutive sample of 49 women who had already participated in a subliminal Stroop task. Accordingly, one Stroop session consisted of 108 trials presented subliminally and 108 trials presented supraliminally. Subliminality was checked by a lexical decision task administered after the experimental trials. Performance was chance (differences in amount of false responses to real versus nonsense words: $t(48) = 0.18$; $P = 0.86$).

To avoid priming effects of words presented supraliminally, the subliminal trials were presented before the supraliminal trials (see also Fox, 1996).

2.3. General procedure

The Stroop task was administered in hospital at the department of Medical Psychology. Women were asked to participate in a reaction-time experiment as part of a study on the

emotional aspects of IVF or ICSI treatment. They sat in front of the computer screen and were instructed to say the colour of the material presented as quickly as possible into the microphone in front of them. Before the start of the first trial, ten practice trials were administered to instruct the patients on how loudly to say the colour of the presentation appearing on the screen. After administration of the Stroop task, the women were asked to complete the questionnaire on neuroticism, trait and state anxiety and depression. Four weeks after the pregnancy test, they received a second questionnaire in the post at home. They were asked to complete the questionnaire and return it within two weeks in the enclosed, prepaid envelope.

2.4. Statistical analyses

To investigate interference differences between threat and neutral words, difference scores were calculated by subtracting reaction time on neutral words from reaction time on threat words (in conformity with Van den Hout et al., 1995). This revealed two measures for subliminal threat interference indices and two for supraliminal threat interference: the subliminal general threat interference index (GTII-sub) is reaction time on neutral words subtracted from reaction time on general threat words in the subliminal presentation mode. The subliminal specific threat interference index (STII-sub) is reaction time on neutral words subtracted from reaction time on fertility-related threat words in the subliminal presentation mode. The same applies to the supraliminal presentation mode (GTII-sup and STII-sup). A positive value on these threat interference indices means a slower reaction time on threat words, compared with neutral words.

Trials with an incorrect answer were omitted from analysis, just as trials with a reaction time more than three S.D.s above or below mean reaction time.

Student's *t*-tests were used to measure differences in reaction time on the different word types and presentation modes (subliminal and supraliminal).

ANOVAs were performed in order to control for the effects of differences in word length between the three word types.

Pearson's correlation coefficients were determined in order to examine the concurrent relationship of neuroticism, trait anxiety and Stroop interference factors to state anxiety. These correlational analyses were repeated after controlling for depression at baseline in order to control for the confounding effect of depression (Mogg, Bradley, Williams, & Mathews, 1993).

To investigate the predictive value of the Stroop threat interference indices, sequential regression analyses were carried out, with state anxiety after the failed treatment as dependent variable. Baseline measures of state anxiety were entered in the first step, neuroticism and trait anxiety in the second step, and subliminal Stroop interference indices in the third step. Standardised Beta coefficients for all variables in the model were calculated to allow comparison of the relative importance of variables entered. Additional regression analyses were carried out in a subsample of women showing an increase in state anxiety between T1 and T2 (residual gain score ⩾ 0). These regression analyses were performed in the same way as those in the total sample.

To investigate the interaction between neuroticism and both subliminal Stroop interference factors, interaction terms were determined by multiplying the *z*-scores of neuroticism by the *z*-scores of the interference indices.

3. Results

The mean age of women was 33.5 (S.D. 4.1). At pre-treatment (T1), the mean score was 36.8 (S.D. 7.7) for trait anxiety (STAI), 36.5 (S.D. 8.9) for state anxiety (STAI), 5.7 (S.D. 4.3) for depression (BDI), and 4.4 (S.D. 2.9) for neuroticism.

There was a significant increase in state anxiety from pre-treatment to post-treatment measurements [$t(48) = -2.09$; $P = 0.04$]. Depression too, increased significantly after the first treatment cycle failed [$t(48) = -2.70$; $P = 0.01$].[1]

Table 1 gives the mean reaction times on the three word types in the subliminal and supraliminal condition. t-Tests on mean differences did not reveal any significant subliminal differences between either general [$t(48) = -0.18$; $P = 0.86$] and infertility-related [$t(48) = 0.10$; $P = 0.92$] threat words, and neutral words. In addition, no differences in interference were found between supraliminal general threat words and neutral words [$t(48) = 0.66$; $P = .52$]. However, there was a significant difference in supraliminal Stroop interference on infertility-related words and neutral words [$t(48) = -2.13$; $P = 0.04$].

