SAFETY BEHAVIORS AND THE PERSISTENCE OF IRRATIONAL FEARS

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Safety behaviors and the persistence of irrational fears

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INTRODUCTION

INTRODUCTION

We take precautions against feared outcomes on a daily basis. Examples are wearing a seatbelt to increase our chance of surviving a potential accident or thoroughly cleaning our hands after preparing chicken to prevent salmonella poisoning. Such protective actions aimed at preventing or minimizing feared catastrophes are called safety behaviors. They are logical and predominantly functional responses to perceived threats. In the absence of actual threat, however, safety behaviors are nonfunctional. Superstitions, such as knocking on wood and not walking under ladders to ward off bad luck, are common nonfunctional safety behaviors. They are generally not problematic, because superstitious behaviors are often of little or no cost to the individual (i.e., they take little time and energy to perform). However, when safety behaviors are performed in response to the excessive threat beliefs that are hallmark to pathological anxiety, they are considered ubiquitously deleterious and dysfunctional. Examples are always carrying safety aids, such as a mobile phone, when leaving the house in panic disorder, and avoiding eye contact in social anxiety disorder.

Safety behaviors are considered to play a role in the persistence of irrational fears, because they can prevent patients from learning that the catastrophe they expect does not occur. For example, a patient with panic disorder may not experience that he will not die of a heart attack when he leaves the house without a mobile phone, and a patient with social anxiety disorder may not learn that others will not reject her if she looks them in the eyes. Clinical guidelines (e.g., Abramowitz, Deacon, & Whiteside, 2011; Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014; Keijsers, van Minnen, & Hoogduin, 2011) therefore recommend eliminating all safety behaviors during the treatment of pathological anxiety. However, the notion that safety behaviors are always detrimental to the beneficial effects of psychological therapy was challenged by Rachman, Radomsky, and Shafran (2008). They proposed a reconsideration of the categorical rejection of safety behaviors during treatment, and suggested that safety behaviors may be used judiciously (i.e., carefully) in exposure-based therapy. This triggered a discussion about the role of safety behaviors in the persistence of pathological anxiety, and encouraged new research on the effects of safety behavior during exposure therapy (for an overview, see Blakey & Abramowitz, 2016; and Meulders, Van Daele, Volders, & Vlaeyen, 2016).

In light of this discussion, the current dissertation applied an experimental psychopathology approach to investigate the role of safety behaviors in the persistence of irrational fears. In this introductory chapter, we first provide more background information about safety behavior, and its relationship to pathological anxiety. Next, we explain the theoretical and empirical justifications for the elimination of safety behavior during treatment, and discuss the controversial thesis of the incorporation of safety behavior in exposure therapy. Furthermore, we review the causal effect of safety behavior on anxiety and danger perceptions, and explore the potentially beneficial effects of approach-enhancing safety behaviors on treatment outcomes. We conclude this introduction with a description of the aims and outline of this dissertation.

SAFETY BEHAVIOR

Safety behaviors are overt (observable) and covert (unobservable) actions aimed at preventing, escaping, minimizing, or neutralizing a feared outcome (Blakey & Abramowitz, 2016; Deacon & Maack, 2008; Gangemi, Mancini, & van den Hout, 2012; Salkovskis, 1991). Safety behaviors consist of behavioral and cognitive strategies (Helbig-Lang & Petermann, 2010; McManus, Sacadura, Clark, 2008) that are functionally related to the expected threat (Salkovkis, Clark, & Gelder, 1996). They are often adaptive, inherently normal, and foster survival and well-being in the presence of actual threat (Deacon & Maack, 2008). In relatively safe situations, however, they are unnecessary and are considered to be maladaptive (Helbig-Lang &

Petermann, 2010). The scope of safety behavior encompasses full avoidance of feared situations (Salkovskis, 1991), and subtle behavioral tricks or aids that are carried out within a specific situation (Rachman et al., 2008; Meulders et al., 2016). Although the definition of safety behavior was originally limited to actions intended to avoid an expected *catastrophe* (i.e., safety-seeking behavior; Salkovskis, 1991), more recent reviews of the literature also include actions aimed at preventing, escaping, or reducing *distress* that is associated with the perceived threat in the definition of safety behavior (Blakey & Abramowitz, 2016; Goetz, Davine, Siwiec, & Lee, 2016; Helbig-Lang & Petermann, 2010; Telch & Lancaster, 2012).

PATHOLOGICAL ANXIETY

Safety behaviors are common in anxiety-related psychopathology, such as anxiety disorders, obsessive-compulsive disorder (OCD), posttraumatic stress disorder (PTSD), and illness anxiety disorder (Blakey & Abramowitz, 2016). Although PTSD, OCD, and illness anxiety disorder are not classified as anxiety disorders in the current edition of the Diagnostics and Statistical Manual of Mental Disorders (i.e., the DSM-5; American Psychiatric Association, 2013), there appears to be quite some overlap between these disorders and anxiety disorders (Deacon & Abramowitz, 2008; McManus, Shafran, & Cooper, 2010). Additionally, despite the distinct characteristics of the safety behaviors associated with these disorders, the role that safety behaviors may play in the persistence of these disorders is expected to be functionally equivalent (Blakey & Abramowitz, 2016; Rachman 2002; Telch & Lancaster, 2012).

Anxiety disorders are characterized by debilitating fears that are irrational and cause substantial suffering and/or substantial impairment (American Psychiatric Association, 2014). They are the most prevalent disorders in mental health care, with an estimated lifetime prevalence of 30% and a 12-month prevalence of 18% in the USA and 19% in the Netherlands (De Graaf, ten Have, & van Dorsselaer, 2010;

Merikangas et al., 2010; Kessler, Berglund, et al., 2005; Kessler, Chiu, Demler, & Walters, 2005). Pathological anxiety substantially reduces the quality of life (Olatunji, Cisler, & Tolin, 2007), and often follows a chronic course when left untreated (Penninx et al., 2011). Individuals with anxiety-related psychopathology expect that innocuous stimuli (e.g., situations, objects, or thoughts) will be followed by a catastrophe. For example, a patient with panic disorder may fear that dizziness will result in fainting, and a patient with OCD may expect that touching doorknobs will cause infection and illness. Patients commonly use safety behaviors in response to these perceived threats. The patient with panic disorder may quickly sit down when he feels dizzy to avoid passing out, and the patient with OCD may excessively clean her hands to counteract the expected infection. Safety behaviors are thus a transdiagnostic feature of anxiety-related psychopathology.

EXPOSURE THERAPY

Cognitive-behavioral therapy (CBT), in particular, exposure-based therapy, is the treatment of first choice for anxiety disorders, OCD, PTSD, and illness anxiety disorder (Hofmann, Asnaani, Vonk, Sawyer, & Fang, 2012; Van Balkom et al., 2013). During exposure therapy, patients are repeatedly exposed to the feared, but innocuous stimulus (e.g., dizziness or doorknobs) to learn that the catastrophe that they expect (e.g., fainting or illness) does not follow or is less severe than expected, which typically decreases their fear response. Exposure therapy originated from the application of basic learning theory principles to the treatment of fear (Rachman, 2009), and can be understood in terms of Pavlovian fear conditioning. In fear conditioning terms, the feared, but innocuous stimulus is a conditional stimulus (CS), and the expected threat is an unconditional stimulus (US). The CS elicits a fear response (conditional response or CR), because it activates the representation of the US. In our previous example, the internal sensation of dizziness (CS) evokes fear

(CR), because the patient with panic disorder expects that this predicts fainting (US). Similarly, touching a doorknob (CS) evokes distress (CR) in the patient with OCD, because it activates the representation of infection and illness (US). Exposure therapy derives its positive effects from extinction, which is the decrease in fear response (i.e., CR) to the CS, due to repeated presentations of the CS without the occurrence of the associated US (Vervliet, Craske, & Hermans, 2013). Much evidence suggests that extinction does not entail unlearning of the CS – US association, but involves new learning of an inhibitory association between the CS and the US (i.e., a CS - no US association; Bouton, 2002, 2004, 2016; Craske et al., 2014). After extinction, this inhibitory association exists alongside the original excitatory association (Bouton, 2002, 2004, 2016), see Figure 1.

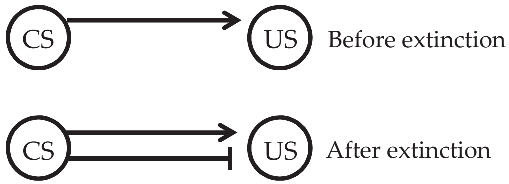

Figure 1. Graphical depiction of the inhibitory learning model of extinction (Vervliet et al., 2013). The circle with CS indicates the conditional stimulus and the circle with US the unconditional stimulus. The arrow indicates an excitatory association, and the line with a bar at the end an inhibitory association. Before extinction, there is an excitatory CS – US association (top panel). The CS thus evokes fear. After extinction, there is an excitatory CS – US association *and* an inhibitory CS – no US association (bottom panel). When the inhibitory association is active, the CS does not evoke fear.

SAFETY BEHAVIOR AND THE MAINTENANCE OF PATHOLOGICAL ANXIETY

Clinical guidelines generally recommend to motivate patients to inhibit all safety behaviors during exposure therapy (e.g., Abramowitz, Deacon, & Whiteside, 2011; Craske et al., 2014; Keijsers, van Minnen, & Hoogduin, 2011). The theoretical justification for this guideline is that safety behaviors impede extinction. Salkovskis (1991) proposed that anxious individuals misattribute the nonoccurrence of the expected catastrophe to the safety behavior, which leaves the core threat belief unaffected (the 'misattribution of safety' hypothesis). For example, the patient with panic disorder may believe that he did not faint *because* he quickly sat down, and the patient with OCD may attribute the absence of illness to her careful hand washing.

In addition to the misattribution of safety to the behavior, safety behavior prevents the occurrence of disconfirming learning experiences. By sitting down, the patient with panic disorder never experiences that he would not have fainted if he had remained standing, and washing her hands precludes the patient with OCD from learning that touching doorknobs without subsequent handwashing does not result in infection and illness either. Safety behavior prevents the disconfirmation of the CS – US association, and thus prevents inhibitory learning. As a result, the innocuous stimulus or situation (i.e., the CS) retains its subjective threat value. In other words, dizziness and doorknobs remain fearful to the patient with panic disorder and OCD, respectively. Finally, the extent to which inhibitory learning occurs depends on the discrepancy between the expected outcome (i.e., the feared catastrophe) and the actual outcome (i.e., the nonoccurrence of this catastrophe; Bouton, 2004). Hence, a larger violation of negative expectancies results in more inhibitory learning (Baker et al., 2010). When safety behavior reduces the perceived likelihood or severity of the expected catastrophe, it decreases this discrepancy, and thus hampers inhibitory learning (Blakey & Abramowitz, 2016; Craske et al., 2014).

There are numerous experimental studies that examine the effects of safety behaviors on exposure outcomes. The typical set-up of these studies is that highly fearful individuals receive an exposure treatment either with or without safety behaviors. For example, Powers, Smits, and Telch (2004) asked students with claustrophobic fear to remain in a small chamber. One group had to use safety behaviors, such as opening a small window to allow access to fresh air. A second group had the availability of these safety behaviors, and a third group was not provided any safety behaviors. Exposure with the use of safety behaviors and exposure with safety behavior availability resulted in smaller reductions of claustrophobic fear than exposure without safety behaviors (Powers et al., 2004). Another example is a study by Milosevic and Radomsky (2013a), in which individuals with spider phobia were encouraged to approach a live spider. Half of them could use safety behavior in the form of protective gear, such as gloves, goggles, and a protective apron, and the other half could not. In this study, exposure with and without the use of these safety behaviors resulted in comparable reductions of a fear of spiders (Milosevic & Radomsky, 2013a).

Overall, the empirical evidence to justify the guideline to drop all safety behaviors during exposure therapy is inconsistent. In line with the clinical guidelines, several studies found unfavorable effects of exposure with safety behavior compared to exposure without safety behavior (e.g., McManus, Sacadura, & Clark, 2008; Powers et al., 2004; Salkovskis, Clark, Hackmann, Wells, & Gelder, 1999; Sloan & Telch, 2002). Other studies, however, found that safety behaviors did not reduce the effects of exposure (e.g., Deacon, Sy, Lickel, & Nelson, 2010; Hood, Antony, Koerner & Monson, 2010; Milosevic & Radomsky, 2008), and even enhanced exposure effects (e.g., Milosovic & Radomsky, 2013a; Sy, Dixon, Lickel, Nelson & Deacon, 2011). In a recent review of the literature, Blakey and Abramowitz (2016) concluded that safety behaviors tend to be detrimental to the beneficial effects of exposure, but do not always interfere with the therapeutic effects of exposure. In a meta-analysis, on the other hand, Meulders et al. (2016) did not find differences in effects of the incorporation or removal of safety behaviors during exposure. Meulders et al. (2016) argued that the inconsistency in empirical findings may be caused by variability in the conceptualization and operationalization of safety behavior.

This argument is in line with an earlier proposal of Rachman et al. (2008). They argued that there is no evidence that *all* types of safety behaviors are detrimental to the beneficial effects of exposure, and called for a reconsideration of the categorical rejection of safety behaviors during treatment. The incorporation of safety behavior in exposure may be beneficial, because it could make the therapy less demanding and less threatening to patients. This may facilitate treatment and may reduce drop-out and refusal. Several studies suggest that adding safety behavior to exposure can indeed enhance treatment acceptability (Levy & Radomsky, 2014; Levy, Senn & Radomsky, 2014; Milosevic & Radomsky, 2013b). However, other studies did not find differences in the acceptability of exposure with and without safety behaviors (see, for example, Deacon et al., 2010; Milosevic & Radomsky, 2013a).

The crucial question is under which conditions are safety behaviors harmful or innocuous for the effects of exposure therapy? Answering this question is not only theoretically, but also clinically relevant, because it has consequences for the psychological treatment of pathological anxiety. A hypothesis follows from learning theory: under some conditions, safety behaviors may interfere with inhibitory learning, because they preclude the occurrence of the expected catastrophe. An example is sitting down when one feels dizzy to avoid fainting: this will prevent learning that dizziness does not predict passing out. Under other conditions, however, safety behaviors may not interfere with this learning, because they do not preclude the occurrence of threat. An example would be wearing gloves, goggles, and an apron when approaching a spider (Milosevic & Radomsky, 2013a). These safety behaviors may not interfere with learning that the spider (CS) does not predict the US (e.g., getting attacked). To our knowledge, the hypothesis that the negative effects of safety behaviors depend critically on whether they preclude the occurrence of threat has never been directly tested.

An anomaly to this hypothesis are three experiments that investigated the effect of exposure with the use of cleaning safety behavior on feelings of contamination, fear, danger, and disgust (Rachman, Shafran, Radomsky, & Zysk, 2011; van den Hout, Engelhard, Toffolo, & van Uijen, 2011; van den Hout, Reininghaus, van der Stap, & Engelhard, 2012). In these studies, healthy volunteers repeatedly touched a contaminant, either while abstaining from any form of safety behavior, or with the use of disinfectant wipes after each instance of exposure (i.e., cleaning safety behavior). At the post-test measurement, participants were not allowed to clean themselves. The most remarkable finding was that the reduction in feelings of contamination, fear, danger, and disgust was comparable for both groups. It is hard to see how the cleaning behavior could not have interfered with extinction learning, because it prevents the occurrence of contamination and illness. The explanation for the positive effects of using cleaning safety behavior during exposure to a contaminant remains unclear.

INTERMEDIATE SUMMARY

Safety behavior can be detrimental to the beneficial effects of exposure, because it causes a misattribution of safety to the safety behavior, and prevents the occurrence of disconfirming learning experiences. Additionally, safety behavior can decrease the discrepancy between the expected and actual outcome of exposure, and thereby hamper inhibitory learning. Safety behavior is therefore traditionally eliminated during exposure therapy. However, empirical findings are inconsistent, and show detrimental, neutral, and beneficial effects of using safety behavior during exposure therapy. A hypothesis for this inconsistency is that the negative effects of safety behavior depend on whether they preclude the occurrence of an expected catastrophe. Furthermore, it remains unclear how the beneficial effects of cleaning behavior during exposure to a contaminant can be explained. Cleaning behavior prevents the occurrence of contamination and illness, and may therefore prevent extinction learning.

SAFETY BEHAVIOR AND THE EXACERBATION OF ANXIETY

In addition to interfering with obtaining information about perceived threats, safety behavior itself may provide information about the danger of a situation. Influential cognitive models conceptualize emotions as associative networks of network-nodes comprised of stimulus, meaning, and response information (Lang, 1977). For example, for the patient with OCD doorknobs (stimulus) may be associated with danger (meaning), and with a response that consists of the subjective experience of fear, a physiological fear response (e.g., increased heartbeat), and a behavioral fear response (e.g., avoidance; Rachman, 1990). Activation of one of the information components activates the network, and thus the other components. For example, Arntz, Rauner, and van den Hout (1995) found that anxious individuals infer danger on the basis of a subjective fear response, that is, they tend to engage in emotional reasoning: "If I feel anxious, then there must be danger". Additionally, Ehlers, Margraf, Roth, Taylor, and Birbaumer (1988) found that patients with panic disorder infer danger from a physiological fear response. Their study showed that false feedback of an increased heart rate induces anxiety and physiological arousal in patients with panic disorder, but not in healthy controls. Safety behavior is a behavioral fear response that is aimed at preventing or escaping a feared outcome, and is therefore meaningfully linked to the perceived threat (Salkovskis, Clark, & Gelder, 1996). Hence, safety behavior may activate danger perceptions (Sloan & Telch, 2002). Indeed, Gangemi, Mancini, and van den Hout (2012), and van den Hout et al. (2014, 2017) found that anxious individuals use safety behavior as information about the danger in a situation, "I avoid, so there must be danger".

