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BRIEF REPORTS

Automatic Negative Evaluation of Suffocation Sensations in Individuals With Suffocation Fear

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The current study tested whether "suffocation sensations" (respiratory loads) are automatically evaluated in a negative way by people fearing these sensations. It was found that, after having been primed with a slight respiratory load, participants with high suffocation fear (n = 15) reacted more quickly to suffocation words and more slowly to positive words than participants with low suffocation fear (n = 21). However, the effect was present only in participants who had noticed the primes. The findings are relevant to the cognitive model of panic disorder because automatic negative appraisal of sensations may play a role in initiating a panic attack.

Keywords: affective priming, panic disorder, catastrophic misinterpretation, suffocation fear, cognitive model

In Clark's (1986) cognitive model of panic disorder, the misinterpretation of bodily sensations plays a central role. These misinterpretations may occur on a conscious level but, according to Clark (1988), may also be "so fast and automatic that patients may not always be aware of the interpretative process" (p. 76). This latter assumption is necessary to explain why not all panic attacks are preceded by conscious, catastrophic misinterpretations (e.g., Rachman, Lopatka, & Levitt, 1988); how nocturnal panic attacks may occur (e.g., McNally, 1994); and generally, why some panic attacks come "out of the blue." Furthermore, it suggests that strategies aimed at changing negative thoughts may be less effective when they fail to also tackle unconscious appraisals. The aim of the current study is to determine whether bodily sensations are indeed evaluated negatively and in a relatively automatic way by persons fearing these sensations.

Automatic stimulus evaluation has been demonstrated by a task known as the *affective priming task* (see Klauer & Musch, 2003, for an overview). In this paradigm, individuals are first presented with a prime and subsequently with a target to which they have to react. For instance, participants react by naming the valence of the target, by deciding whether the target is a word or a nonword, or by pronouncing the target. When the prime and the target are affectively congruent, participants typically react quicker than when the prime and the target are unrelated. Affective priming seems to work best with stimulus intervals between primes and targets (*stimulus onset asynchrony*; SOA) of 0 to 300 ms, indicating the automatic character of stimulus evaluation (Hermans, de Houwer, & Eelen, 2001). Affective priming has also been demonstrated using subliminally presented primes, which further supports its automatic character (Greenwald, Klinger, & Liu, 1989).

Schniering and Rapee (1997) investigated whether panic patients automatically associate words denoting bodily sensations with threat by using a primed lexical decision task. No differences were found between a panic group and a healthy control group. However, their study is problematic in that most of the prime words were quite negatively tinged (e.g., *dizzy*, *nausea*, *pain*), which may have caused the priming effect in the control participants. Furthermore, semantic priming might have occurred and overshadowed other effects. Another limitation of the study—which pertains to many studies in cognitive research into anxiety disorders—is the use of words as stimuli. Especially in the case of bodily sensations, it can seriously be questioned whether words are adequate stimuli. Unfortunately, most bodily sensations are not easily provoked in a controlled way, and those that are, for instance pain sensations, are not necessarily relevant for panic disorder patients. In the current study we wanted to resolve these problems by using respiratory loads as stimuli in an affective priming task. The "suffocation sensations" thereby provoked seem more relevant to patients with panic disorder.

In a first experiment with these sensations, it was investigated whether participants with high suffocation fear (SF) have a tendency to automatically evaluate these sensations in a threatening way. This evaluation was measured by using an affective priming task wherein suffocation sensations were presented as primes and threatening or positive words were presented as targets. To find out whether any effects of priming by the sensations should be attributed to the relationship with suffocation or to the affective value

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only, both words related to suffocation and words unrelated to suffocation were presented. The design was a 2 (high vs. low SF) × 2 (sensation vs. no sensation) × 3 (positive vs. negative related words vs. unrelated positive words) mixed factorial design with repeated measures (see also Method).

It was hypothesized that after having been primed with a respiratory load, high SF participants would evaluate the sensations more negatively and would therefore react more quickly to the threatening words than the low SF participants. Also, high SF participants were expected to react more slowly than the low SF participants to the positive words after priming.