3.1. Concurrent relationship to state anxiety

To investigate the relationship of neuroticism and preattentive and attentional biases towards threat to state anxiety prior to IVF or ICSI treatment, Pearson's correlation coefficients between these factors were calculated. These correlations are provided in Table 2.

A significant relationship was found between both state anxiety and neuroticism, and trait anxiety. There were no significant relationships found between state anxiety and general subliminal Stroop interference indices and a trend of a relationship between state anxiety and infertility related subliminal Stroop interference indices. In addition, correlation analyses between state anxiety and supraliminal interference indices did not reveal any significant relationships.

To control for a possible suppressive effect of depression at baseline on the Stroop interference indices (Mogg, Kentish et al. 1993), partial correlations between trait and state anxiety and TII were calculated, controlling for depression at baseline. These partial correlations did not

Table 1
Reaction time to different word types, subliminal and supraliminal in ms ($N = 49$)

	Subliminal		Supraliminal	
	Mean	S.D.	Mean	S.D.
Reaction time to neutral words	628	100	672	114
Reaction time to general threat words	627	100	669	114
Reaction time infertility-related threat words	628	101	698	132

---

[1] To examine possible differences in reaction time between words with more or less syllables, an analysis of variance was carried out in a subgroup of 36 women with the number of syllables between factor and reaction time as dependent variable. The ANOVA did not reveal any difference in reaction time related to the number of syllables [(varying from one to four) $F(3.33) = 1.33$; $P = 0.28$]. In addition, no difference was found in reaction time between short words (six letters or less) or longer words [$t(35) = 0.73$; $P = 0.47$].

Table 2
Correlations between subliminal and supraliminal General Threat Interference Indices (GTII) and Infertility-related Threat Interference Indices (ITII), neuroticism, trait and state anxiety and depression prior to IVF or ICSI treatment and state anxiety and depression after the unsuccesful treatment ($N = 49$)

	Subl GTII	Subl ITII	Supr GTII	Supr ITII	Neuroticism	Trait anx.	State anx. T1	Depr. T1	State anx. T2
Subl ITII	0.37**								
Supr GTII	0.18	0.18							
Supr ITII	0.02	0.18	0.27*						
Neuroticism	−0.02	−0.08	0.04	0.04					
Trait anxiety	0.00	0.11	−0.18	0.14	0.44**				
State anx. T1	−0.15	0.25	−0.11	−0.14	0.19	0.29*			
Depression T1	0.06	0.02	−0.08	−0.06	0.34**	0.41**	0.35*		
State anx. T2	−0.22	0.26	−0.20	−0.04	0.54**	0.49**	0.45**	0.48**	
Depression T2	0.01	−0.02	0.02	0.06	0.36*	0.39**	0.11	0.65**	0.48**

  * $P < 0.05$.
 ** $P < 0.01$ (two tailed).

demonstrate any significant relationships between anxiety and interference factors (coefficients ranged from −0.13 ($P = 0.22$) to 0.16 ($P = 0.12$). Accordingly, depression at baseline did not significantly confound the threat interference indices.

To explore whether the relationship between preattentive bias towards threat and state anxiety was dependent on levels of trait anxiety, a subsample of women was selected on the basis of their trait anxiety scores. The median split method was used as cut-off criterion. In the subgroup of women scoring above the median, additional correlations were calculated between Stroop interference and state anxiety. Again, these correlations were insignificant (GTII * state anxiety: $r = −0.13$; $P = 0.58$; ITII * state anxiety: $r = 0.19$; $P = 0.39$).

3.2. Prospective relationships to change in anxiety after the first failed treatment cycle

To identify the predictive value of both neuroticism and subliminal Stroop interference prior to treatment, regression analyses were carried out with neuroticism, trait anxiety and subliminal Stroop interference indices as predictors, and changes in state anxiety after the treatment failed as dependent variable. In the first step, baseline levels of state anxiety were entered, followed by neuroticism and trait anxiety in the second step and both subliminal threat interference indices in the third step. The results of the regression analyses are provided in Table 3.