Additionally, three studies found that safety behaviors exert a causal influence on anxiety. First, Deacon and Maack (2008) investigated the effects of safety behavior on the fear of contamination in healthy participants with high and low levels of contamination fear. Participants spent one week actively engaging in a wide range of contamination-related safety behaviors on a daily basis (e.g., washing and disinfecting hands excessively, and trying to avoid touching public door handles). This increased contamination fear in all participants, irrespective of their initial level of contamination fear. Second, Olatunji, Etzel, Tomarken, Ciesielski, and Deacon (2011) compared a group of participants that engaged in a large array of health-related safety behaviors for one week (safety behavior condition) to a group of participants that monitored their usual safety behavior (control condition). Olatunji et al. (2011) found that participants in the safety behavior condition reported higher levels of health anxiety, hypochondriacal beliefs, and avoidant responses to health-related behavioral tasks than participants in the control condition. Third, in a fear conditioning experiment, Engelhard, van Uijen, van Seters, and Velu (2015) investigated the effect of using safety behavior in response to a safety cue (i.e., a CS that has never been paired with shock; CS-). Participants who displayed safety behavior (i.e., they could avoid a potential subsequent shock) to a CS- subsequently had higher threat expectations to this cue when it was presented without safety behavior than participants who were not given the opportunity to avoid. Together, these findings suggest that even in healthy individuals, the mere act of engaging in safety behaviors can increase fear and anxiety. Safety behavior may thus contribute to the exacerbation of pathological anxiety symptoms. It remains unknown if checking behavior, the most commonly observed safety behavior in patients with OCD (i.e., in 80% among those with lifetime OCD; Ruscio, Stein, Chiu & Kessler, 2010), contributes to the severity of fears in OCD.

SAFETY BEHAVIOR AND THE RETURN OF FEAR

If safety behavior exerts a causal influence on fear and anxiety, then it may play a role in relapse after therapy. A substantial number of patients relapse after initial recovery (Vervliet et al., 2013). Relapse can be explained by the inhibitory learning account of fear extinction. During extinction, the CS acquires a second, inhibitory association (i.e., CS – no US) that is available alongside the first, excitatory association (i.e., CS – US; Bouton, 2002). Hence, the meaning of the CS (i.e., danger or safety) becomes ambiguous, and depends on which association is activated. Inhibitory learning is context-specific (Bouton, 2004), which means that the inhibitory association is active in the context (e.g., external surrounding or the individual's internal physical state) in which it was learned, see Figure 2.

Figure 2. Inhibitory learning is context-dependent (graphical depiction by Vervliet et al., 2013). The circle with CX indicates the context in which the inhibitory association was learned. In the extinction context, the inhibitory CS – US association is active.

The context-specificity of inhibitory learning also means that the inhibitory association is inactive, and the excitatory association is active in contexts that are different from the context in which inhibitory learning occurred. A change in the external context or person's internal state after extinction reactivates the excitatory CS – US association, and returns fear for the CS (Vervliet et al., 2013). This is called renewal. Additionally, extinguished fears can return with the passage of time (spontaneous recovery), and following an unsignaled US (reinstatement; Bouton 2002, 2016; Vervliet et al., 2013). The return of fear after extinction, that is, the reactivation of the excitatory CS – US association may be a cause of relapse (Vervliet et al., 2013). By triggering danger perceptions, safety behavior may activate the excitatory CS – US association and trigger a return of fear. Does safety behavior after fear extinction promote the return of fear?

INTERMEDIATE SUMMARY

Safety behavior itself may provide information about the danger of a situation. Anxious individuals infer danger from safety behavior, and safety behavior exerts a causal influence on anxiety. Safety behavior may therefore contribute to the exacerbation of pathological anxiety symptoms. Hence, checking behavior, the most common safety behavior in patients with OCD, may contribute to the severity of fears in OCD. Additionally, by triggering danger perceptions, safety behavior may promote a return of fear after extinction. Safety behavior may therefore be involved in relapse after exposure therapy.

APPROACH BEHAVIOR

Although most safety behaviors are aimed at avoidance, certain safety behaviors may *enhance approach* that may otherwise not have occurred. An example is wearing gloves, goggles, and an apron during exposure to a spider (Milosevic & Radomsky, 2013a). Approach-enhancing safety behaviors may increase access to disconfirmatory evidence about the occurrence of a US, and may therefore not be detrimental to the beneficial effects of exposure. Additionally, approach is associated with positive evaluations (Chen & Bargh, 1999; Strack & Deutsch, 2004), and with the perception of safety. Anxious individuals have a tendency to infer danger from information about physiological responses (Ehlers et al., 1988), anxiety responses (Arntz et al., 1995), and safety behaviors (Gangemi et al., 2012; van den Hout et al., 2014, 2017). This suggests that anxious individuals may also infer safety from approach behavior. If approach triggers the processing of safety information, then it may be relevant to the understanding of the beneficial effects of exposure therapy. Exposure is regularly established by the patient actively approaching a feared stimulus. Hence, in addition to facilitating disconfirmatory experiences about the CS – US association, approach itself may add to the beneficial effects of exposure.

AIMS AND OUTLINE

The current dissertation aimed to investigate the role of safety behavior in the persistence of irrational fears. The first aim of the current dissertation was to test the hypothesis that the negative effects of safety behaviors on exposure outcomes depend on whether safety behavior precludes the occurrence of threat (chapter 2 and 3). Secondly, we aimed to increase our understanding of the causal influence of safety behavior on anxious psychopathology by assessing the effect of checking behavior on the severity of fears in OCD (chapter 4), and by examining the effect of safety behavior on the return of fear after fear extinction (chapter 5). Third and finally, we aimed to explore the potentially beneficial effects of approach-enhancing safety behavior by investigating whether anxious individuals infer safety from approach behavior (chapter 6), and whether approach adds to the beneficial effects of exposure (chapter 7).

Chapter 2 describes two fear conditioning experiments that tested whether the detrimental effects of safety behavior on exposure outcomes depend on whether safety behavior precludes the occurrence of threat. In a computer task, participants learned that two neutral stimuli (CS+) were followed by an aversive loud noise (US), and one stimulus (CS-) was not. Participants also learned to use safety behavior that prevented the loud noise (i.e., precluded the occurrence of threat), and safety behavior that minimized the volume of the loud noise (i.e., minimized, but did not preclude the occurrence of threat). Next, during an extinction phase, one of the CS+ was no longer followed by the loud noise. Participants could use safety behavior that prevented the loud noise, safety behavior that minimized the volume of the loud noise, or no safety behavior during these unreinforced CS presentations. To assess whether these manipulations resulted in extinction learning, threat expectancy for the CS was subsequently measured without the availability of safety behavior. Additionally, in **chapter 3**, we investigated whether using cleaning safety behavior during exposure to a contaminant prevents the disconfirmation of threat beliefs related to feelings of contamination, fear, danger, and disgust. Healthy participants were randomly assigned to one of three groups: repeated exposure to a contaminant whilst abstaining from safety behavior, with the use of disinfectant wipes after each instance of exposure, or no exposure or safety behavior. Participants rated their threat belief associated with the contaminant before and after the experimental manipulation.

In **chapter 4**, we investigated the causal influence of safety behavior on anxiety by examining whether checking safety behavior exacerbates OCD-related threat beliefs. Building on the studies by Deacon and Maack (2008), Olatunji et al. (2011), and Engelhard et al. (2015), we measured the effect of engaging in real-life OCD-like checking behavior for one week on obsession-related cognitions about the importance of checking and the overestimation of threat in healthy participants. Furthermore, **chapter 5** concerns a fear conditioning experiment that tested the effect of safety behavior on the return of fear. Similar to the experiments described in chapter 2, participants learned that two neutral stimuli (CS+) were followed by an aversive loud noise (US), and one stimulus (CS-) was not. They also learned to use safety behavior that prevented the loud noise. Then, *after* successful extinction learning, safety behavior became available again during unreinforced CS trials. To assess if this caused a return of fear, we measured threat expectancy for the CS without the availability of safety behavior.

Chapter 6 includes a study that investigated whether anxious individuals infer safety from approach behavior. Participants with low and high spider fear rated the danger they perceived in general and spider-relevant scenarios in which information about objective safety versus objective danger, and approach behavior versus no approach behavior, was varied. In **chapter 7**, we investigated whether approach behavior adds to the beneficial effects of exposure. Spider fearful participants were repeatedly exposed to a spider by pulling the spider toward themselves, or by having the experimenter pull the spider towards them. The effects of these exposure interventions on self-reported, behavioral, and implicit spider fear were compared with a no-exposure control intervention. Finally, **chapter 8** includes a summary and integration of the findings from the studies described in chapter 2 to 7, and a discussion of the potential clinical implications and directions for future research.

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DO SAFETY BEHAVIORS PRESERVE THREAT BELIEFS?

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ABSTRACT

Empirical evidence for the detrimental effect of safety behaviors on fear extinction is inconsistent. This fear conditioning study investigated whether the negative effects of safety behavior on extinction learning depend on whether safety behavior precludes the occurrence of threat. In two experiments, participants first underwent fear acquisition. During a subsequent extinction procedure, participants used safety behavior that precluded the occurrence of threat, safety behavior that minimized threat severity, or no safety behavior. Safety behavior that precluded the occurrence of threat prevented extinction learning in the first and second experiment. Additionally, in the second experiment, safety behavior that minimized threat severity did not prevent extinction for several participants. For other participants, however, this safety behavior prevented extinction. The current findings suggest that the negative effects of safety behavior on extinction learning do not only depend on whether safety behavior precludes the occurrence of threat.

INTRODUCTION

Clinical guidelines generally recommend to motivate patients to inhibit all safety behaviors during exposure-based therapy (e.g., Abramowitz, Deacon, & Whiteside, 2011; Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014; Keijsers, van Minnen, & Hoogduin, 2011). Safety behaviors are actions aimed at preventing, minimizing, or escaping a feared outcome (e.g., Deacon & Maack, 2008; Salkovskis, 1991). They are common in individuals with anxiety disorders and are functionally related to the expected threat (Salkovskis, Clark, & Gelder, 1996). For example, a patient with social anxiety disorder may hide her face in social situations, because she fears that others will ridicule and reject her when they see her blush. Safety behaviors can preclude the occurrence of disconfirming experiences, because the patient may misattribute the nonoccurrence of the expected threat to the safety behavior (Salkovskis, 1991). This prevents the violation of negative expectancies (Blakey & Abramowitz, 2016; Craske et al., 2014), and thus prevents extinction. Hiding her face may prevent the patient with social anxiety from learning that others will not ridicule and reject her if they see her blush.

However, whether safety behavior is detrimental to the beneficial effects of exposure is an empirical issue, and overall, the findings from various studies are inconsistent. Several studies found unfavorable effects of exposure with safety behavior compared to exposure without safety behavior (e.g., McManus, Sacadura, & Clark, 2008; Salkovskis, Clark, Hackmann, Wells, & Gelder, 1999; Sloan & Telch, 2002). Other studies found that safety behavior did not reduce the effects of exposure (e.g., Deacon, Sy, Lickel, & Nelson, 2010; Hood, Antony, Koerner & Monson, 2010; Milosevic & Radomsky, 2008), and even enhanced exposure effects (e.g., Milosovic & Radomsky, 2013; Sy, Dixon, Lickel, Nelson & Deacon, 2011). In a recent review, Blakey and Abramowitz (2016) concluded that safety behaviors tend to be detrimental to the beneficial effects of exposure, but do not always interfere with the therapeutic effects of exposure. A meta-analysis, however, did not find differences in effects between the incorporation or removal of safety behaviors during exposure (Meulders, Van Daele, Volders, & Vlaeyen, 2016).

The crucial question is how to explain this inconsistency. This is not only theoretically, but also clinically relevant, because it has obvious consequences for the psychological treatment of anxiety disorders. Rachman, Radomsky, and Shafran (2008) argued that not all safety behaviors necessarily prevent disconfirmatory experiences, and they called for a reconsideration of the categorical rejection of safety behavior during treatment. If the negative effects of safety behavior on extinction learning indeed depend on whether safety behaviors preclude disconfirmatory experiences, then safety behaviors that allow the occurrence of threat should not hamper extinction, and may not be detrimental to the beneficial effects of exposure. Preliminary empirical support for this ‘interference with disconfirmation’ hypothesis can be derived from two studies by Milosevic and Radomsky (2008, 2013), in which participants could use protective gear, such as gloves and goggles during exposure to a snake or spider. Exposure with and without the use of these safety behaviors resulted in comparable reductions of a fear of snakes (2008) and spiders (2013). One possible explanation is that this safety behavior did not prevent the corrective learning experience of not getting attacked by the snake or spider, and therefore did not hinder fear extinction.

Additional empirical support for the interference with disconfirmation hypothesis comes from a study by Lovibond, Mitchell, Minard, Brady, and Menzies (2009). In a laboratory fear conditioning experiment, safety behavior that precluded the occurrence of threat prevented the extinction of subjective threat expectancy and skin conductance responses, which are measures of fear in fear conditioning research (Boddez, Baeyens, Luyten, Vansteenwegen, & Hermans, 2013). In a Pavlovian acquisition phase, participants learned that two neutral stimuli (A and C, which both served as conditional stimuli or CS+) were followed by shock (unconditional stimulus or US), and a third neutral stimulus (B, which served as CS-) was not. Next, participants learned to use safety behavior during presentation of stimulus A by pressing a button on a response box that effectively cancelled the shock. During a subsequent extinction phase, stimulus C was no longer followed by shock. Participants in the experimental condition, but not those in the control condition, were given the opportunity to use safety behavior during C trials. All participants in the experimental condition used safety behavior on all C trials. In a following test phase, in which safety behavior was no longer available for any stimulus, threat expectancy and skin conductance responses for C remained high in the experimental condition, whereas they had decreased in the control condition (Lovibond et al., 2009). Presumably, participants in the experimental condition misattributed the nonoccurrence of the shock to the safety behavior, which prevented extinction. This suggests that safety behaviors that preclude the occurrence of threat prevent fear extinction. However, neither the study by Lovibond et al. (2009) nor the studies by Milosevic and Radomsky (2008, 2013) are direct, experimental tests of the crucial remaining issue: does safety behavior that allows the occurrence of threat prevent fear extinction? Answering this question was the aim of the present research.

EXPERIMENT 1

In Experiment 1, we aimed to replicate Lovibond et al.'s (2009) finding that safety behavior that precludes the occurrence of threat prevents fear extinction in an adapted version of their fear conditioning paradigm. A first change to the paradigm was that instead of a shock, the US was an aversive loud noise presented through headphones that were connected to the computer with a sound amplifier. This allowed us to operationalize safety behaviors that did and did not prevent the occurrence of threat. The fear conditioning task started with the Pavlovian acquisition phase, during which participants learned the CS – US associations. Stimulus A and C (CS+) were followed by the loud noise, and stimulus B (CS-) was not. Next, during the Safety behavior acquisition phase, all participants learned to make a *full* avoidance response, which was analogous to the safety behavior in the study by Lovibond et al. (2009). However, a second change to the paradigm was that this response was not pressing a button on a response box, but unplugging the headphones from the sound amplifier, which prevented participants from hearing the loud noise. The full avoidance response thus precluded the (potential) occurrence of threat. A third change was that all participants also learned to use *subtle* safety behavior, which entailed taking off the headphones. This did not prevent participants from hearing the loud noise, but decreased how loud, and thus how unpleasant, it was for participants. Hence, the subtle safety behavior minimized threat severity, but did not preclude the occurrence of threat. In a subsequent Extinction phase, the full avoidance response was available during unreinforced presentations of stimulus C for participants in the Full avoidance condition, but not for participants in the Control condition (analogous to Lovibond et al.'s [2009] experimental condition and control condition, respectively). Note that the effect of subtle safety behavior during unreinforced presentations of stimulus C was investigated in Experiment 2.

A fourth and final change was that we did not measure skin conductance responses, because the full avoidance response and subtle safety behavior required participants to move both hands during CS presentations. Movement causes artifacts in skin conductance responses (Society for Psychophysiological Research Ad Hoc Committee on Electrodermal Measures, 2012). Movement also affects another commonly used psychophysiological measure in fear conditioning studies, namely the fear potentiated startle responses (Blumenthal et al., 2005). Additionally, the auditory probes that are used to induce the startle responses may interfere with the acquisition of contingencies (Lonsdorf et al., 2017). An alternative psychophysiological measure of fear learning are pupillary dilation responses (Leuchs, Schneider, Czisch, & Spoormaker, 2017). Pupil dilations in response to conditional stimuli are a measure of autonomic arousal and covary with skin conductance responses (Bradley, Miccoli, Escrig, & Lang, 2008). They can be used as a measure of associative learning in fear conditioning research (e.g., Visser, Scholte, Beemsterboer, & Kindt, 2013). Hence, instead of skin conductance responses, we included pupil dilation responses as a psychophysiological measure of fear learning in Experiment 1.