Method

Participants

Approximately 400 first-year psychology students at Leiden University, Leiden, the Netherlands, filled out the Suffocation Fear Scale (SFS; Rachman & Taylor, 1993). Students who scored above 16 were invited to participate in the experiment. This score was used as a cutoff because it is one standard deviation above the mean score of nonclaustrophobic participants ($M = 9.1$) and one standard deviation below the mean score of claustrophobic participants ($M = 24.0$; Rachman & Taylor, 1993). Forty students fulfilled the criteria, and 21 agreed to participate. The other 19 declined for various reasons, such as fear of the experiment. Two of the participating students were men; 19 were women. In addition, 30 students who scored 4 or below on the SFS were randomly selected for the control group. Six students of the control group were men; 24 were women.

Apparatus

Participants wore a face mask, to which a pneumotachograph (Standard PT 36; Jaeger, Würzburg, Germany) was connected. A two-way nonrebreathing valve (Type 1410B; Hans Rudolph, Inc., Kansas City, MO) was attached to the pneumotachograph, separating inspiratory air from expiratory air. On the inspiratory side, a tube (diameter: 35 mm, length: 2,750 mm) was connected that ended in a manually operated valve. On one side of this valve a respiratory resistance was added. By turning the valve the experimenter could determine whether the inspiratory resistance was 0.5 cm H_2O/L/s (“no resistance”) or 1.6 cm H_2O/L/s (“resistance”). Because the experimenter was seated behind the participant, the participant could not see when the experimenter turned the valve. The experimenter was warned by a small light when the resistance had to be added. The warning light always switched on at the start of an exhalation to give the experimenter time to turn the valve.

Exhalations and inhalations were determined by specifically designed electronic equipment on the basis of the signal from the pneumotachograph. When an exhalation was detected, this was electronically fed into the computer on which the affective priming task was running. This information could then be used by the computer program (E-Prime, Version 1.0; Schneider, Eschman, & Zuccolotto, 2002). When a respiratory resistance was needed, the program waited until the start of an exhalation and then sent a signal that switched on the light. This light warned the experimenter to switch the valve to add the resistance. Details about the task are presented below. When the valve was switched, the participant would feel the respiratory load at the beginning of the next inspiration. This inspiration (again detected by electronic equipment) triggered the presentation of a word on the computer screen (see below). The electronic equipment was specifically designed and built for this project by the Department of Pulmonology at Leiden University Medical Center.

Questionnaires

The SFS is a 15-item questionnaire. On a 5-point scale ranging from 0 (*not at all*) to 4 (*extremely*), participants rate how anxious they would be in various situations. It contains items such as “standing in an elevator on the ground floor with the doors closed” and “using an oxygen mask.” The scale was translated into Dutch by Sabine Kroeze and translated back into English by a native English speaker to control for changes of meaning.

Also, a brief Anxiety and Panic Questionnaire (APQ; Van der Does, 1997) was administered. This questionnaire contains several questions about current and past panic attacks and panic-related bodily sensations experienced during the past 4 weeks. These sensations are rated on an 8-point scale, ranging from 0 ([having experienced these sensations] *not at all*) to 7 ([having experienced these sensations] *constantly*).

In addition, the Anxiety Sensitivity Inventory (ASI; Reiss, Peterson, Gursky, & McNally, 1986; Dutch translation by Arrindell & Albersnagel, 1987) was administered. This 16-item questionnaire measures the fear for anxiety-related symptoms. All questions are answered on a rating scale ranging from 0 (*not at all*) to 4 (*extremely*).

Affective Priming Task

Participants were presented with a respiratory resistance 30 times, each lasting one inhalation. The resistance was used as the prime in the affective priming task. Directly after each beginning of a loaded inhalation a target word was presented on a computer screen. The task of the participant was to determine as quickly as possible whether the word on the screen was positive or negative and indicate as such by pressing one of two buttons. There were three categories of words: negative words related to suffocation (e.g., *suffocating*, *asthmatic*, *strangle*), positive words related to suffocation (e.g., *airy*, *relief*, *freely*), and positive words not related to suffocation (e.g., *holiday*, *music*, *present*). Suffocation words were selected by searching in dictionaries for synonyms and antonyms of words such as *suffocating* and *strangle* and by free association. The positive words not related to suffocation were taken from a validated list of words from Hermans and de Houwer (1994). The words were matched for length as much as possible. However, because of the limited number of suffocation words, four of these were not matched optimally and differed between one and five letters in length. A small pilot test was carried out to establish whether the suffocation words had the right valence and a strong-enough relationship with suffocation. Five participants rated the valence of the words on a 5-point scale ranging from 0 (*very negatively*) to 4 (*very positively*) and rated the relevance to suffocation on a 3-point scale ranging from 0 (*not at all related*) to 2 (*very related*). While doing this they were breathing through a straw to better understand the feelings of someone with SF. Words that were rated in the wrong category by 1 or more persons were discarded.