After controlling for baseline levels of state anxiety, the analyses revealed that neuroticism significantly predicted a change in state anxiety ($\beta = 0.41$; $P = 0.001$), followed by subliminal interference on infertility-related threat words ($\beta = 0.26$; $P = 0.03$). Trait anxiety and subliminal general threat interference did not explain additional variance. So higher levels of neuroticism, together with more interference on subliminally presented infertility-related threat words, predicted greater increase in state anxiety after the first treatment failed. However, it has to be noted that, in addition to neuroticism and trait anxiety, the relative contribution of subliminal threat interference to the change in state anxiety tended towards significance ($P = 0.06$). To investigate the possible effect of the interaction between neuroticism and both Stroop interference factors,

Table 3
Regression analyses predicting change in anxiety after the treatment failed ($N = 49$); P values between parentheses

	β	t	Delta R^2
Pre-treatment anxiety	0.32	2.89 (0.01)	0.27 (0.00)
Neuroticism	0.41	3.63 (0.00)	0.24 (0.00)
Trait anxiety	0.20	1.73 (0.10)	
Subliminal interference			0.06 (0.06)
General threat words	−0.19	−1.74 (0.09)	
Fertility-related words	0.26	2.31 (0.03)	

two interaction terms were added into the fourth step of the regression analyses. This did not reveal any significant results.

The same regression analyses were performed using the two supraliminal Stroop interference indices as predictors, in addition to neuroticism, trait and state anxiety. These analyses did not reveal any significant results (delta R^2 of supraliminal Stroop interference indices = 0.01; $P = 0.81$).

Theories that propose a relationship between preattentive biases towards threat and the emotional response to a stressor, assume that these biases make them more vulnerable to developing higher levels of anxiety when under stress (Mogg & Bradley, 1998; Williams et al., 1996). This means that the occurrence of a stressor is a condition for making this vulnerability obvious. Accordingly, it is possible that the results could be more pronounced in a sample of women who show an increase in anxiety from pre treatment to post treatment assessments.

That is why additional regression analyses were conducted in a subgroup of patients who showed an increase of anxiety between pre-treatment and post-treatment assessments ($N = 25$). The cut-off score was based on the residual gain scores of regression of pre-treatment anxiety on post-treatment anxiety (residual gain score ⩾ 0). Table 4 shows that neuroticism (β = 0.39; $P = 0.03$) and interference on subliminally presented fertility-related words (β = 0.41; $P = 0.05$) at pre-treatment assessments were predictors of higher levels of anxiety after the first treatment, after controlling for pre-treatment levels of anxiety. The reduced explained variance of neuroticism in the subsample is due to the reduction of variance in change in anxiety in this sample (correlation between neuroticism and change in anxiety $r = 0.52$). As in the total sample, trait anxiety and subliminal interference on general threat words did not explain additional variance in state anxiety.

Table 4
Regression analyses predicting change in anxiety after the failed treatment failed (subgroup with high change in anxiety [$N = 25$]), P values between parentheses

	β	T	Delta R^2
Pre-treatment anxiety	0.49	3.04 (0.01)	0.34 (0.01)
Neuroticism	0.39	2.39 (0.03)	0.10 (0.25)
Trait anxiety	0.13	0.82 (0.43)	
Subliminal interference			0.21 (0.03)
General threat words	0.12	0.68 (0.51)	
Fertility-related words	0.41	2.16 (0.05)	

Higher levels of neuroticism and subliminal infertility-related Stroop interference at pre-treatment predicted greater increase in anxiety after failed treatment. The prediction was more pronounced in a subgroup of women who showed an increase of anxiety in response to the failed treatment. Interference on subliminally presented infertility-related threat words was the only Stroop factor that significantly predicted post-treatment anxiety.

4. Discussion

The first aim of the study was to explore the concurrent relationship of neuroticism, trait anxiety and preattentive and attentional biases towards threat to state anxiety in a non-clinical sample. As expected, we found support for the relationship between both neuroticism and trait anxiety to state anxiety. However, we could not identify a relationship between either supraliminal or subliminal interferences and state anxiety. We only identified a trend of a relationship between state anxiety and infertility related preattentive Stroop interference indices. The absence of a relationship between supraliminal attentional bias and state anxiety corresponded to results from other studies (Fox, 1996; MacLeod & Ruthenford, 1992; Mogg, Kentish et al. 1993). A relationship between subliminal Stroop interference and state anxiety, however, was found in some studies (MacLeod & Hagan, 1992; Van den Hout et al., 1995), while not in others (MacLeod & Ruthenford, 1992; Mogg, Kentish et al., 1993). It is possible that the different results were due to a lack of power of the present and previous studies.