We had intended to include a third condition in Experiment 1, in which participants could use subtle safety behavior during the Extinction phase: the Subtle safety behavior condition. However, we tested several participants in this condition, and they reported different interpretations of the procedure and uncertainty about the experimental task at the debriefing. The cause of these differences was unclear. We therefore did not include this condition in Experiment 1, and first investigated whether we could replicate the findings by Lovibond et al. (2009) in the current paradigm. Note that, in Experiment 1, subtle safety behavior was available for all participants during the Safety behavior acquisition phase, but none of the participants could use this response during the Extinction phase.

In Experiment 1, we investigated the effect of full avoidance versus no avoidance or safety behavior on the extinction of threat expectancy ratings, and on a psychophysiological measure of fear learning (cf. Lovibond et al., 2009). We hypothesized that making the full avoidance response during unreinforced CS presentations would prevent extinction. In line with the findings by Lovibond et al. (2009), we hypothesized that threat expectancy and pupil dilation responses for stimulus C in the Test phase that followed the Extinction phase would be higher, and larger, in the Full avoidance condition than in the Control condition.

METHOD

Participants

Participants were 64 student volunteers (M_{age} = 22.63, *SD* = 5.12, 41 women, 23 men). They gave written informed consent and received money or course credit for their cooperation. The study was approved by the Ethics Review Board of the Faculty of Social and Behavioural Sciences of Utrecht University. Participants were randomly allocated to the Full avoidance or Control condition.

Apparatus, stimuli, and measures

State-trait anxiety inventory (STAI)

The STAI (Spielberger, Gorusch, & Lushene, 1970) was included to measure state and trait anxiety, because they may affect fear learning (Grillon et al., 2006; Lissek et al., 2005). Each scale contained 20 items, rated on a scale from 1 (*not at all*) to 4 (*severely*). In this study, Cronbach's α = .87 and .86 for state and trait anxiety, respectively.

Experimental task

The experimental task was programmed in Python (Python Software Foundation) using the PyGaze toolbox (Dalmaijer, Mathôt & van der Stigchel, 2014) and presented on a 21 inch ViewSonic P227f CRT monitor (1024 x 768 px, 100 Hz) at a distance of 67 cm from the participant. The US was 1 s of 100 dB white noise presented through headphones (cf. Leer & Engelhard, 2015) that were connected to the computer with a sound amplifier. CS were a black (0.24 cd/m^2) circle, square, and triangle presented on a light grey (6.41 dc/m^2) background. CS were equiluminant and of the same surface area.

Threat expectancy

Immediately after each CS presentation, but before (possible) presentation of the aversive loud noise (Unconditional Stimulus; US), participants rated to what extent they expected the noise to follow by using a 0 (*certain no noise*) to 100 (*certain noise*) visual analogue scale (VAS) shown on the computer screen.

Pupil dilations

Pupil size of the left eye was measured during CS presentation with an Eyelink 1000 (SR Research, Mississauga, ON, Canada), a video-based eye tracker sampling at 1000 Hz. Pupil dilation responses to the CS were calculated as the relative growth (proportion) during stimulus presentation from 0 to 5 s after stimulus onset compared to baseline (200 ms before stimulus onset) and the maximum proportional dilation in this window was used for further analysis (cf. Visser et al., 2013).

Contingencies and pleasantness

After the experimental task, participants indicated whether each CS (i.e., the square, triangle, and circle) was followed by the loud noise on a 3-point Likert scale with the categories *never*, *sometimes*, and *always* as an additional check of contingency awareness. As a manipulation check, participants rated the (un)pleasantness of the loud noise when they had the headphones on and when they had the headphones off on two 100 mm VAS from *extremely unpleasant* (left, i.e., 0) to *extremely pleasant* (right, i.e., 100). Finally, they were asked to describe what happened when they unplugged the headphones and when they took off the headphones to assess if they had understood the consequences of the full avoidance response and subtle safety behavior.

Procedure

Participants were tested individually in a darkened room with dimmed lights. After the informed consent procedure, participants filled out the STAI. They then received oral instructions from the experimenter, followed by written instructions on the computer screen. Participants were told that there was a relationship between the CS and the US, and that they should try to discover this relationship. They were also instructed and demonstrated how to unplug the headphones (full avoidance) and plug them back into the sound amplifier, and how to take off the headphones (subtle safety behavior) and put them back on. Participants were not told what the consequences of these responses were. Next, they were seated with their head in a chin- and forehead rest to restrict head movements. A nine-point calibration procedure was performed for the eye tracker. Participants practiced rating threat expectancy twice, making the full avoidance response twice, and using subtle safety behavior twice. The experimental task then started.

Each trial consisted of the presentation of a CS for 5 s in the middle of the screen, followed by a 5-s waiting period during which participants rated threat expectancy, followed by the US or nothing. The inter-trial interval was 3 s. During each CS presentation, a dark grey picture of a plug was visible in the upper right corner of the screen, and a dark grey picture of headphones was visible in the upper left corner of the screen. These pictures indicated availability and unavailability of the full avoidance response and subtle safety behavior. If the picture of the plug turned green, participants could unplug the headphones from the sound amplifier (full avoidance), and if the headphones turned green, participants could take off the headphones (subtle safety behavior). If the full avoidance response or subtle safety behavior had been available, an instruction screen would appear at the end of the trial to inform participants to plug the headphones back into the sound amplifier, or to put the headphones back on.

The design of the study is shown in Table 1. A, B, and C were randomly allocated to the three different shapes for each participant. In the Pavlovian acquisition phase, A and C were followed by the loud noise, and B was not. In the Safety behavior acquisition phase, full avoidance and subtle safety behavior were available during presentation of A. A was also presented without full avoidance or subtle safety behavior availability to remind participants that A was still followed by the loud noise if the full avoidance response was not available (cf. Engelhard, van Uijen, van Seters, & Velu, 2015; Lovibond et al., 2009).

Table 1. Design of the experimental task in Experiment 1.

<table>
<tr><th></th><th colspan="4">Phase</th></tr>
<tr><th></th><th>Pavlovian acquisition</th><th>Safety behavior acquisition</th><th>Extinction</th><th>Test</th></tr>
<tr><td>Full avoidance condition</td><td rowspan="2">A+ (3)
B- (6)
C+ (3)</td><td rowspan="2">A*(+) (4)
A~[+] (4)
A+ (1)
B- (2)
C+ (1)</td><td>A+ (2)
B- (2)
C*- (6)</td><td rowspan="2">A+ (1)
B- (1)
C- (1)</td></tr>
<tr><td>Control condition</td><td>A+ (2)
B- (2)
C- (6)</td></tr>
</table>

Note. A, B, and C refer to visual stimuli (CS); + and – refer to presence and absence, respectively, of the loud noise (US) following the CS; * indicates the availability of the full avoidance response (i.e., unplugging the headphones); ~ indicates the availability of subtle safety behavior (i.e., taking off the headphones); (+) indicates that participants only heard the US if they made the full avoidance response (i.e., if they did not unplug the headphones); [+] indicates that the US was less loud for participants if they used subtle safety behavior (i.e., if they took off the headphones); numbers in parentheses indicate the number of trials of each type.

From the Extinction phase onwards, C was no longer followed by the loud noise. During the Extinction phase, the full avoidance response was available during unreinforced C presentations for participants in the Full avoidance condition, but not for participants in the Control condition. Finally, in the Test phase, A, B, and C were presented once without the availability of full avoidance or subtle safety behavior. The order of trial types was randomized within each phase, with the restriction that there were no more than two consecutive trials of the same type. Furthermore, C was always presented last in the Test phase to prevent that the nonoccurrence of the US at this trial would affect the response to stimuli A and B (cf. Lovibond et al., 2009).

After finishing the experimental task, participants filled out the questionnaire about contingencies and pleasantness. Next, they were debriefed and given their reward.

Scoring and analysis

Pupil data were preprocessed by interpolating blinks via Mathôt's (2013) method, and then dividing the pupil signal from 0 - 5000 ms after CS onset by the median pupil size during a baseline period of 200 ms before CS onset. The maximum value of the pupil trace in this 0 - 5000 ms period was used for further analysis. Fear acquisition had to take place to allow drawing conclusions about fear extinction (see Lonsdorf et al., 2017). Therefore, participants who did not show contingency awareness were excluded from the analyses (Lovibond & Shanks, 2002). Contingency awareness was defined as a higher threat expectancy for A and C than for B on the final trial of the Pavlovian acquisition phase, and correctly indicating which CS were followed by the loud noise on the contingencies questionnaire after the experimental task. Analyses were performed on data with and without replaced outliers. Outliers were defined as more than 3 *SD* from the mean, and were replaced with $M \pm 3$ *SD*. Replacing outliers did not affect the direction of the main findings. We therefore reported the analyses that were performed on the original data. The data were analyzed with mixed ANOVAs (α = .05), comparing threat expectancy and pupil dilation responses between Stimuli (A vs. B vs. C) and Conditions (Full avoidance vs. Control). Corrected values were reported in case the assumption of sphericity was violated. Planned comparisons were conducted with paired and independent *t*-tests.

RESULTS

Participants

Data were not collected for three participants due to malfunctioning of the task. Three participants did not show contingency awareness after the Pavlovian acquisition phase, and another participant could not explain the contingencies afterwards. The data of the remaining 57 participants (M_{age} = 22.18, *SD* = 3.19, 39 women, 18 men) were included in the analyses (Full avoidance condition n = 28, Control condition n = 29). The two conditions did not differ in age, $F < 1$, state, $F < 1$, and trait anxiety scores, $F(1,55) = 1.06$, $p = .31$, $\eta_p^2 = .02$. Participants rated the loud noise as unpleasant when they had the headphones on (M = 18.45, *SD* = 15.76), and as neutral when they had the headphones off (M = 52.16, *SD* = 18.88).

Threat expectancy

Figure 1 depicts that Pavlovian acquisition occurred for both conditions. At the end of the Pavlovian acquisition phase, threat expectancy was higher for A and C than for B, $F(1.65,90.68) = 1771.04$, $p < .001$, $\eta_p^2 = .97$. There was no main effect of Condition or a Stimulus x Condition interaction, both *F*s < 1. Additionally, safety behavior learning occurred. In the Safety behavior acquisition phase, threat expectancy decreased in a linear trend during full avoidance trials (see the A*(+) trials in Figure 1), $F(1,55) = 8.57$, $p = .005$, $\eta_p^2 = .14$, which was similar for both conditions, $F < 1$. Participants thus learned that the full avoidance response cancelled the loud noise. Additionally, threat expectancy increased in a quadratic trend during subtle safety behavior trials (see the A~[+] trials), $F(1,55) = 19.80$, $p < .001$, $\eta_p^2 = .27$, which did not differ between conditions, $F(1,55) = 1.82$, $p = .18$, $\eta p^2 = .03$. This indicates that participants learned that the subtle safety behavior response did not prevent them from hearing the loud noise. Finally, in the Extinction phase, threat expectancy decreased in a quadratic trend over the six C trials, $F(1,55) = 22.57$, $p < .001$, $\eta_p^2 = .29$. This trend showed a Stimulus x Condition interaction effect, because this decrease was steeper in the Control condition (see the C- trials in the bottom panel of Figure 1) than in the Full avoidance condition (C*- trials in the upper panel) due to the lower starting point in the Full avoidance condition (see Figure 1, the first Extinction phase C trial is lower in the top panel than in the bottom panel), $F(1,55) = 7.09$, $p = .01$, $\eta_p^2 = .11$.

In the Test phase, threat expectancy showed a main effect of Stimulus $F(2,110) = 624.97$, $p < .001$, $\eta_p^2 = .92$, Condition, $F(1,55) = 168.39$, $p < .001$, $\eta_p^2 = .75$, and, crucially, a Stimulus x Condition interaction, $F(2,110) = 159.38$, $p < .001$, $\eta_p^2 = .74$. Threat expectancy was higher for A than for B, $F(1,55) = 1424.60$, $p < .001$, $\eta_p^2 = .96$. This did not differ between conditions, $F(1,55) = 1.32$, $p = .26$, $\eta_p^2 = .02$, or show a Stimulus x Condition interaction, $F(1,55) = 1.50$, $p = .23$, $\eta_p^2 = .03$. In line with our hypothesis, threat expectancy for C was higher in the Full avoidance condition than in the Control condition (see Figure 1, C- in the Test phase is higher in the top panel than in the bottom panel), $t(28.90) = 18.30$, $p < .001$, $d = 4.77$. To further decompose the Stimulus x Condition interaction, we examined threat expectancy for C compared with the danger stimulus (A) and safety stimulus (B) in the Test phase for each condition. In line with our hypothesis, in the Control condition, threat expectancy was lower for C than for A, $t(28) = 13.21$, $p < .001$, $d = 3.26$, and higher for C than for B, $t(28) = 2.77$, $p = .01$, $d = 0.73$ (see Figure 1, C is lower than A, and higher than B in the bottom panel). This indicates that extinction for C occurred in the Control condition. In the Full avoidance condition, threat expectancy for C was also higher than for B, $t(27) = 97.82$, $p < .001$, $d = 35.72$, but it did not differ between A and C, $t(27) = 1.30$, $p = .20$, $d = 0.22$ (see Figure 1, C is similar to A, and higher than B in the top panel). Thus, threat expectancy for C was maintained in the Full avoidance group.

Pupil dilations

As depicted in Figure 2, the conditioning effect observed on threat expectancy was not reflected in pupil dilations. At the end of the Pavlovian acquisition phase, pupil dilation responses did not differ between A, B, and C, $F < 1$, between conditions, $F(1,54) = 2.97$, $p = .09$, $\eta_p^2 = .05$, or show a Stimulus x Condition interaction, $F(2,108) = 1.70$, $p = .19$, $\eta_p^2 = .03$. However, pupil dilation responses increased on full avoidance and subtle safety behavior trials. In the Safety behavior acquisition phase, pupil dilation responses were larger on full avoidance trials (see the A*(+) trials in Figure 2), $F(1,54) = 14.67$, $p < .001$, $\eta_p^2 = .21$, and subtle safety behavior trials (see the A~[+]

trials), $F(1,55) = 17.69$, $p < .001$, $\eta_p^2 = .24$, compared to no avoidance or safety behavior trials (the A+ trial). Additionally, in the Extinction phase, pupil dilation responses for C were larger in the Full avoidance condition (C*- trials) than in the Control condition (C- trials), $F(1,55) = 13.94$, $p < .001$, $\eta_p^2 = .20$.

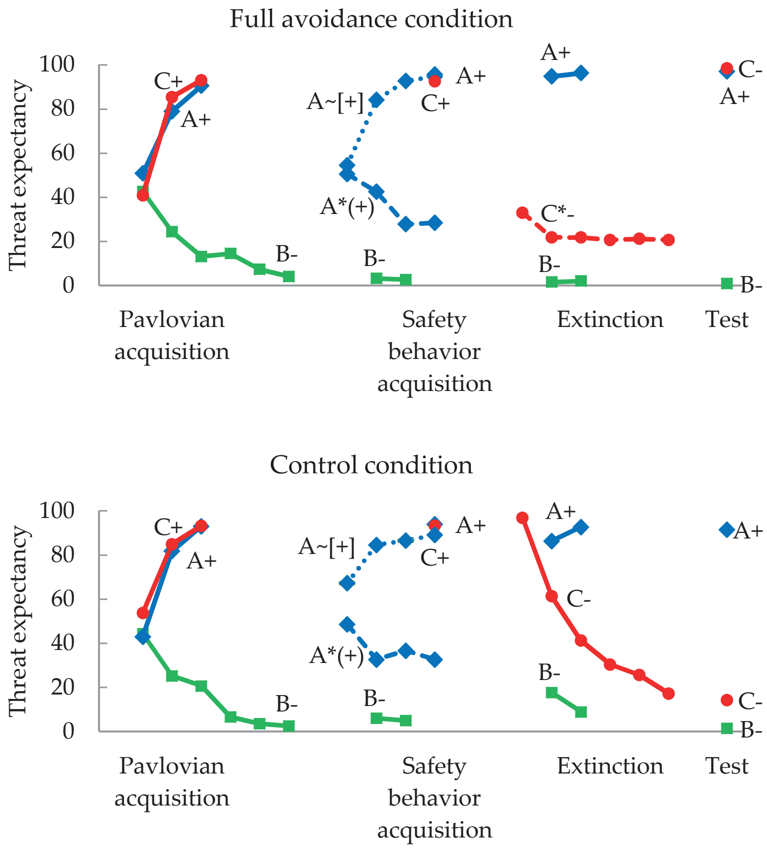

Figure 1. Mean threat expectancy for A, B, and C in the Full avoidance condition (top panel) and Control condition (bottom panel) in Experiment 1. See Table 1 for explanation of trial types.