Half of the words were presented after a prime (i.e., a loaded inspiration); the other half were unprimed. All categories contained 18 words, and all words were presented once in random sequence but such that half of the words of each category were presented with a prime and half without. Between two primes was always at least one inhalation without resistance. Because of this, the interstimulus interval was relatively long (around 5 s). The time between primes and stimuli (SOA) cannot be determined exactly because the computer calculated whether an inspiration had started on the basis of the data from the pneumotachograph before presenting a stimulus. It is not known exactly how long this took. Second, it is not known when exactly an inspiratory resistance is noticed by the participants. The literature states only that this is somewhere in the beginning of the inspiration (Narbed, Marcer, & Howell, 1982). Subjectively, the prime and the target word came almost simultaneously.

Procedure

Participants who were selected for the experiment were first contacted by phone. When they consented to participate, they made an individual appointment with the experimenter. On arriving they were told the following:

> This experiment is about the relationship between anxiety and bodily sensations. You will receive some questionnaires and a task in which you have to determine as quickly as possible whether words you see on the PC screen are positive or negative. During this task you will have to wear this face mask. You see that a tube is attached to this mask. At the end of this tube you see two openings. Sometimes when you are doing the task I will change the opening through which you are breathing. Then you may perceive a small resistance when breathing in. You will receive as much air as normal but it will be a little more difficult to inhale. The next inhalation will be normal again. Do you have any questions?

Next, participants signed the informed consent form and filled out the APQ and the ASI. Then they were seated before the computer and were equipped with the face mask. There were 20 practice trials. After the task, participants were questioned about what they thought about the experiment, how anxious they had been before and during the experiment, and whether they had noticed the inspiratory resistances. Answers were given on 4-point rating scales. Agreeableness was rated from 0 (*extremely disagreeable*) to 3 (*extremely agreeable*). Anxiety was rated from 0 (*not at all*) to 3 (*extremely*).

Results

Questionnaire Data

The mean scores on age, the SFS, the ASI, and the rating scales are shown in Table 1. The groups did not differ in age, $t(49) = 0.34$, *ns*, but they did differ on the SFS, $t(49) = 18.04$, $p < .001$, and the ASI, $t(49) = 5.07$, $p < .001$. Also, the participants in the high SF group found the experiment less agreeable than the control group, $t(49) = 2.67$, $p < .01$; were more anxious when noticing the resistances, $t(34) = 4.10$, $p < .001$; and were more anxious during the experiment, $t(49) = 3.59$, $p = .001$. Furthermore, 6 (out of 21) participants of the experimental group and 10 (out of 30) of the control group reported that they had not noticed the resistances. This difference was not significant, $\chi^2(1, N = 51) = 0.75$. The fact that almost one third of the participants failed to notice any of the 30 resistances illustrates how short and subtle the intervention was (just above perception threshold for the majority of participants). This was as intended, because automatic negative evaluations are thought to act on and exacerbate mild, hardly detectable sensations. However, it is not certain whether priming effects can be expected when the resistances are below the perception threshold. Although priming effects have been found with subliminally presented words (Greenwald et al., 1989), this does not necessarily apply to the current stimuli. We therefore decided to conduct all analyses with the affective priming task twice: with and without the participants who failed to notice the resistances.

The APQ results showed that in the high SF group, 11 (out of 21) participants had experienced at least one panic attack or a limited symptom attack during the past 4 weeks. In the control group, 1 (out of 30) participant had experienced a limited symptom attack. This difference was significant, $\chi^2(1, N = 51) = 16.51$, $p < .001$. In the high SF group, 18 (out of 21) participants had experienced at least one panic attack or a limited symptom attack in their lifetime. In the low SF group, 8 (out of 29) participants had experienced such an attack. This difference was also significant, $\chi^2(1, N = 50) = 16.49$, $p < .001$.

Affective Priming Task

Reaction times shorter than 100 ms or longer than 1,600 ms were excluded from analysis. Incorrect responses were also excluded. Skewness and kurtosis of the reaction time variables were checked. Skewness and kurtosis of all the variables were below 1. None of the variables had a skewness of more than 2 times its standard error, and none had a kurtosis of more than 2 times its standard error.