Another explanation for the absence of a relationship between subliminal Stroop interference and state anxiety in the present study could be the possible suppressive effect of depression on interference on threat-related words (Mogg, Bradley et al., 1993). But correlational analyses, controlling for baseline levels of depression did not reveal significant results.

The moderate levels of trait and state anxiety in the sample could be another reason for lack of support for the hypothesis of a positive relationship between state anxiety and subliminal attentional bias towards threat. Additional analyses in a subgroup of women with high levels of trait anxiety did not reveal significant results.

A next explanation for lack of a relationship between preattentive and attentional biases and state anxiety might be the blocked design with respect to the presentation mode we used in our study. This design was employed to prevent temporary activation of the fear structure as a result of presentation of supraliminal words (see also Fox, 1996). The absence of this priming effect may explain the lack of significant relationships between preattentive biases towards threatening information and state anxiety in the present study.

The second aim of the study was to investigate the relationship between neuroticism, trait anxiety and a preattentive bias towards threat with a change in state anxiety after a failed IVF treatment. As expected, regression analyses revealed an additional explanation of variance in change of anxiety by subliminal Stroop interference, together with neuroticism. Trait anxiety did not, however, explain additional variance.

These results support theories that assume preattentive biases towards threat as vulnerability factors in the development of anxiety (Mogg & Bradley, 1998; Williams et al., 1996). Accordingly, they replicated results of empirical studies that showed a relationship between pre stressor preattentive biases towards threat and post stressor assessments of emotional states (MacLeod &

Hagan, 1992; Pury, 2002; Van den Hout et al., 1995). In the present study, the relationship between preattentive biases and *changes* in anxiety was firstly demonstrated. In addition, the present study controlled for levels of neuroticism and trait anxiety. Even after controlling for this negative affectivity on a strategic level, as indicated by self report measures of neuroticism and trait anxiety, preattentive biases towards threat explained additional variance. This result brought the question of the relationship between preattentive biases towards threat and neuroticism or trait anxiety. A positive relationship between these vulnerability factors would be expected but the results of the present study did not support this (see Table 2). It seems as if preattentive biases to threat and indications of negative affectivity as indicated in self report measures from personality questionnaires, are the results of different processes. Further research is needed to clarify the relationship between these different types of vulnerability factors in non-clinical samples.

A significant issue that we have not previously discussed is the predictive power of infertility-related threat words, compared with that of interference on general threat words. More subliminal bias towards infertility-related threat words predicted higher levels of anxiety as a result of the failed treatment, whereas a subliminal bias towards general threat words did not predict changes in anxiety. The subliminal bias towards infertility-related threat words might be an indication that infertility-related stimuli more easily triggered the fear structure than general threat stimuli. It seems as though the attention paid to stressor-related stimuli at the beginning of processing threatening information gave a better indication of vulnerability to a higher anxiety response to the failed treatment than attention paid to general threatening stimuli. Comparison with other studies cannot provide definite answers, because the studies that prospectively investigated the subliminal Stroop factors did not differentiate between general and stressor-related stimuli. While subliminal Stroop interference on infertility-related words predicts anxiety response to a failed IVF or ICSI treatment, the subliminal Stroop interference on general threat words might predict emotional responses to a more life-threatening stressor. Further research might clarify this.

How do the results of the present study contribute to vulnerability models for developing anxiety? It was clear from the outset that personality factors, such as measured by self-report inventories, have predictive value for the development of anxiety. In previous studies, preattentive and attentional biases towards threatening information were proved to be associated with clinical anxiety. Little was known, however, about the value of these biases in a vulnerability model for explaining the development of anxiety in a general, non-clinical population. Neither was it clear to what extent both kinds of factors (personality factors and preattentive and attentional biases) are interrelated in the development of anxiety. This study shows that both neuroticism and preattentive biases towards threatening information are vulnerability factors for the development of higher levels of anxiety as the result of a severe stressor in a non-clinical sample. Accordingly, the results underlined the importance of preattentive biases towards threat as an additional vulnerability factor in the development of anxiety.

Acknowledgements

References

Beck, A. T., & Clark, D. A. (1997). An information processing model of anxiety: automatic and strategic processes. *Behaviour Research and Therapy*, *35*, 49–58.

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erlaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry*, *4*, 561–565.