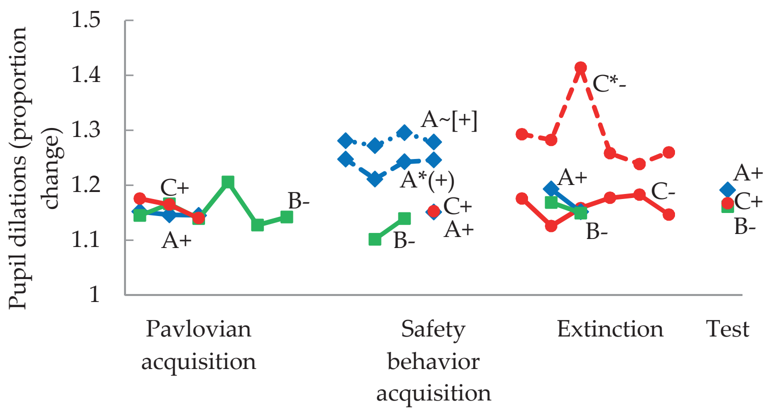

Figure 2. Proportion of change in pupil dilations in response to A, B, and C for the Full avoidance condition and Control condition in Experiment 1. Pupil dilation responses are depicted for both conditions together, expect for C*- trials in the Full avoidance condition and C- trials in the Control condition in the Extinction phase. See Table 1 for explanation of trial types.

DISCUSSION EXPERIMENT 1

We replicated Lovibond et al. (2009)'s findings for threat expectancy. Presumably, participants in the Full avoidance condition misattributed the nonoccurrence of the loud noise during C trials in the Extinction phase to the full avoidance response. Hence, threat expectancy for C was maintained in the Full avoidance condition, whereas it had decreased in the Control condition. In line with our hypothesis and the findings by Lovibond et al (2009), Experiment 1 showed that safety behavior that prevents the occurrence of threat maintains threat beliefs when safety behavior is no longer available, and may therefore be detrimental to the beneficial effects of exposure.

Contrary to our hypothesis, pupil dilation responses did not show associative learning effects. Pupil dilations discriminate most strongly between the CS+ and CS- shortly before US onset (Reinhard & Lachnit, 2002), because the peak pupil response occurs in a time window immediately preceding the US (Visser, Kunze, Westhoff, Scholte, & Kindt, 2015). However, the US did not coincide with CS+ offset in the current paradigm, because participants rated threat expectancy for 5 s between CS offset and US onset. Simultaneously measuring pupil dilations during this time window may cause the pupillary responses to be affected by arousal associated with filling out the VAS (Sirois, & Brisson, 2014). Additionally, the availability or use of the full avoidance response and subtle safety behavior increased pupil dilation responses. Together, this indicates that pupil dilation responses were not a suitable psychophysiological measure of fear learning in the current paradigm. Pupil dilations were therefore not measured in Experiment 2.

In Experiment 1, we did not investigate whether subtle safety behavior that minimizes threat severity prevents extinction learning. Participants in the Subtle safety behavior differed in their interpretation of the experimental task, and reported uncertainty about the task at the debriefing. This may be due to the several limitations of Experiment 1. First, in Experiment 1 the instructions in the Subtle safety behavior condition may not have been entirely clear to participants. Second, although all participants in Experiment 1 correctly described the consequences of the full avoidance responses and subtle safety behavior after the experimental task, they may not have understood these consequences correctly at the beginning of the experimental task. Third, the availability of the full avoidance response and subtle safety behavior may have functioned as negative occasion setters. An occasion setter is a cue that provides information about whether or not a CS will be followed by a US. A negative occasion setter inhibits the association between a CS and US (Bouton, 2016). At the debriefing, several participants in the Subtle safety behavior condition reported that they had reasoned that C was not followed by the loud noise as long as it was combined with the availability of the subtle safety behavior response. Hence, the picture of the green headphones may have functioned as a negative occasion setter.

EXPERIMENT 2

Experiment 2 entailed the same basic design as Experiment 1 with several improvements, to investigate whether safety behavior that allows the occurrence of threat prevents extinction. First, we simplified and clarified the oral and written instructions based on pilot studies. Second, after receiving the oral instructions from the experimenter, participants were asked to explain the experimental task in their own words to check if they had understood the instructions correctly. Third, participants were told that the full avoidance response prevented a possible subsequent loud noise, and that the subtle safety behavior reduced the volume of a possible subsequent loud noise. Fourth, the availability of the full avoidance response and subtle safety behavior was not indicated by a picture of a plug and a picture of headphones that were presented simultaneously with the CS, to prevent that these pictures might function as negative occasion setters. Instead, during full avoidance and subtle safety behavior trials an instruction screen preceded CS presentation to inform participants that they could unplug or take off the headphones, respectively. Fifth, to further prevent that the full avoidance response and subtle safety behavior may function as negative occasion setters, the full avoidance response and subtle safety behavior were learned during two A and two C trials in the Safety behavior acquisition phase, instead of during four A trials in Experiment 1 (see Table 2). Hence, in Experiment 2, stimulus C was not exclusively combined with the full avoidance response and subtle safety behavior on unreinforced presentations, but also on reinforced trials.

We hypothesized that we would replicate the findings of Experiment 1 and Lovibond et al. (2009), as evidenced by higher threat expectancy for C in the Test phase in the Full avoidance condition than in the Subtle safety behavior and Control condition. Furthermore, we hypothesized that using subtle safety behavior during unreinforced C trials would not prevent extinction learning for C. To be precise, we hypothesized that threat expectancy in the Test phase would be lower for C than for A in the Subtle safety behavior and Control condition.

METHOD

Participants

The sample consisted of 64 student volunteers (M_{age} = 22.64, *SD* = 2.89, 44 women, 20 men). They were randomly allocated to the Full avoidance (*n* = 21), Subtle safety behavior (*n* = 22), or Control condition (*n* = 21).

Apparatus, stimuli, measures, and procedure

The apparatus, stimuli, and measures were similar to Experiment 1. The design of Experiment 2 is shown in Table 2. The procedure was similar to Experiment 1, except for the changes described under Experiment 2. Participants in the Subtle safety behavior condition could use subtle safety behavior (i.e., could take off the headphones) during unreinforced C trials in the Extinction phase. Because we did not measure pupil dilations, the eye tracker and chin- and forehead rest were not used, and participants were tested in a regularly lighted room. In this study, Cronbach's α was .89 for state and trait anxiety.

Table 2. Design of the experimental task in Experiment 2.

<table>
<tr><th></th><th colspan="4">Phase</th></tr>
<tr><th></th><th>Pavlovian acquisition</th><th>Safety behavior acquisition</th><th>Extinction</th><th>Test</th></tr>
<tr><td>Full avoidance condition</td><td rowspan="3">A+ (3)
B- (6)
C+ (3)</td><td rowspan="3">A*(+) (2)
A~[+] (2)
A+ (1)
B- (2)
C+ (1)
C*(+) (2)
C~[+] (2)</td><td>A+ (2)
B- (2)
C*- (6)</td><td rowspan="3">A+ (1)
B- (1)
C- (1)</td></tr>
<tr><td>Subtle safety behavior condition</td><td>A+ (2)
B- (2)
C~- (6)</td></tr>
<tr><td>Control condition</td><td>A+ (2)
B- (2)
C- (6)</td></tr>
</table>

Note. See Table 1 for explanation of trial types.

RESULTS

Participants

Five participants did not show contingency awareness using the predefined criteria (see Experiment 1). Analyses were performed on the data of the remaining 59 participants (M_{age} = 22.56, *SD* = 2.96, 42 women, 17 men, Full avoidance condition n = 19, Subtle safety behavior condition n = 21, Control condition n = 19). There were no significant differences between conditions in age, $F(2,56) = 1.53$, $p = .23$, $\eta_p^2 = .05$, and trait anxiety scores, $F(2,56) = 1.49$, $p = .23$, $\eta_p^2 = .05$. There was a trend for state anxiety scores to differ between conditions, $F(2,56) = 3.10$, $p = .053$, $\eta_p^2 = .10$. State anxiety scores were higher in the Control condition than in the Subtle safety behavior condition, $t(38) = 2.38$, $p = .02$, $d = 0.75$, but did not significantly differ between the

Full avoidance and Subtle safety behavior condition, $t(38) = 1.68$, $p = .10$, $d = 0.53$, and between the Full avoidance and Control condition, $t < 1$. Results were similar when analyses were performed with state anxiety scores included as a covariate, which suggests that the differences between conditions in state anxiety did not affect the results. We therefore reported the analyses without state anxiety as a covariate. Participants rated the loud noise as unpleasant when they had the headphones on ($M = 12.51$, $SD = 12.16$), and as neutral when they had the headphones off ($M = 53.56$, $SD = 16.33$).

Threat expectancy

As is depicted in Figure 3, Pavlovian acquisition occurred for all three conditions. At the end of the Pavlovian acquisition phase, threat expectancy was higher for A and C than for B, $F(1.44,80.56) = 2718.18$, $p < .001$, $\eta_p^2 = .98$. There was no main effect of Condition or a Stimulus x Condition interaction, both Fs < 1. Safety behavior learning also occurred. In the Safety behavior acquisition phase, threat expectancy for A and C was lower on full avoidance trials (see the A*(+) and C*(+) trials in Figure 3) than on no avoidance or safety behavior trials (A+ and C+ trials in the Safety behavior acquisition phase), $F(1,58) = 508.45$, $p < .001$, $\eta_p^2 = .90$, and subtle safety behavior trials (A~[+] and C~[+] trials), $F(1,58) = 424.31$, $p < .001$, $\eta_p^2 = .88$. In the Extinction phase, threat expectancy decreased over the six C trials in all conditions, which was indicated by a quadratic trend for Stimulus, $F(1,56) = 53.55$, $p < .001$, $\eta_p^2 = .49$. This decrease was steeper in the Control condition (see the C- trials in the bottom panel of Figure 3) and Subtle safety behavior condition (C~- trials in the middle panel) than in the Full avoidance condition (C*- trials in the top panel), $F(2,56) = 8.98$, $p = .01$, $\eta_p^2 = .24$, which was due to the lower starting point in the Full avoidance condition (see Figure 3, the first Extinction phase C trial is lower in the top panel than in the middle and bottom panel), $F(2,56) = 139.34$, $p < .001$, $\eta_p^2 = .83$.

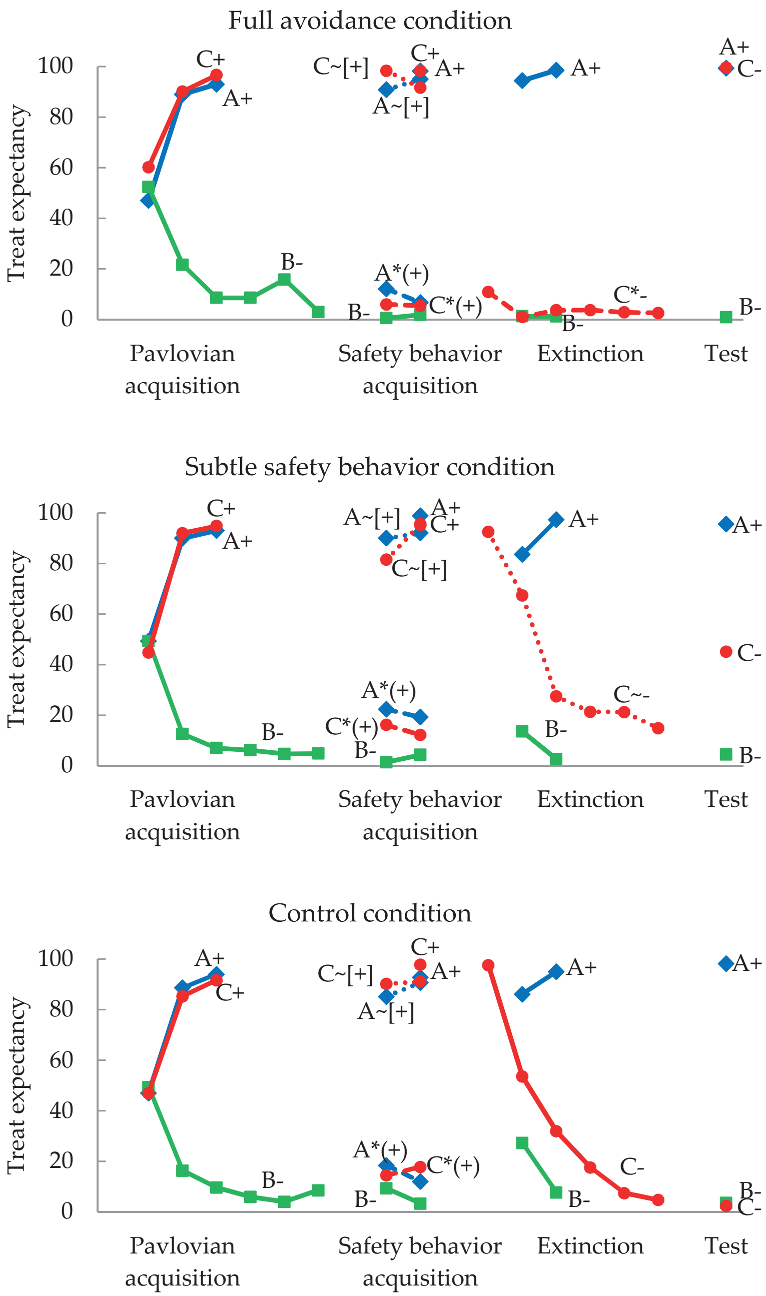

Figure 3. Mean threat expectancy for A, B, and C in the Full avoidance condition (top panel), Subtle safety behavior condition (middle panel), and Control condition (bottom panel) in Experiment 2. See Table 1 for explanation of trial types.

In the Test phase, threat expectancy showed a main effect of Stimulus, $F(1.12,62.77) = 437.53$, $p < .001$, $\eta_p^2 = .89$, Condition, $F(2,56) = 59.99$, $p < .001$, $\eta_p^2 = .68$, and a Stimulus x Condition interaction, $F(2,112) = 47.20$, $p < .001$, $\eta_p^2 = .63$. Threat expectancy was higher for A than for B, $F(1,56) = 7603.51$, $p < .001$, $\eta_p^2 = .99$. This did not differ between conditions or show a Stimulus x Condition interaction, both *F*s < 1. Thus, the experimental manipulation of full avoidance, subtle safety behavior, or no avoidance or safety behavior during the Extinction phase had not differentially influenced threat expectancy ratings for danger stimulus A and safety stimulus B. The experimental manipulation had, however, caused differences between conditions in threat expectancy ratings for C in the Test phase. In line with our hypothesis, threat expectancy for C was higher in the Full avoidance condition than in the Control condition, $t(20.53) = 66.53$, $p < .001$, $d = 21.59$, and in the Subtle safety behavior condition, $t(20.05) = 5.36$, $p < .001$, $d = 1.61$ (see Figure 3, C- in the Test phase is higher in the top panel than in the middle and bottom panel). This indicates that full avoidance maintained threat expectancy for C. Additionally, threat expectancy for C was higher in the Subtle safety behavior condition than in the Control condition, $t(20.74) = 3.94$, $p = .001$, $d = 1.19$ (see Figure 3, C- in the Test phase is higher in the middle panel than in the bottom panel). This suggests that not avoiding or using subtle safety behavior during unreinforced C trials (i.e., during the Extinction phase) resulted in a larger reduction of threat expectancy than when subtle safety behavior was used during unreinforced C trials.

Next, we examined threat expectancy for C compared with A and B in the Test phase for the Subtle safety behavior and Control condition to investigate whether using subtle safety behavior during unreinforced C trials had prevented extinction learning. In line with our hypothesis, threat expectancy was higher for A than for C in the Control condition, $t(18) = 44.07$, $p < .001$, $d = 16.72$, and Subtle safety behavior condition, $t(20) = 5.09$, $p < .001$, $d = 1.62$ (see Figure 3, C- is lower than A+ in the Test phase in the middle and bottom panel). This indicates that extinction learning occurred in the Subtle safety behavior and Control condition. However, in the

Control condition, threat expectancy did not significantly differ between B and C, $t < 1$, whereas threat expectancy was higher for C than for B in the Subtle safety behavior condition, $t(20) = 3.73$, $p = .001$, $d = 1.19$ (see Figure 3, C- is similar to B- in the bottom panel, but C- is higher than B- in the middle panel). This again indicates that, on average, the Control condition resulted in a larger reduction of threat expectancy for stimulus C than the Subtle safety behavior condition.

A closer look at the data, however, showed that threat expectancy ratings for C varied substantially between participants within the Subtle safety behavior condition ($SD = 47.53$), and showed a dichotomous distribution (see Figure 4). This was not the case in the Full avoidance ($SD = 1.61$) and Control condition ($SD = 6.14$). In the Subtle safety behavior condition, threat expectancy for C had decreased for approximately half of the participants ($n = 11$), whereas for approximately the other half of the participants, it had persisted ($n = 9$), or had become ambiguous ($n = 1$). State and trait anxiety scores did not differ between participants within the Subtle safety behavior condition whose threat expectancy had, and had not, decreased, ts < 1.