To determine whether the groups showed different priming effects when presented with the inspiratory resistances, we performed a 2 × 2 × 3 (Group × Prime × Word Category) general linear model multivariate analysis of variance (MANOVA) with repeated measures. The MANOVA showed no effect of group or prime (Fs < 1), a significant effect of word category, $F(1, 50) = 120.33$, $p < .001$, but no significant interaction effect of Group × Prime × Word Category, $F(1, 50) = 1.12$. The nonsignificant interaction effect indicates that the groups were not differentially primed. However, with only the participants who reported that they had noticed the inspiratory resistances, the MANOVA showed no effect of group or prime (Fs < 1) but a significant

Table 1
Descriptive Characteristics of Participants With High and Low Suffocation Fear (SF)

Characteristic	High SF *M*	High SF *SD*	High SF %	Low SF *M*	Low SF *SD*	Low SF %	*t*	*df*
Age (years)	22.70	10.00		21.90	5.40		0.34	49
Suffocation Fear Scale	20.90	4.50		2.30	1.50		18.04***	49
Anxiety Sensitivity Inventory	16.40	7.40		7.80	4.70		5.07***	49
Agreeableness of experiment	1.62	0.97		2.30	0.84		2.67*	49
Anxiety								
During resistances	1.27	0.80		0.38	0.50		4.10***	34
Before experiment	0.29	0.46		0.10	0.31		1.73	49
During experiment	0.71	0.56		0.20	0.41		3.59**	50
Panic attack in past 4 weeks			14			0		
Limited symptom attack			38			3		
Panic attack in lifetime			67			19		
Panic symptom score	18.60	6.80		13.30	3.50		3.26*	49

* $p < .01$. ** $p = .001$. *** $p < .001$.

effect of word category, $F(1, 33) = 78.87$, $p < .001$, and a significant interaction effect of Group × Prime × Word Category, $F(1, 33) = 3.92$, $p < .05$. To find out to which word category this effect was due, a 2 × 2 × 2 MANOVA (Group × Prime × Word Category) was carried out with only the words related to suffocation. The interaction effect was again significant, $F(1, 33) = 7.29$, $p = .01$. The partial η^2 of this effect was .18; thus, 18% of the total variance can be attributed to the interaction of Group × Prime × Word Category. Figure 1 illustrates that after a respiratory resistance the high SF participants reacted quicker to the negative suffocation words and slower to the positive suffocation words. We found the opposite effect for the control group.

To investigate whether the relatedness to suffocation was important, we performed a 2 × 2 × 2 (Group × Prime × Word Category) MANOVA, this time with the negative suffocation words and the positive words unrelated to suffocation. This MANOVA did not show an interaction effect ($F < 1$). The priming effect was only apparent in the words related to suffocation.

Because of the small sample size we checked whether a few outliers might have had excessive influence on the results. Two participants could be identified as outliers (i.e., persons who were more than 1.5 times the interquartile range remote from the first or the third quartile). However, removal of these data from the analyses did not alter any of the results.

Discussion

This is the first study in which the automatic evaluation of fear-relevant bodily sensations was investigated. Results show that participants with high SF indeed react differently to the respiratory resistances than do control participants: After having been primed with such a sensation, the high SF participants had shorter reaction times to negative suffocation words and longer reaction times to positive words. The reverse effect was found with the control participants. These findings clearly support the hypothesis that suffocation sensations are evaluated automatically in a negative way by individuals fearing these sensations.

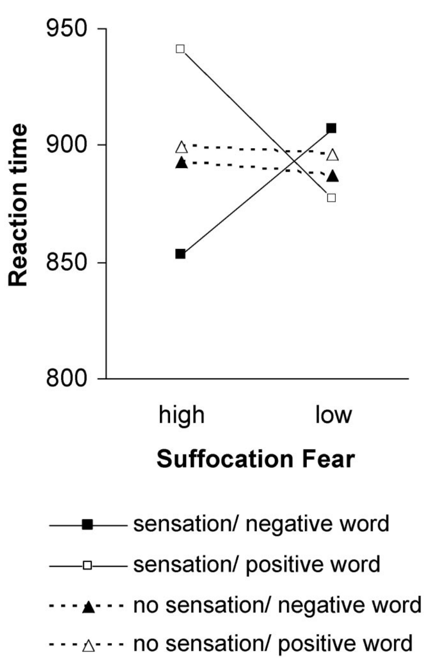

Figure 1. Mean reaction times (in milliseconds) on positive and negative words while participants were primed with a respiratory resistance (sensation) or without a respiratory resistance (no sensation). Only those participants who reported to have noticed the primes are included ($N = 35$).