Bouman, T. K., Luteijn, F., Albersnagel, F. A., & Van der Ploeg, F. A. E. (1985). Enige ervaringen met de Beck Depression Inventory. (Some experiences with the Beck Depression Inventory). *Gedrag*, *13*, 13–24.

Clark, L. A., Watson, D., & Mineka, S. (1994). Temperament, personality, and the mood and anxiety disorder. *Journal of Abnormal Psychology*, *103*, 103–116.

Eugster, A., & Vingerhoets, A. J. J. M. (1999). Psychological aspects of in vitro fertilisation. *Social Science and Medicine*, *48*, 575–589.

Eysenck, H. J. (1970). *The structure of human personality*. New York: Methuen.

Eysenck, H. J. (1998). *Dimensions of personality*. New York: New Brunswick.

Eysenck, H. J., & Eysenck, S. B. G. (1975). *Manual of the Eysenck personality questionnaire*. San Diego: Educational and Industrial Testing Service.

Foa, E. B., & Kozak, M. J. (1986). Emotional processing of fear: exposure to corrective information. *Psychological Bulletin*, *99*, 20–35.

Fox, E. (1996). Selective processing of threatening words in anxiety: the role of awareness. *Cognition and Emotion*, *10*, 449–480.

Lundh, L. G., Wikstrom, J., Westerlund, J., & Ost, L. G. (1999). Preattentive bias for emotional information in panic disorder with agoraphobia. *Journal of Abnormal Psychology*, *108*, 222–232.

MacLeod, C., & Hagan, R. (1992). Individual differences in the selective processing of threatening information, and emotional responses to a stressful life event. *Behaviour Research and Therapy*, *30*, 151–161.

MacLeod, C., & Ruthenford, E. M. (1992). Anxiety and the selective processing of emotional information: mediating roles of awareness, trait and state variables, and personal relevance of stimulus material. *Behaviour Research and Therapy*, *30*, 479–491.

Mathews, A., & MacLeod, C. (1994). Cognitive approaches to emotion. *Annual Review of Psychology*, *45*, 25–50.

Mogg, K., & Bradley, B. P. (1998). A cognitive-motivational analysis of anxiety. *Behaviour Research and Therapy*, *36*, 809–848.

Mogg, K., Bradley, B. P., Williams, R., & Mathews, A. (1993). Subliminal processing of emotional information in anxiety and depression. *Journal of Abnormal Psychology*, *102*, 304–311.

Mogg, K., Kentish, J., & Bradley, P. (1993). Effects of anxiety and awareness on colour-identification latencies for emotional words. *Behaviour Research and Therapy*, *31*, 559–567.

Pury, C. S. (2002). Information processing predictors of emotional response to stress. *Cognition and Emotion*, *16*, 667–683.

Sanderman, R., Arrindell, W. A., Ranchor, A. V., Eysenck, H. J., & Eysenck, S. B. G. (1995). *Eysenck Personality Questionnaire (EPQ)*. Groningen: Noordelijk Centrum voor Gezondheidsvraagstukken.

Spielberger, C. D. (1983). *Manual for the state-trait anxiety scale*. Palo Alto: Consulting Psychologists Press.

Van den Hout, M., Tenney, N., Huygens, K., Merckelbach, H., & Kindt, M. (1995). Responding to subliminal threat cues is related to trait anxiety and emotional vulnerability: a successful replication of MacLeod and Hagan (1992). *Behaviour Research and Therapy*, *33*, 451–454.

Van der Ploeg, H. M. (2000). *Handleiding bij de Zelfbeoordelingsvragenlijst: een Nederlandse bewerking van de Spielberger State Trait Anxiety Inventory [Manual to the Dutch version of the Spielberger State Trait Anxiety Inventory]*. Lisse: Swets Test Publishers.

Verhaak, C. M., Smeenk, J. M. J., Eugster, A., Van Minnen, A., Kremer, J. A. M., & Kraaimaat, F. W. (2001). Stress and marital satisfaction among women before and after their first cycle of in vitro fertilisation and intracytoplasmic sperm injection. *Fertility and Sterility*, *76*, 525–531.

Watson, D., & Clark, L. A. (1984). Negative affectivity: the disposition to experience aversive emotional states. *Psychological Bulletin*, *96*, 465–490.

Williams, J. M. G., Mathews, A., & MacLeod, C. (1996). The emotional Stroop Task and Psychopathology. *Psychological Bulletin*, *120*, 3–24.