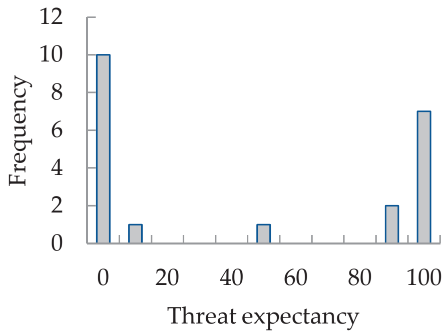

Figure 4. Distribution of threat expectancy ratings for C in the Test phase for the Subtle safety behavior condition in Experiment 2 ($n = 21$).

GENERAL DISCUSSION

The aim of the current study was to investigate whether the negative effects of safety behavior on fear extinction depend on whether safety behavior precludes the occurrence of threat. In Experiment 1 and 2, we replicated Lovibond et al.'s (2009) finding that safety behavior that precludes the occurrence of threat prevents fear extinction. In line with our hypothesis, threat expectancy ratings for C in the Test phase were higher in the Full avoidance condition than in the Subtle safety behavior and Control condition. This is depicted in Figure 1 for Experiment 1 and in Figure 3 for Experiment 2 by the red dots (C-) in the Test phase that are higher in the Full avoidance condition (upper panel of Figure 1 and 3) than in the Subtle safety behavior (middle panel of Figure 3) and Control condition (bottom panel of Figure 1 and 3). Furthermore, in Experiment 2, it seemed that safety behavior that minimized threat severity, but did not preclude the occurrence of threat (subtle safety behavior) did not prevent extinction. Threat expectancy was lower for C than for the danger stimulus A in the Subtle safety behavior and Control condition, which was in line with our hypothesis. This is depicted in Figure 3 by the red dot (C-) that is lower than the blue dot (A+) in the middle panel for the Subtle safety behavior condition and in the bottom panel for the Control condition. However, a closer look at the data showed that extinction occurred for approximately half of the participants in the Subtle safety behavior condition, but did not occur for the other half. At the debriefing, participants whose threat expectancy had decreased described that they had learned that C was no longer followed by the loud noise, irrespective of whether they could use subtle safety behavior. Participants whose threat expectancy had not decreased explained that they had learned that C was followed by the loud noise, except on trials when they could use subtle safety behavior.

The current findings replicate the findings of Lovibond et al. (2009), and together they indicate that, generally, safety behaviors aimed at preventing the occurrence of threat prevent fear extinction, and may thus be detrimental to the beneficial effects of exposure, and safety behavior aimed at minimizing the severity of threat ('subtle safety behavior') may not hinder extinction learning. Nevertheless, Experiment 2 of the current research also showed that for some participants who used subtle safety behavior extinction was prevented. There are various explanations for this. Two parsimonious explanations come from the inhibitory learning model of fear extinction (Craske et al., 2014). The inhibitory learning model posits that fear extinction involves new learning of an inhibitory association between the CS and the US (Bouton 2002, 2004, 2016). A first potential explanation is that the availability of the subtle safety behavior functioned as a negative occasion setter (Bouton, 2016) and prevented inhibitory learning, despite the changes we had made to the experimental task in Experiment 2 to prevent this. In Experiment 2, participants may have perceived the instruction screen that preceded the CS on full avoidance and subtle safety behavior trials or taking off the headphones itself as a cue that inhibited the CS – US association. This would have prevented participants from learning the inhibitory CS – US association.

A second potential explanation is that participants who did not show extinction in the Test phase may have perceived different contexts in the experimental task, which caused contextual renewal of threat expectancy for C in the Test phase. According to the inhibitory learning model, the individuals learned two associations: an excitatory association (CS – US) and an inhibitory association (CS – no US; Craske et al., 2014). Extinction learning is context-dependent (Bouton, 2004), which means that the inhibitory association is dominant in the context in which extinction learning occurred. A change in the external context or in a person's internal state after extinction can cause a return of fear for the CS (contextual renewal; Bouton, 2002, 2004, 2016; Vervliet, Craske, & Hermans, 2013). Extinction learning occurred in the 'headphones off' context for participants in the Subtle safety behavior condition, whereas threat expectancy in the Test phase was assessed in the 'headphones on' context. The Test phase context, which was similar to the acquisition context, was related the excitatory CS – US association, and may have returned threat expectancy for C.

It is unclear what caused the between-subjects differences in extinction learning within the Subtle safety behavior condition. The data were obtained from a small (n = 21 for the Subtle safety behavior condition), and specific (i.e., undergraduate students who were approximately 23 years old) group of participants, and yet they showed maximal variation in threat expectancy ratings for C in the Test phase. This variation was not caused by between-subjects differences within the Subtle safety behavior condition in state or trait anxiety. There are numerous individual difference factors that impact fear conditioning processes (see Lonsdorf et al., 2017, for a non-exhaustive list of individual differences factors). However, the between-subjects differences within the Subtle safety behavior condition were an unexpected finding and should be interpreted with caution. Replication of the current findings in a larger and more heterogeneous sample, and on additional outcome measures is warranted.

Furthermore, future research should investigate the role of individual differences in the negative effects of safety behavior on extinction learning. Safety behaviors that minimize threat severity, but do not prevent the occurrence of threat, may allow extinction learning for some, but not all, individuals. In a recent fear conditioning study, patients with anxiety disorders more often showed impaired extinction learning than healthy control participants (Duits et al., 2017). Furthermore, impaired extinction learning predicted poorer treatment outcomes. Identifying individual characteristics that predict the negative effects of safety behaviors on fear extinction can provide insights for the development of personalized treatment, and may improve treatment outcomes.

In conclusion, safety behavior that precludes the occurrence of threat prevents extinction learning, and may therefore be detrimental to the beneficial effects of exposure. Furthermore, in Experiment 2, we found that safety behavior that minimized threat severity, but does not prevent the occurrence of threat, can allow extinction learning. This finding supports the proposition for the reconsideration of the categorical rejection of safety behavior during treatment made by Rachman et al. (2008). However, for several participants, safety behavior that minimized threat severity prevented extinction learning. The negative effects of safety behavior on extinction learning may not only depend on whether safety behavior aims to preclude the occurrence of threat. Future research is needed to investigate which safety behaviors should be eliminated during exposure-based therapy, and which safety behaviors may be incorporated into treatment, and for whom.

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3

DISCONFIRMING CONTAMINATION-RELATED THREAT BELIEFS BY EXPOSURE PLUS SAFETY BEHAVIOR

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ABSTRACT

Background and objectives: Safety behavior (SB) is detrimental to the beneficial effects of exposure, because it prevents patients from obtaining evidence that disconfirms their excessive threat beliefs. However, previous studies showed that cleaning SB during exposure to a contaminant does not prevent a reduction in feelings of contamination, fear of contamination, danger, and disgust (CFDD). We aimed to directly examine the effect of SB during exposure to a contaminant on threat beliefs associated with CFDD.

Method: Healthy participants were randomly assigned to one of three groups: repeated exposure to a contaminant whilst abstaining from SB (exposure plus response prevention; E+RP); with the use of disinfectant wipes after each instance of exposure (exposure plus SB; E+SB); or no exposure or safety behavior (control condition). Participants identified their threat belief associated with the contaminant and rated CFDD and the degree to which they believed their threat belief at the pre- and post-test.

Results: The E+RP and E+SB condition resulted in a larger decrease of CFDD and threat belief ratings than the control condition, whereas these reductions did not differ between the E+RP and E+SB condition.

Limitations: Results were obtained from a nonclinical sample, and with a single session of exposure.

Conclusion: Cleaning SB did not impede the beneficial effects of exposure.

INTRODUCTION

In patients with anxiety disorders safety behavior (SB) maintains threat beliefs, and thereby anxiety, because it prevents them from obtaining evidence that disconfirms their excessive threat beliefs (e.g., Salkovskis, 1991). Patients are therefore encouraged to inhibit their SB during exposure (i.e., exposure response prevention or ERP), in order not to misattribute the non-occurrence of a catastrophe to the SB. Rachman, Radomsky, and Shafran (2008), however, called for a reconsideration of the categorical rejection of SB during treatment. They argued that there is no evidence that all SBs necessarily prevent disconfirmatory experiences, and that the incorporation of SB in exposure could facilitate treatment and may reduce drop-out and refusal. Recent research suggests that adding SB to exposure can indeed enhance treatment acceptability (Milosevic & Radomsky, 2013a; Levy & Radomsky, 2014; Levy, Senn & Radomsky, 2014), although other studies did not find differences in acceptability between exposure with SB (E+SB) and without SB (E+RP; see, for example, Deacon, Sy, Lickel, & Nelson, 2010; Milosevic & Radomsky, 2013b). Additionally, although several studies have shown unfavorable effects of E+SB compared to E+RP (e.g., Salkovskis, Clark, Hackmann, Wells, & Gelder, 1999; McManus, Sacadura, & Clark, 2008), other studies suggest that SB is not always detrimental to the beneficial effects of exposure. E+SB and E+RP resulted in comparable reductions in fear of snakes (Milosevic & Radomsky, 2008), fear of spiders (Hood, Antony, Koerner & Monson, 2010; Milosovic & Radomsky, 2013b), claustrophobic fear (Deacon et al., 2010; Sy, Dixon, Lickel, Nelson & Deacon, 2011), and feelings of contamination (Rachman, Shafran, Radomsky, & Zysk, 2011; van den Hout, Engelhard, Toffolo, & van Uijen, 2011; van den Hout, Reininghaus, van der Stap, & Engelhard, 2012). Overall, findings concerning SB effects on exposure outcomes are mixed. In a recent literature review, Blakey and Abramowitz (2016) concluded that while SB is not always detrimental to the beneficial effects of exposure, it does tend to interfere with therapeutic effects. However, a meta-analysis did not find evidence in favor of either the incorporation or removal of SB during exposure (Meulders, Van Daele, Volders, & Vlaeyen, 2016).

How can the beneficial effects of E+SB be explained? From a cognitive perspective, it seems unlikely that participants' fears would decrease if their threat beliefs remained unchanged. Closer inspection of the operationalization of SB in these studies suggests that the behavior may not have prevented disconfirmation of threat beliefs. For example, in the studies by Milosevic and Radomsky (2008, 2013), participants in the E+SB condition could wear protective gear, such as gloves and goggles, during exposure to a harmless snake (2008) or spider (2013). This would not have prevented the corrective learning experience of, for example, not getting attacked by the snake. Additionally, Milosevic and Radomsky (2013) directly assessed threat beliefs which indeed decreased not only in the E+RP condition, but also during E+SB. It thus appears that if SB does not preclude learning about the non-occurrence of the feared catastrophe, it does not impede the effects of exposure.

Notable exceptions to this explanation seem to be studies on feelings of contamination (Rachman et al., 2011; van den Hout et al., 2011, 2012). During two sessions, separated by a two-week interval, healthy participants repeatedly touched a contaminated stimulus, either while abstaining from any form of SB (E+RP) or with the use of disinfectant wipes after each instance of exposure (E+SB). At the post-test after each session, none of the participants could clean themselves. E+SB and E+RP produced comparable, large, and stable reductions in feelings of contamination, fear of contamination, danger and disgust (CFDD). However, cleaning oneself with a wipe after exposure to a contaminant should logically *prevent* disconfirmatory learning experiences about the feared consequences of contamination. Participants should misattribute the non-occurrence of contamination and subsequent infection or illness to the use of SB: "Nothing bad happened, because I cleaned myself".

Several explanations for the positive effect of using wipes after exposure to a contaminant have been provided. First, van den Hout et al. (2012) hypothesized that SB did not prevent a reduction of contamination fear through the commitment to future exposures: the knowledge that one would re-contaminate oneself again after wiping may have made the SB irrelevant. An E+SB and an E+RP condition with high commitment to exposure were compared to an E+SB condition with low commitment to exposure. Participants signed a declaration stating that they would do their utmost best to finish the series of twenty exposure trials, because the data would otherwise be unusable (high commitment), or stating that they could quit at any moment, because finishing the experiment was not necessary for the usability of the data (low commitment). Contrary to the hypothesis, the effects of E+SB with a strong commitment to exposure were comparable to the effects of E+SB with a small commitment to exposure and to E+RP (van den Hout et al., 2012). Second, Levy and Radomsky (2016) argued that the beneficial effects of E+SB are due to the novelty of the SB: SB that has never been used before has not been associated with prevention or avoidance of feared outcomes, and may therefore not cause a misattribution of safety to the behavior. In their study, patients with obsessive-compulsive disorder (OCD) and contamination fear received one exposure session to a contaminant without the use of SB (E+RP), with SB they routinely used, or with SB they had never used before. The three conditions showed comparable reductions in contamination fear on a behavioral approach test and on subjective anxiety ratings. Notably, exposure with never-used SB resulted in a greater reduction of self-reported contamination fear than exposure with routinely-used SB and E+RP. Third, Goetz and Lee (2015) showed that it is important to distinguish whether SB is aimed at preventing future distressing emotional responses or increases in anxiety, or performed to decrease the emotional experience in a feared situation (i.e., restorative), as is the case with cleaning yourself after touching a contaminating object. In their study, healthy participants repeatedly touched a contaminant without the use of SB (E+RP), with the use of preventive SB (e.g., holding a tissue while touching), or with the use of restorative SB (e.g., using hand sanitizer after touching). Exposure with restorative SB resulted in greater reductions in fear and behavioral avoidance than exposure with preventive SB and E+RP, and E+RP outperformed exposure with preventive SB. Goetz & Lee (2015) reasoned that using restorative SB after exposure can decrease fear of contamination, because it enables patients to learn about their ability to tolerate distress during exposure and to cope with feelings of contamination. However, they defined SB based on its function in relation to emotional distress (cf. Helbig-Lang & Petermann, 2010), which may not be synonymous with SB aimed at preventing feared outcomes. Restorative SB can still be expected to prevent the disconfirmation of threat beliefs about future catastrophes.

Whether cleaning SB prevents the disconfirmation of threat beliefs associated with touching a contaminant is an empirical question that can be assessed directly. We therefore aimed to extend the findings by Rachman et al. (2011) and van den Hout et al. (2011) by incorporating a direct examination of the effect of SB on threat beliefs associated with feelings of contamination, fear of contamination, danger and disgust (CFDD). We expected that the results for feelings of CFDD would be replicated, that is, that the E+RP and E+SB condition would show a pre- to post-test decrease in CFDD ratings, compared to a no-exposure control condition (cf. van den Hout et al., 2011). Furthermore, in line with cognitive theory, we hypothesized that participants in the E+RP condition would show a larger pre- to post-test decrease in the degree to which they believed a threat belief related to the contaminant than participants in the E+SB condition and participants in a no-exposure control condition. Additionally, we explored the time course of effects on CFDD in the E+RP and E+SB condition, and effects of the interventions on perceived control (cf. van den Hout et al, 2011, 2012).

METHOD

Participants

Participants were recruited using posters, flyers and online advertisement on the university website. A total of 297 students were screened for contamination fear with the Padua Inventory - Contamination Obsessions and Washing Compulsions subscale (PI–COWC; Burns, Keortge, Formea, & Sternberger, 1996; see 2.3.1). Individuals who scored 3 or higher (n = 225, above the lowest-quartile range, to decrease the likelihood that participants had to be excluded after the pre-test, see 2.2.1) and indicated willingness to participate (n = 180) were invited to participate, of whom 103 agreed to make an appointment. Exclusion criteria were past or current OCD diagnosis (n = 1); contamination scores for all six contaminants (see 2.4) at the pre-test below 60 (n = 11, cf. van den Hout et al., 2011); and a score below 60 for the threat belief at the pre-test (n = 25; see 2.2.1), because this indicated that participants considered their threat belief largely unbelievable. This resulted in a final sample of 66 participants (13 men; M_{age} = 21.68, SD = 2.95; $M_{PI\text{-}COWC}$ = 8.89, SD = 5.54), who were randomly assigned to the E+RP (n = 22; 4 men), E+SB (n = 22; 5 men), or control (n = 22; 4 men) condition. Participants gave written informed consent and received money or course credit for their cooperation.

Procedure

The procedure for session 1 by van den Hout et al. (2011; see also Rachman et al., 2011) was replicated, with the addition of the identification of a threat belief and rating it at the pre- and post-test.

Pre-test measurement

The contaminant (see 2.4) that evoked the highest feeling of contamination was selected as the contamination stimulus for the experimental trials (see van den Hout et al., 2011, Baseline measurement). The experimenter put the contaminant in front of the participant and asked "What did you feel when you just touched this object? Can you describe this feeling in one word?" (e.g., disgust) "Can you rate the intensity of this feeling on a scale of 0 to 100?" The experimenter asked as many of the following questions as necessary to identify the catastrophic belief: "Which thought went through your head when you touched this object and felt … (e.g., disgusted)?"; "What might happen when you touch this object? And what would happen next?"; "What is the worst thing that might happen when you touch this object?". After the participant had identified his or her threat belief (e.g., if I touch this object, I will get ill), the experimenter repeated it to the participant, and asked "How believable is this statement to you?", and to rate this on a 0 (*not at all believable*) to 100 (*extremely believable*) scale.