It is important that a clear priming effect was found while using real bodily sensations as primes because experimental studies in anxiety disorders rely heavily on paradigms using words or pictures as threatening stimuli. Until now it has not been established whether words are adequate substitutes for the sensations that anxiety patients are believed to process differently. Bodily sensations, especially, seem widely different from words that describe these sensations. Moreover, some of these words imply an interpretation (e.g., *suffocating*) and are not as neutral as the stimuli they represent (e.g., the feeling of a slight bronchoconstriction).

Note that the priming effect was found only in participants who reported to have noticed the resistances. This may have been due to the fact that the added resistance was small and below the perception threshold of these participants. Indeed, Dahme, Richter, and Mass (1996) reported that great individual differences exist with regard to the perception of respiratory loads. It may be argued that resistances below the perception threshold could be regarded as subliminal primes. However, the only way to determine that they can be regarded as such would be if there were an effect on the reaction times. Given that this effect was not found, the most conservative conclusion is that the respiratory loads were too far below the perception threshold to act as subliminal primes.

Alternatively, the participants who reported not to have felt the sensations might have had a different processing strategy. For instance, they might have inhibited the processing of the sensations, and this may also have influenced the processing of related words. Although the short SOA in the priming paradigm prevents conscious manipulations, corrective effects seem sometimes possible. Indeed, because accuracy instructions have been found to induce reversed priming effects (Wentura & Rothermund, 2003), it is possible that participants who succeeded in avoiding noticing the prime were in fact more focused on the task and therefore might have succeeded in reducing or even reversing the priming effect.

Is it possible, then, that the priming effect is less automatic than it seems? As is clear from the study by Wentura and Rothermund (2003), priming effects are not inherently present in every situation. However, the effect may still be unconscious even when (healthy) persons succeed in overcoming the effect. A study by Hermans et al. (2001) shows that when persons get enough time to evaluate the prime consciously, the priming effect disappears. Therefore, it seems unlikely that the effect can be attributed to conscious evaluation of the primes.

It is remarkable that the priming effect was found only for words that were semantically associated with the primes and not for the unrelated words. As Hermans, Smeesters, de Houwer, and Eelen (2002) have shown, affective priming is also possible with targets that are semantically unrelated to the primes. Could it be that instead of affective priming, the current effect is one of semantic priming? Then it would be inexplicable that the positive and negative words rendered opposite effects in our experiment. Our finding of this can only be explained by the priming effect being due to the affective difference of the words. A more plausible explanation for not finding differential priming effects in the unrelated words might be that these words have been categorized more quickly than the related words, probably because these words were more familiar. Indeed, Hermans et al. (2002) also have found that when reaction times become very quick, priming effects disappear.

It should be noted that priming effects found with an affective classification task such as that used in the current experiment are not always found with tasks in which other types of classifications have to be made, for instance with a word–nonword classification task (Hermans et al., 2001). It may therefore be that evaluation of bodily sensations is dependent on the participants' being primed to make evaluative judgments. A word–nonword classification task would have been a better alternative to rule this out. In the current study, however, the classification task was chosen because the word–nonword classification task requires twice as many trials. This not only would be more burdensome for the participants, but they might also habituate to the priming stimulus.

It seems an important finding that bodily sensations are automatically evaluated in a negative way by participants fearing these sensations. This suggests that slight bodily sensations may also be evaluated automatically by persons with panic disorder. Consequently, a panic attack may be initiated before a person is aware of any sensations or evaluations. This suggests that therapies need tools that also tackle unconscious appraisals of feared stimuli. For instance, participants may be taught to appraise sensations more positively by coupling them with positive stimuli. Automatic evaluations may also be important in other anxiety disorders. Beck and Clark (1997) suggested that patients with anxiety disorders assign threat meanings to innocuous stimuli. This assignment may already occur in the early stages of information processing, when valence and personal relevance of incoming stimuli are quickly assessed to determine whether one should pay attention to the stimulus. Similarly, Mogg and Bradley (1998) suggested a crucial role for a valence evaluation system that is responsible for assessing the threat value of stimuli. Mogg and Bradley also proposed that the outcome of this evaluation determines whether attention is shifted toward the stimulus. The current study suggests that the priming paradigm might be a valuable tool for studying such an evaluation system.

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