Experimental trials

A detailed description of the procedure for the experimental trials can be found in van den Hout et al. (2011). Participants in the E+RP and E+SB condition touched the contaminant 20 times, and rated CFDD right after touching it and after a 30s delay. During this delay, participants in the E+SB condition cleaned their hands with a hygienic wipe, except at the final (20th) trial, when they did not use a wipe. Participants in the control condition waited for 20 min while reading a magazine or newspaper. After this, they touched the selected contaminant and rated CFDD. None of the participants in the E+RP and the control condition washed or cleaned themselves.

Post-test measurement

After the final experimental trial, the threat belief that participants had identified at the pre-test was repeated to them, and they were asked to rate how believable they though it was again. Participants were then asked to describe why they thought the degree to which they believed their threat belief had decreased/increased/stayed the same from the pre-test to the post-test. We did this to gain insight in the reasons for potential changes in these belief ratings. Participants were thanked, debriefed, and rewarded for their participation.

Measures

CFDD, expectations regarding the effectiveness of the intervention, and perceived control were measured cf. van den Hout et al. (2011; Measures).

Padua inventory - contamination obsessions and washing compulsions subscale (PI-COWC)

The PI-COWC (Burns et al., 1996) was used for screening individuals on contamination fear. This 10-item (rated on a scale from 0 [*not at all*] to 4 [*very much*]) self-report measure was translated to Dutch, and item 6 was modernized by changing it from "I avoid using public telephones, because I am afraid of contagion and disease" to "I avoid using handrails in public places, because I am afraid of contagion and disease". The PI-COWC shows good test-retest reliability, r = .72, and internal consistency, α = .85 (Burns et al., 1996), in this sample, Cronbach's α = .88.

Contaminants

In a pilot study prior to the experiment, 10 contaminants that were used in previous studies (Rachman et al., 2011; van den Hout et al., 2011; Levy & Radomsky, 2014) were presented to 10 student volunteers. The procedure was similar to the pre-test measurement procedure (see 2.2.1). The six items that elicited the highest contamination ratings were selected for the experiment:[1]

1) Shoe: Participants were asked to rub the bottom of their shoe with one hand.
2) Hair: Human hair was collected and placed in a small plastic container.
3) Garbage: A small garbage can was presented to the participant. The items inside included actual (safe) garbage collected by the experimenters, such as food wrappers, used coffee cups, a diaper made to look dirty with tea, an unused condom with hand gel inside, and a clean tampon wrapped in toilet paper.

[1] Details about the nature and findings of the pilot study can be obtained from the first author.

4) Dirty laundry: A plastic laundry basket filled with items of clothing, underwear, old cleaning cloths and an old oven glove was presented. All items were made to look dirty using coffee.
5) Bedpan: A white plastic bedpan that was made to look dirty with tea and yellow food coloring was presented to the participant. It contained yellow liquid made with food coloring to resemble urine.
6) Lab specimen: A small biohazard zip bag containing the following items was presented to the participant: surgical gloves, oral thermometer, open grimy looking plaster, 2 ml micro-tube containing a drop of hand sanitizer, small piece of ripped rolled-up gauze, and a cotton stick.

Data analysis

Pre-test differences between conditions were analyzed with one-way ANOVAs and one-way MANOVAs for CFDD, perceived control, and expectations. 2 (Time, pre-test vs. post-test) x 3 (Condition, E+RP vs. E+SB vs. control) mixed MANOVAs, and subsequent 2x3 mixed ANOVAs were used to analyze CFDD and perceived control. Pre-test CFDD ratings (see van den Hout et al., 2011) for the selected contaminant were used as pre-test ratings. Post-test ratings were CFDD ratings for trial 20 before the 30s delay (E+RP and E+SB), or trial 2 (control). Threat belief ratings were analyzed with a 2 (Time, pre-test vs. post-test) x 3 (Condition, E+RP vs. E+SB vs. control) mixed ANOVA. The relationship between pre- to post-test changes in threat beliefs and CFDD ratings was explored with Pearson r correlations. To explore the time course of effects in CFDD in the E+RP and E+SB condition, quadratic trends were analyzed with 21 (Time, pre-test to trial 20) x 2 (Condition, E+RP vs. E+SB) ANOVAs. The immediate effects of wiping (E+SB) and waiting (E+RP) on CFDD were assessed by comparing CFDD ratings at the moment right after touching the contaminant (i.e., before wiping or the 30s delay) and after wiping or the 30s delay. This was analyzed with 19 (Trial, trial 1 to 19) x 2 (Moment, before vs. after wiping or the 30s delay) x 2 (Condition, E+RP vs. E+SB) mixed ANOVAs. Planned comparisons were performed with independent and paired t-tests. For all analyses we used α = 0.05.

RESULTS

Pre-test measures

At the pre-test, participants described that they felt disgusted (n = 29; 44%), dirty (n = 27; 41%), or fearful (n = 9; 14%) while touching the contaminant. There were no pre-test differences between conditions in the intensity of these feelings (M = 78.41, SD = 13.91), threat belief ratings, and PI-COWC, Fs(2,63) < 0.57, p's > .56; or in CFDD feelings and perceived control, Fs(8,122) < 1.18, ps > .31. All participants identified threat beliefs along the lines of "If I touch this object, then I will get contaminated and get ill".

Expectation ratings regarding the effectiveness of the intervention differed between conditions, $F(8,122) = 2.31$, $p = .02$, $\eta_p^2 = .13$, see Table 1. This effect was found for contamination, fear of contamination, and danger, Fs(2,63) > 5.36, ps < .008, η_p^2s > .14, but not for disgust, $F(2,63) = 2.31$, $p = .13$. For contamination, fear of contamination, and danger, expectations were higher in the E+RP condition than in the control condition, ts(42) > 2.59, ps < .02, ds > 0.78, and were higher in the E+SB than in the control condition, ts(42) > 2.75, ps < .010, ds > 0.83. Expectations did not differ between the E+RP and E+SB condition, ts(42) < 0.66, ps > .51. Results for CFDD ratings were similar when analyses were performed with 2x3 mixed ANCOVAs with expectations included as covariates, which suggests that the differences between conditions in the expected effectivity of the intervention did not influence the changes found in CFDD ratings.

Table 1. Mean (*SD*) expectations and between-group comparisons regarding the effectiveness of the intervention for contamination, fear of contamination, danger, and disgust for the exposure plus response prevention (E+RP), exposure plus safety behavior (E+SB), and control condition.

	E+RP[1]	E+SB[2]	Control[3]	Comparisons
Contamination	61.59 (20.55)	66.14 (25.45)	44.55 (22.88)	1, 2 > 3
Fear	58.18 (25.57)	55.91 (21.42)	35.00 (26.55)	1, 2 > 3
Danger	62.18 (29.02)	57.05 (26.84)	35.91 (23.89)	1, 2 > 3
Disgust	42.73 (30.54)	52.05 (20.85)	36.82 (27.45)	1, 2, 3

Effects of the intervention

CFDD

Multivariate analyses. There was a pre- to post-test decrease in CFDD, $F(4,60) = 62.65$, $p < .001$, $\eta_p^2 = .81$, which differed between conditions, $F(8,122) = 6.27$, $p < .001$, $\eta_p^2 = .29$. CFDD decreases were larger in the E+RP and E+SB condition than in the control condition, see Figure 1. The main effect of Condition, $F(8,122) = 3.66$, $p = .001$, $\eta_p^2 = .19$, appears to be caused by the lower scores at the post-test in the E+RP and E+SB conditions compared to the control condition.

Univariate analyses. There was a main effect of Condition for contamination, fear of contamination, and disgust, Fs$(2,63) > 4.41$, ps $< .02$, η_p^2s $> .12$, but not for danger, $F(2,63) = 2.38$, $p = .10$. Contamination, fear of contamination, danger, and disgust decreased from pre- to post-test, Fs$(1,63) > 130.50$, ps $< .001$, η_p^2s $> .67$. For all four measures, this decrease differed between conditions, Fs$(2,63) > 19.26$, ps $< .001$, η_p^2s $> .37$. Compared to the control condition, decreases were larger for the E+RP, ts$(29.87) > 4.68$, ps $< .001$, ds > 1.41, and E+SB condition, ts$(42) > 5.51$, ps $< .001$, ds > 1.66. They did not differ between the E+RP and E+SB condition, ts$(42) < 1.18$, ps $> .25$. Correlations between pre- to post-test changes in threat belief and CFDD ratings were medium to large, see Table 2.

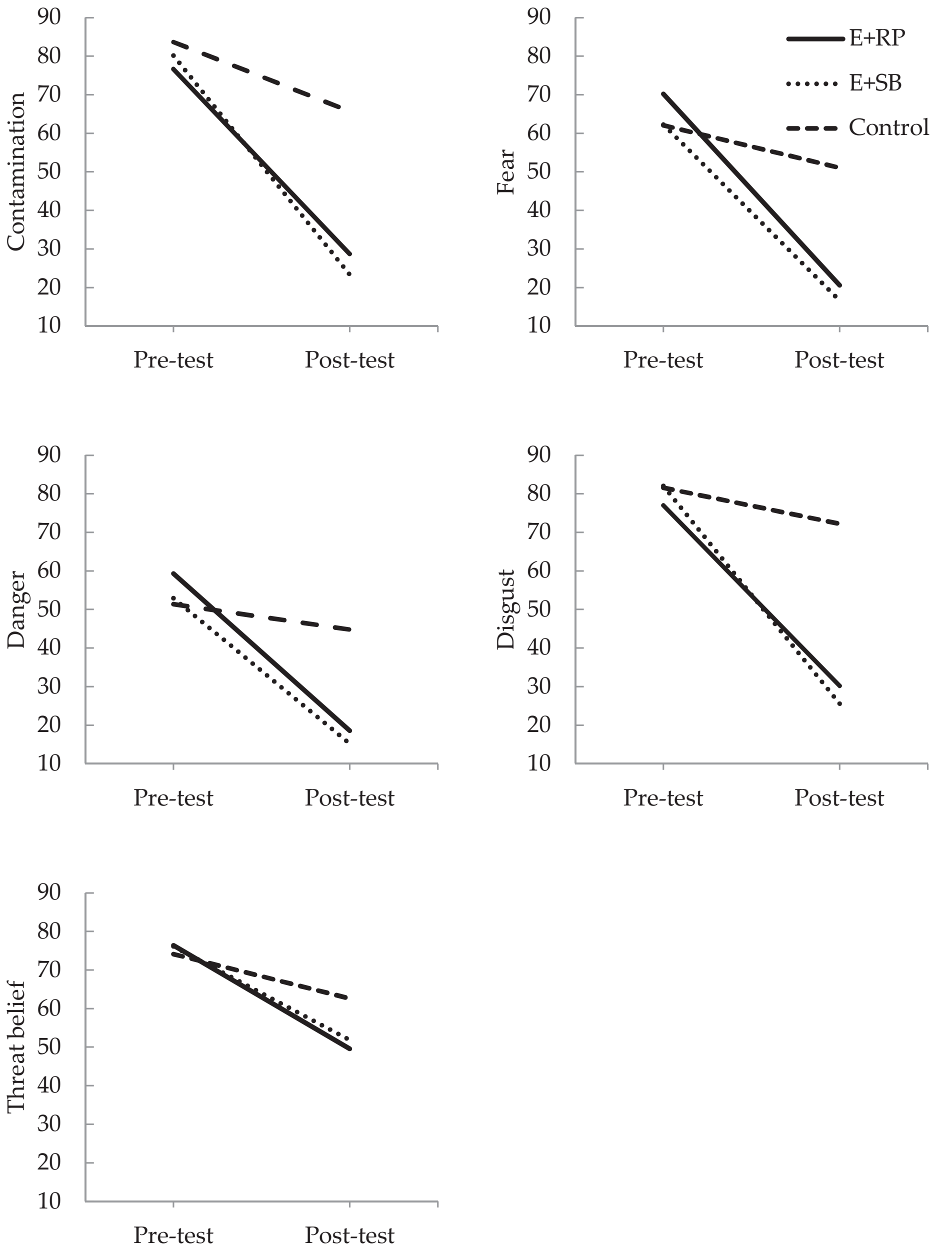


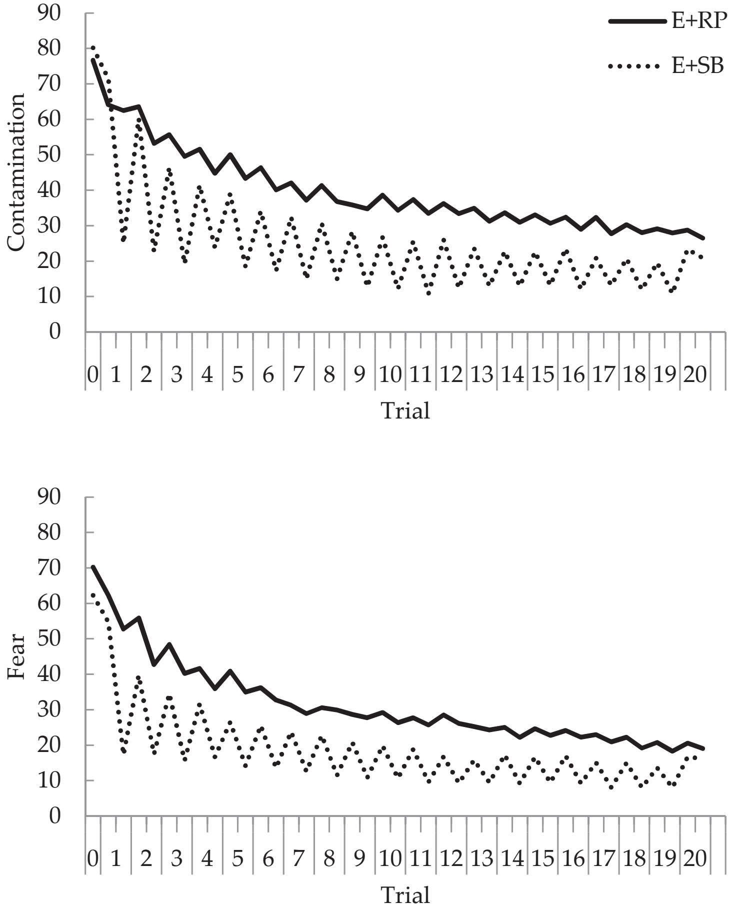
Figure 1. Pre- to post-test changes in contamination, fear of contamination, danger, disgust, and threat belief ratings for the exposure plus response prevention (E+RP), exposure plus safety behavior (E+SB), and control condition.

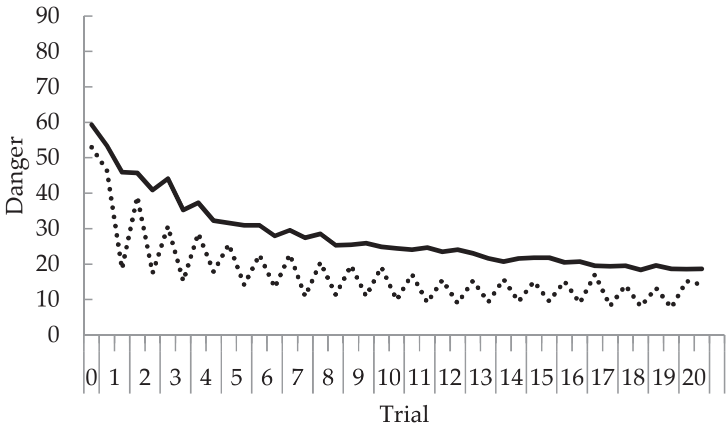
Table 2. Pearson r correlations between pre- to post-test changes in contamination, fear of contamination, danger, disgust, and threat belief ratings; *df* = 66, all *p*s < .001.

	Fear	Danger	Disgust	Threat belief
Contamination	.77	.67	.88	.58
Fear		.76	.77	.50
Danger			.68	.44
Disgust				.45

E+RP vs. E+SB: time course of effects. Figure 2 depicts the CFDD ratings at the pre-test (trial 0), and before and after wiping (E+SB) or the 30s delay (E+RP) at each exposure trial. The curves suggest that the largest reductions in CFDD took place in the first trials. When looking at the ratings immediately after touching the contaminant, the curves indeed followed a quadratic trend over Time, *F*s(1,42) > 68.67, *p*s < .001, η_p^2s > .62, for all four measures. These quadratic trends were stronger in the E+SB condition than in the E+RP condition for contamination and disgust, indicated by Time x Condition interactions in quadratic trends, *F*s(1,42) > 5.31, *p*s < .03, η_p^2s > .11. These interactions were not significant for fear of contamination and danger, *F*s(1,42) < 0.21, *p*s > .65. As can be seen in Figure 2, CFDD ratings in the E+SB condition increased slightly from trial 19 to trial 20, when participants did not use a wipe after touching the contaminant. These increases were significant for contamination, fear, and disgust, *F*s(1,21) > 6.90, *p*s < .02, η_p^2s > .24, and showed a trend for danger, $F(1,21) = 4.00$, $p = .059$, $\eta_p^2 = .16$. However, CFDD ratings did not differ between the E+SB and E+RP condition in trial 20, *t*s(42) < 0.68, *p*s > .50.

Figure 2 also depicts the immediate effects of wiping (E+SB) and waiting (E+RP) at each exposure trial. The E+SB curve shows a distinct saw tooth pattern, whereas this pattern is less pronounced in the E+RP curve. Compared to the ratings immediately after touching the contaminant, decreases in CFDD ratings were larger after wiping (trial 1 to 19 in the E+SB condition) than after the 30s delay (in the E+RP condition), $Fs(1,42) > 8.69$, $ps < .01$, $\eta_p^2 s > .17$.





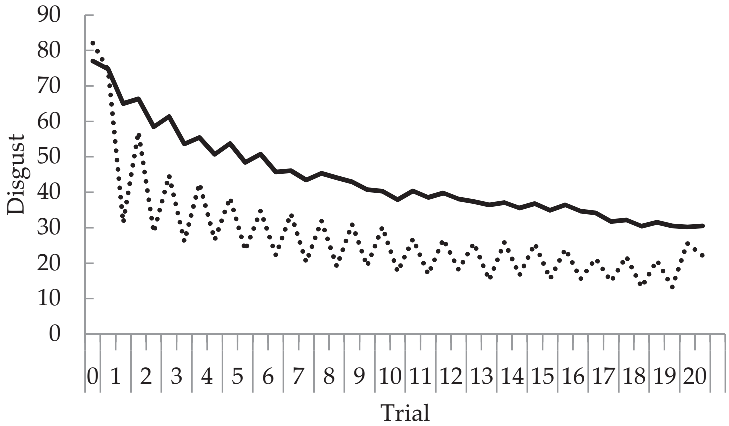


Figure 2. Contamination, fear of contamination, danger, and disgust (CFDD) ratings for the exposure plus response prevention (E+RP) and exposure plus safety behavior (E+SB) condition at the pre-test (trial 0), and before and after wiping (E+SB) or the 30s delay (E+RP) at each of the 20 exposure trials. Note that participants in the E+SB condition did not use a wipe at trial 20 either.

Perceived control

Perceived control did not change from pre- to post-test, $F(4,60) = 0.62$, $p = .65$, or differ between conditions, $F(8,122) = 0.86$, $p = .55$. There was no Time x Condition interaction, $F(8,122) = 1.01$, $p = .43$. Mean perceived control ranged from 52.62 (SD = 24.42; pre-test disgust) to 71.64 (SD = 21.87; post-test danger).

Threat belief

There was a pre- to post-test decrease in threat belief ratings, $F(1,63) = 67.98$, $p < .001$, $\eta_p^2 = .52$, which differed between conditions, $F(2,63) = 3.51$, $p = .04$, $\eta_p^2 = .10$, see Figure 1. There was no main effect of Condition, $F(2,63) = 0.87$, $p = .42$. Compared to the control condition, the decrease was larger in the E+RP, $t(42) = 2.49$, $p = .02$, d = 0.75, and E+SB condition, $t(42) = 2.16$, $p = .04$, $d = 0.65$. The decrease in the E+RP and E+SB condition did not differ, $t(42) = 0.38$, $p = .70$. Paired-tests show that threat beliefs decreased significantly and substantially in each condition: E+RP $t(21) = 5.65$, $p < .001$, $d = 1.52$; E+SB $t(21) = 5.46$, $p < .001$, $d = 1.36$; and control $t(21) = 2.94$, $p = .008$, $d = 0.66$.

Reasons for change in belief ratings

Participants' explanations of why the degree to which they believed their threat belief had decreased/increased/stayed the same from the pre-test to the post-test are summarized in Table 3. Participants could provide more than one reason. The reported reasons for decrease could conveniently be divided into five categories. The first was a habituation and emotional reasoning (Arntz, Rauner, & van den Hout, 1995; Engelhard & Arntz, 2005) pattern: participants explained that their feelings of CFDD had decreased due to repeated exposure to the contaminant, and that they therefore considered it less likely that they would get ill after touching the contaminant. The second argument related to disconfirmation: participants noticed that they did not get ill immediately after touching the contaminant, and they therefore considered it less likely that they would get ill on the long-term. The third process entailed stimulus (conditioned stimulus or CS) reevaluation: participants reported that they had noticed that the contaminant was not as dirty or dangerous as they had originally thought. The fourth process involved threat (unconditioned stimulus or US) reevaluation: participants reported that they had cognitively reevaluated their threat belief, for example, by relating it to other instances when they had to touch something disgusting (e.g., while cleaning a toilet), which had not resulted in catastrophe either. The fifth process was only reported by participants in the E+SB condition, and is related to the use of SB: participants reported that they considered it less likely that they would get ill, because they had learned that they could easily clean their hands.

DISCUSSION

We aimed to extend the findings by Rachman et al. (2011) and van den Hout et al. (2011) by directly examining the effect of using cleaning SB during exposure to a contaminant on threat beliefs. In line with our hypothesis, we replicated the finding that the E+RP and E+SB condition resulted in a larger pre- to post-test decrease of CFDD than a no-exposure control condition, whereas this decrease did not differ between the E+RP and E+SB condition. We want to emphasize that none of the participants used SB at the post-test. Remarkably, and contrary to our hypothesis, we found a similar effect for threat beliefs: the E+RP and E+SB condition showed a larger pre- to post-test decrease in threat belief ratings than the control condition, and this decrease did not differ between the E+RP and E+SB condition. It appears that using wipes after exposure did not prevent a reduction in the degree to which participants believed their threat belief. CFDD ratings before and after wiping (E+SB) or the 30s delay (E+RP) at each exposure trial showed a distinct saw tooth pattern in the E+SB curve, which was less pronounced in the E+RP condition. It is notable that the within-trial return of CFDD in the E+SB condition did not prevent an over-trial decrease.

Table 3. Participants' explanations for the pre- to post-test change in threat belief ratings in the exposure plus response prevention (E+RP), exposure plus safety behavior (E+SB) and control condition.

Change	Explanation	Example	E+RP	E+SB	Control
Increase	ER	"The longer I looked at it, the more disgusted I became."	2	2	5
No change	No disconfirmation	"The duration was not long enough to find out if I will get ill or not."	1	1	3
Decrease	Habituation/ER	"My feelings of disgust and contamination decreased, I got used to it. The risk seems less severe now."	11	12	9
	Disconfirmation	"I have not gotten ill immediately."	5	3	1
	CS reevaluation	"I got to take a better look at the object, which made me see that it was not as dangerous as I thought."	2	2	3
	US reevaluation	"I associated it with cleaning a toilet: You do not get ill from that either."	6	2	4
	SB availability	"Because I know I can clean my hands, the risk felt less severe".	-	5	-

Note. Change = the pre- to post-test change threat belief ratings; No. = the number of participants who reported an increase, no change, or a decrease in plausibility of their threat belief; Explanation = the category of the explanation participants reported; ER = emotional reasoning; CS reevaluation = reevaluation of the contaminant; US = reevaluation of the expected catastrophe; Fr. = the frequency with which each category of explanation was given by participants. Note that some participants reported more than one explanation.

We regard the finding that cleaning SB after exposure did not prevent a reduction in threat beliefs as unusually curious for various reasons. A theoretical reason is that cleaning SB logically prevents the acquisition of information that disconfirms inaccurate threat beliefs associated with contamination and illness (Salkovskis, 1991), and impedes inhibitory learning by preventing the maximal violation of negative expectancies (Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014). An empirical reason is that several studies have shown unfavorable effects of using SB during exposure compared to ERP (for an overview, see Meulders et al., 2016; and Blakey & Abramowitz, 2016). SBs in and by itself even appear sufficient to induce threat beliefs (Engelhard, van Uijen, van Seters, & Velu, 2015; van Uijen & Toffolo, 2015), health anxiety (Olatunji, Etzel, Tomarken, Ciesielski, & Deacon, 2011), and contamination fear (Deacon & Maack, 2008). How can we reconcile these findings, and explain the decrease in threat belief ratings in the E+SB condition?

The common denominator in the E+RP and E+SB condition was repeated exposure to the contaminant and to the subsequent feelings of contamination and disgust this induced, albeit short in the E+SB condition. It seems unlikely that expectancies about a feared future catastrophe were violated in this short period of exposure. However, it is possible that expectancies about the acute feelings of contamination evoked by touching the contaminant, the amount of distress, and the ability to tolerate this distress were violated, which caused inhibitory learning (Blakey & Abramowitz, 2016). CFDD ratings remained relatively low at the post-test when participants no longer used SB, which suggests that the inhibitory associations generalized to exposure without SB. Future studies that assess negative expectancies about immediate consequences of exposure to a contaminant are needed to give insight into the role of inhibitory learning in the reduction of CFDD and associated threat beliefs in E+SB.

Additionally, it may be relevant that the role of SB was examined in the context of contaminated objects that give rise to disgust. In the case of fear, a stimulus (e.g., heart palpitations in panic disorder) evokes fear, because it activates an expectancy of a threatening outcome (e.g., dying). A contaminated object may not (only) activate a representation of threat, but may directly evoke disliking and motivate avoidance of the stimulus. In other words, whereas fear may be best explained by Pavlovian (classical) conditioning, disgust may be better understood in terms of evaluative conditioning, which involves a hedonic judgment about the stimulus itself (i.e., like or dislike; see Engelhard, Leer, Lange, & Olatunji, 2014). Evaluative responses (like disgust) are more resistant to extinction than fear and threat expectancies (see Engelhard et al., 2014). However, evaluative-conditioned disgust may be reduced by counterconditioning (Engelhard et al., 2014), and habituation (Mason & Richardson, 2012). Unlike extinction, which involves inhibitory learning (Myers & Davis, 2007), habituation entails a reduction in responding to the stimulus. This can be achieved by repeated physical contact with the disgust-eliciting stimulus (Bosman, Borg, & de Jong, 2016), and may explain why the CFDD ratings decreased. We should note that this is different from the assumed mechanism of change in habituation-based models of exposure therapy (Foa & Kozak, 1986). Participants in the E+SB condition did not remain in the fearful situation (i.e., contaminated state) until fear decreased, but “wiped away” their feelings of CFDD. Moreover, the within-trial returns of CFDD at each exposure trial did not prevent over-trial reductions.

The reduction in CFDD ratings may have subsequently influenced threat belief ratings. Participants may have inferred danger from the emotions evoked by the judgment of the stimulus, that is, used emotional reasoning: “I feel disgusted, therefore this contaminant must be dangerous”. Indeed, Verwoerd, de Jong, Wessel, and van Hout (2013) found that students with a high fear of contamination inferred the risk of becoming ill on the basis of experienced disgust. As CFDD decreased over the exposure trials, perhaps emotional reasoning, and thus threat beliefs, declined too. This line of reasoning fits with the explanation the majority of participants gave for the decrease in threat beliefs (see Table 3).

Furthermore, the results may, at least partly, be explained by measurement issues. The semantic distinction between CFDD ratings and belief ratings is crucial for this study. However, participants may not have made a strict distinction between these measurements, but a more crude and general evaluation based on negative valence and arousal. Possibly, touching the contaminant became less unpleasant over the various trials, and participants may have subsequently rated all related items, i.e., CFDD and threat beliefs, as less negative. The moderate to high correlations between declines in CFDD ratings and declines in threat belief ratings (see Table 2) suggest that this may be the case. Additionally, several participants reported that they had difficulty explaining why the degree to which they believed their threat belief had decreased. The explanations (see Table 3) could be a case of "telling more than we can know" (Nisbett & Wilson, 1977): participants may have attempted to report on cognitive processes that are largely or entirely inaccessible by introspection.

Perceived control did not change from the pre- to the post-test for any of the conditions, or differ between conditions. Van den Hout et al. (2011) found an increase in perceived control over contamination, danger, and disgust after E+SB and E+RP, which was larger for the E+SB than for the E+RP condition for disgust in the first session. However, van den Hout et al. (2012) did not find any pre- to post-test changes or interactions with condition in perceived control. It thus remains unclear whether using SB during exposure affects perceived control, but it is unlikely that perceived control explains the findings in this study.

The generalizability of the current findings should be put to test in a clinical sample. However, results obtained with analogue samples are useful for understanding OC-related phenomena (Abramowitz et al., 2014). OC symptoms are prevalent in nonclinical populations, and the maintenance factors are similar to those in clinical populations. There are quantitative differences in the severity of OC symptoms between clinical and nonclinical populations, but qualitatively, symptoms appear to be largely similar (Abramowitz et al., 2014). Furthermore, Rachman et al. (2011) initiated the investigation of E+SB in healthy participants after successfully treating patients with a fear of contamination and compulsive washing with this method. Levy and Radomsky 2016) also obtained beneficial effects of E+SB in a clinical sample.

Five participants in the E+SB condition provided an explanation for the decrease in threat belief ratings that was related to the availability of SB, which may have implications for the beneficial effects obtained with E+SB. Even though participants did not clean themselves in the final exposure trial, they may have realized that they could clean their hands immediately after the experiment was finished, and taken this into account when they rated their threat belief at the post-test. Their threat beliefs may not have decreased in situations in which SB is not available for a longer period of time (Lovibond, Mitchell, Minard, Brady, & Menzies, 2009; Engelhard et al., 2015). It is a limitation of this study that we did not ask participants *when* they expected the catastrophe (i.e., contamination or illness) to happen, and that we only included a single session of exposure. All participants identified a threat belief related to getting contaminated and ill. Disconfirmation of the threat belief may therefore not have been fully possible during the experiment. Moreover, participants may have hindered a long-term reduction of threat beliefs by washing their hands after the experiment. Despite these limitations and the use of a nonclinical sample, threat belief ratings decreased significantly and substantially, with large effect sizes in the E+RP and E+SB condition. We therefore think that we did manage to capture cognitive change. It is clinically relevant that the beneficial effects of E+SB are maintained over time and generalize to the clinical population, and therefore further research with a clinical sample and multiple sessions of exposure is needed to investigate the long-term effect of E+SB on threat beliefs related to contamination.

Finally, it is remarkable that the within-trial return of CFDD in the E+SB condition did not prevent over-trial reductions of CFDD (see Figure 2). In line with findings of van den Hout et al. (2011, 2012), the reductions in CFDD in both the E+SB and the E+RP condition followed a quadratic curve. Furthermore, in the current study, contamination and disgust declined faster in the E+SB condition than in the

E+RP condition. CFDD increased in the E+SB condition at the final trial, when wipes were no longer used, which resulted in similar CFDD ratings at the post-test for the E+RP and E+SB condition. CFDD ratings after wiping or after the 30s delay were measured, but not reported in previous studies (Rachman et al., 2011; van den Hout et al., 2011, 2012). We revisited the data obtained by van den Hout et al. (2011), and found highly similar results: CFDD ratings showed a distinct saw tooth pattern in the E+SB condition, which was less pronounced in the E+RP condition.[2] This suggests that cleaning SB is indeed restorative, and that restorative SB does not necessarily prevent an over-trial reduction in emotional responses, which is in line with the findings by Goetz and Lee (2015).

To conclude, the use of cleaning SB during exposure to a contaminant did not prevent a reduction in CFDD and threat beliefs. Wiping after each instance of exposure resulted in an immediate decrease in CFDD, and subsequent return of CFDD at the next exposure trial. Remarkably, the within-trial return of CFDD did not prevent an over-trial reduction in emotional responses. Future research with a clinical sample, and looking into the long-term effects of using cleaning SB during exposure to a contaminant on threat beliefs is needed.

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[2] More information is available on request from the first author.

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SAFETY BEHAVIOR INCREASES OBSESSION-RELATED COGNITIONS ABOUT THE SEVERITY OF THREAT

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Author contributions: both authors contributed equally to this work. SvU conceptualized the research idea. SvU and MT designed the experiment and developed study materials. SvU supervised the data collection. MT extracted the data. SvU analyzed the data. MT drafted the introduction and method. SvU drafted the results and discussion. SvU and MT revised the manuscript.

ABSTRACT

This study investigated whether checking behavior, the most common safety behavior in obsessive-compulsive disorder (OCD), contributes to the development of OCD symptoms. Ninety healthy undergraduates spent a week between a pre- and post-test either actively engaging in clinically representative checking behavior on a daily basis (experimental group, n = 30); monitoring their normal checking behavior (monitor group, n = 30); or received no instructions on checking behavior (control group, n = 30). Cognitions about the severity of threat increased from pre- to post-test in the experimental group, but not in the monitor and control group. Cognitions about the importance of checking decreased in the monitor group. The results indicate that checking behavior contributes directly to the exacerbation of OCD symptoms. Together with the findings of previous studies, this suggests that safety behavior may be involved in the development of anxiety disorders and OCD. Potential mechanisms of how engaging in safety behavior increases threat perception are discussed.

INTRODUCTION

Safety behavior is common in both anxiety- and obsessive compulsive related disorders (American Psychiatric Association, 2013), and refers to actions aimed at preventing or minimizing a feared outcome (Salkovskis, 1991). Patients with social phobia, for instance, avoid eye contact because they fear rejection, patients with panic disorder quickly sit down when they feel their heart beat rising to avoid a heart attack, and patients with obsessive compulsive disorder (OCD) frequently check gas stoves, light switches, or electrical outlets, because they fear the catastrophe of their house burning down under their responsibility. Although these behaviors seem useful to patients and provide anxiety relief in the short term, they actually play a pivotal role in the maintenance of pathological anxiety in the long term (Clark, 1999; Salkovskis, Thorpe, Wahl, Wroe, & Forrester, 2003). Most importantly, safety behaviors cause a misattribution of safety, which prevents the acquisition of information that disconfirms inaccurate threat beliefs (Salkovskis, 1991), and divert attentional recourses away from this information (Sloan & Telch, 2002). For instance, in patients with OCD, the non-occurrence of their house burning down may erroneously be attributed to the repeated checking of the gas stove (i.e., safety behavior).

In addition to their role in the maintenance of symptoms, safety behavior seems to contribute directly to the *exacerbation* and *development* of anxiety and OCD symptoms. To illustrate, individuals with hypochondriasis may increase health anxiety by constantly checking their body (e.g., feeling for lumps, inspecting skin spots; see Abramowitz, Schwartz, & Whiteside, 2002), and patients with checking compulsions paradoxically enhance memory uncertainty by perseverative checking (Boschen & Vuksanovic, 2007). Recently, Engelhard, van Uijen, van Seters, and Velu (in press) showed that even in healthy individuals, the use of safety behavior leads to threat expectations to objectively safe stimuli. In a conditioning experiment, participants who displayed safety behavior (i.e., they could avoid a potential subsequent shock) to a safety cue (a stimulus that had never been paired with shock) subsequently had higher threat expectations to this cue than participants who were not given the opportunity to avoid. Thus, safety behavior seems to increase anxiety not only by misattributing safety to the execution of this behavior, but also by directly attributing danger to safe situations.

The possibility that safety behavior exerts a causal influence on anxiety was recently investigated in two studies. First, Deacon and Maack (2008) investigated the effects of safety behavior on the fear of contamination in healthy participants with either high or low levels of contamination fear. After a week-long baseline period, participants spent one week actively engaging in a wide range of contamination-related safety behaviors on a daily basis (e.g., washing and disinfecting hands excessively, trying to avoid touching public door handles), followed by a second week-long baseline period. Independent of initial levels of contamination fear, participants reported increased contamination anxiety following the safety behavior manipulation. However, because this study lacked a control condition that did not perform any safety behavior, it remained unclear what the effect of the manipulation was. Therefore, in a subsequent study, healthy participants were divided in two groups, a safety behavior group and a monitor-control group (Olatunji, Etzel, Tomarken, Ciesielski, & Deacon, 2011). In between two week-long baseline periods in which both groups monitored their normal use of safety behaviors, participants in the safety behavior condition were asked to spent one week engaging in a large array of health-related safety behaviors on a daily basis, whereas participants in the control condition kept monitoring their usual safety behavior. Results showed that, compared to the control condition, participants in the safety behavior condition reported higher levels of health anxiety, hypochondriacal beliefs and avoidant responses to health related behavioral tasks. Thus, even in healthy individuals, the mere act of engaging in health-related safety behaviors for one week increased health anxiety.

Although hypochondria was not classified as an anxiety disorder in the DSM-IV, and OCD has been separated from the anxiety disorders in the DSM-5 (American Psychological Association, 2013), there appears to be quite some overlap between these disorders and anxiety disorders (Deacon & Abramowitz, 2008). Thus, despite the distinct characteristics of the safety behaviors associated with these disorders, the role that safety behaviors may play in the development of OCD and anxiety disorders is expected to be functionally equivalent (Rachman 2002; Telch & Lancaster, 2012). However, checking behavior, the most commonly observed safety behavior in patients with OCD (i.e., in 80% among those with lifetime OCD; Ruscio, Stein, Chiu & Kessler, 2010), has unique features that include rigidity and repetitiveness. The present study was therefore conducted to experimentally investigate whether this more rigid and ritualistic safety behavior (i.e., checking) contributes to the development of OCD symptoms.

According to the self-perpetuating mechanism of compulsive checking (Rachman, 2002), the amount of checking behavior a person performs is determined by the sense of responsibility, probability of harm, and anticipated seriousness of the harmful outcome. Conversely, Rachman (2002) predicts that an increase in checking behavior will lead to an increase in the sense of responsibility, probability of harm, anticipated seriousness of the harmful outcome, and, additionally, a decrease in memory confidence. Since previous research has shown that people with OCD symptoms not only use checking behavior in response to their obsessions, but also have the tendency to display more checking behavior in mildly uncertain situations that are unrelated to obsessions (Toffolo, van den Hout, Engelhard, Hooge, & Cath, 2014; Toffolo, van den Hout, Hooge, Engelhard, & Cath, 2013), checking behavior itself may contribute to the development of the disorder. When people are habitually more inclined to use checking behavior, this may not only increase uncertainty levels (e.g., van den Hout & Kindt, 2003), but also have a direct effect on obsessional beliefs such as the perceived likelihood and severity of threat. Therefore, we conducted a study similar to the one by Olatunji et al. (2011), in which participants in the experimental condition engaged in a large number of checking-related safety behaviors for seven consecutive days, to simulate the natural behavior of patients with checking OCD. Although patients with OCD often repeatedly check the same objects, their rigidity and the repetitiveness of their behavior may also become visible in mere checking rituals. This often involves checking a series of objects in a certain order, every time they leave the house or go to bed, for instance. In the present study we chose to include this last type of checking behavior, because it seemed more plausible that healthy participants would comply to this and be able to incorporate it into their daily life for a period of one week.

As mentioned earlier, contrary to Deacon and Maack (2008), Olatunji et al. (2011) did include a control condition that monitored daily safety behavior. However, as Olatunji et al. (2011) discuss, it is unknown whether merely monitoring one's safety behavior affects behavior and subsequent outcome measures. Prior research suggests that self-monitoring of psychopathological symptoms in treatment decreases anxiety and negative behavior, and increases positive behavior and approach (see Craske & Tsao, 1999). To eliminate the potential influence of safety behavior monitoring, the present study included an additional control condition, in which participants did nothing between the pre- and post-test. Inclusion of a no-monitoring control condition made it possible to isolate the effect of the checking behavior manipulation from potential monitoring effects. Therefore, contrary to Deacon and Maack (2008) and Olatunji et al. (2011), we did not include week-long baseline periods before and after the checking behavior manipulation, but only used a pre- and post-test. It was hypothesized that compared to the monitor and control group, participants in the experimental group would show a pre- to post-test increase in OCD-related cognitions about the importance of checking, the perceived likelihood and severity of a catastrophe (i.e., threat overestimation), and general obsessive beliefs about inflated responsibility and exaggerated threat perceptions. Based on previous findings of Deacon and Maack (2008) and Olatunji et al. (2011) it was also expected that these effects would be specific to OCD-related cognitions, and that the manipulation would not affect general anxiety.

METHOD

Participants

Ninety participants (mean age 22.36, *SD* = 3.39; 73 women) were recruited at Utrecht University and the University of Applied Sciences Utrecht, and randomly assigned to the experimental (*n* = 30), monitor (*n* = 30), or control group (*n* = 30). Individuals with a current psychiatric disorder were excluded from participation. Participants received remuneration or course credit for their participation.

Measures

Checking cognitions scale (CCS)

Based on the Contamination Cognitions Scale used in a similar study by Deacon and Maack (2008), this questionnaire was developed for the present study to assess the effect of checking behavior on OCD-related cognitions about the importance of checking and the perceived likelihood and severity of threat when one does not check things around the house. It consists of 21 questions about 7 items that are often involved in OCD-related checking behavior, such as the gas stove, windows and doors, and electrical plugs. For each item, participants rate the importance of checking (e.g., “I think that checking if the stove is off before I leave the house or go to bed is…”, rated from “not at all important” to “very important”); the likelihood of a dangerous situation happening (e.g., “How likely is it that a dangerous situation will emerge when you do not check if the stove is off before leaving the house or going to bed?”, rated from “very unlikely” to “very likely”); and the severity of a dangerous situation happening (e.g., “How severe would the possible consequences be if you do not check if the stove is off before leaving the house or going to bed?”, rated from “not at all severe” to “very severe”) on 0-100 visual analogue scales (VAS). The overall CCS score was calculated by averaging ratings across all 21 items (cf. Deacon & Maack, 2008). Even though importance of checking, likelihood of threat and severity of threat ratings were moderately to highly correlated (see Table 2), subscales were calculated by averaging ratings across the seven items of each subscale to gain insight in the separate constructs of the CCS. The CCS had excellent internal consistency at both time points (α’s = .89 and .93), and high test-retest reliability (r = .87; calculated using the pre- and post-test of the control group). Subscales showed very good internal consistency too, with importance of checking α’s = .80 and .88, likelihood of threat α’s = .78 and .88, and severity of threat α’s = .81 and .86.

Obsessive beliefs questionnaire-44 (OBQ-44) responsibility and threat estimation (RT) scale

A Dutch translation of the 16-item RT-subscale of the OBQ-44 (Obsessive Compulsive Cognitions Working Group [OCCWG], 2005) assessed participants’ beliefs about preventing harm from happening to oneself or others, beliefs about the consequences of inaction, and responsibility for bad things happening, and was used as a dependent variable. This scale accounts for more variance in OCD-related beliefs than the other belief domains of the OBQ (OCCWG, 2005). Participants rate their agreement with each statement on a 7-point Likert scale (e.g., ‘‘Harmful events will happen unless I am very careful’’, 1 = disagree very much, 7 = agree very much). Internal consistency was excellent at both time point (α’s = .84, and .90).

Obsessive-compulsive inventory-revised (OCI-R)

The Dutch translation (Cordova-Middelbrink, Dek, & Engelbarts, 2007) of the OCI-R (Foa et al., 2002) was used to check for pre-test differences in obsessive compulsive tendencies. The OCI-R contains 18 items concerning OCD characteristics, each measured on a 4-point Likert scale (e.g., “I check things more often than necessary”, 0 = not at all, 4 = extremely). The OCI-R has good test-retest reliability and validity in both clinical (Foa et al, 2002) and non-clinical populations (Hajack, Huppert, Simons, & Foa, 2004). Internal consistency was very good (α = .83).

Beck anxiety inventory (BAI)

The BAI (Beck, Epstein, Brown, & Steer, 1988) was used to measure effects of the manipulation on general anxiety. It assesses to which extent participants experienced 21 common anxiety symptoms during the past week, rated on 4-point Likert scales (e.g., "heart pounding" or "unsteady", 0 = not at all, 3 = very much). It showed excellent internal consistency at both time points, (α's = .83 and .88).

Checklist

The Checklist was developed as a manipulation check and to inspect pre-test differences in checking behavior. The Checklist contains six categories of situations in which people may perform checking behavior, and each category contains several items that could be checked when participants were in that situation (e.g. "checking if the door was locked", or "checking if your laptop was unplugged"). The categories were "Before leaving the house", "Before going to bed", "When being/having been away", "After being in the kitchen", "After using the bathroom/cosmetic appliances", and "Other situations". Respondents noted whether or not they had performed each of the 59 checking behaviors that day by indicating "yes" or "no". A third option, "not applicable (N/A)" was provided in case participants did not have the opportunity that day to perform that particular checking behavior (e.g., if the participant never used a hairdryer). The percentage of "yes" responses of the total number of items that could have been checked (sum of "yes" and "no" responses) was calculated. Test-retest reliability was very good (r = .85; calculated using the pre- and post-test of the control group).

Procedure

Participants were tested individually in a soundproof laboratory room during both sessions. During the first session, participants gave written informed consent after receiving verbal and written instructions about the study. Participants received a package with five questionnaires (the CCS, OCI-R, OBQ-44 RT, BAI, and Checklist) and filled these out.

Then the manipulation followed. Participants in the experimental group were given a plasticized list with all the checking items of the Checklist in present tense (e.g., "Before leaving the house: Check if the door is locked"). Participants were told that the researcher was interested in to what extent people can engage in *more* checking behavior of everyday objects than they normally do on a daily basis, for one week. They were instructed to perform all the checking behavior on the list at every possible opportunity during the upcoming week. They were asked to check every item once more than they would usually do. For instance, if the participant would usually check whether the door was locked when leaving the house once, they were now asked to check this twice. If the participant usually never checked whether the door was locked, they were now asked to check this once. The experimenter went over the list together with the participant to ensure he/she understood when and how they could check each item (e.g., checking the gas stove could involve carefully looking whether the burners were off or physically touching or turning the knobs). Next, participants were given one Checklist for each day during the week between the first and second laboratory session. They were asked to complete a Checklist at the end of each day before going to bed, and indicate for each item whether they had checked it in the past 24 hours. To increase compliance, participants were asked to set a daily alarm on their phone as a reminder.

The monitor group was told that the researcher was interested in to what extent people usually check everyday objects on a daily basis, for one week. They were also handed a Checklist for each day during the week between the first and second laboratory session, and asked to complete one at the end of each day before going to bed. Participants were instructed not to change their behavior in any way, and to "just do what you would normally do and record it on this form every day". The experimenter went over the Checklist together with each participant and asked them to set a daily alarm on their phone as a reminder. The control group did not receive any further instructions.

The second session took place approximately one week later (6-8 days). Participants in the experimental and monitor group handed in their daily Checklists. All participants again filled out the CCS, OBQ-44 RT, BAI, and Checklist. Additionally, participants in the experimental and monitor group indicated on a 0 (not at all) to 100 (exclusively) VAS to what extent they had given socially desirable answers when filling out the daily Checklists, and on a 0% - 100% VAS, which percentage of the behavior they had filled out on the daily Checklists they had actually performed. Participants were thoroughly debriefed, and participants in the experimental group were encouraged to return to their normal frequency of checking behavior. Participants were handed a letter with contact information of the researchers, and asked to contact them in case they would keep thinking about the study or have any further questions (n = 0). Finally, participants were thanked and paid for their participation.

RESULTS

Randomization and manipulation checks

One outlier (CCS post-test; control group) was changed into M + 3SDs (Field, 2009), and one participant in the monitor group was excluded from analyses, because afterwards she reported recently being diagnosed with generalized anxiety disorder. One-way ANOVAs[1] were performed to check for pre-test differences between groups. Groups did not differ in obsessive-compulsive tendencies (OCI-R), $F(2,86) = 1.39$, $p = .26$, or checking behavior (Checklist), $F(2,86) = 0.48$, $p = .62$, at the pre-test, see

[1] For F-tests we reported effect size η_p^2, whereby 0.02 indicates a small effect, 0.13 a medium effect, and 0.26 a large effect. For t-tests we reported effect size Cohen's d, whereby 0.2 indicates a small effect, 0.5 a medium effect, and 0.8 a large effect.

Table 1. Also, no pre-test differences were found on any of the dependent variables, largest $F(2,86) = 2.54$, $p = .09$. To check whether the manipulation was effective, we examined whether the amount of items participants checked (Checklist) changed from pre- to post-test, and whether the experimental and monitor group differed in scores on the Checklists they filled in each day during the week between the pre- and post-test. Overall, there was a pre- to post-test increase in the amount of items checked, $F(1,86) = 82.18$, $p < .001$, $\eta_p^2 = .49$, which differed between conditions, $F(2,86) = 146.58$, $p < .001$, $\eta_p^2 = .77$, see Table 1. The effect of Condition was also significant, $F(2,86) = 42.13$, $p < .001$, $\eta_p^2 = .50$. Planned comparisons showed an increase in the experimental group, $t(29) = 13.42$, $p < .001$, $d = 2.92$; a decrease in the monitor group, $t(28) = 3.49$, $p = .002$, $d = 0.44$; and no change in the control group, $t(29) = 1.30$, $p = .20$. This change in Checklist scores differed between the experimental and monitor group, $t(44.30) = 13.47$, $p < .001$, $d = 3.47$; the experimental and control group, $t(38.66) = 12.89$, $p < .001$, $d = 3.33$; and there was a trend for a difference between the monitor and control group, $t(57) = 1.89$, $p = .05$, $d = 0.51$. On each day during the week between the pre- and the post-test, participants in the experimental group ($M = 74.42$, $SD = 18.34$) checked more items than participants in the monitor group ($M = 18.24$, $SD = 13.86$), $t(57) = 13.24$, $p < .001$, $d = 3.45$.

No participants were excluded from analyses because of giving socially desirable answers when filling in the daily Checklists. A low percentage of socially desirable answers was reported by participants in both the experimental (M = 22.47%, $SD = 24.22$) and monitor group (M = 10.31%, $SD = 11.84$), and they indicated to have performed most of the checking behavior that they had filled in on the daily Checklists (experimental group M = 89.37%, $SD = 8.41$; monitor group M = 91.34%, $SD = 14.70$).

Table 1. Mean (*SD*) participant characteristics and dependent variables by condition.

		Experimental group (*n* = 30)	Monitor group (*n* = 29)	Control group (*n* = 30)	Total (*N* = 89)
OCI-R		11.90 (10.14)	8.59 (5.83)	10.90 (6.75)	10.48 (7.85)
Checklist	Pre	29.08 (13.86)	25.53 (15.97)	28.51 (14.66)	27.73 (14.75)
	Post	77.63 (19.06)	18.76 (14.53)	26.56 (15.08)	41.23 (30.88)
CCS	Pre	37.19 (12.14)	31.15 (15.49)	34.72 (13.37)	34.39 (13.78)
	Post	41.31 (16.81)	28.97 (16.08)	34.02 (13.80)	34.83 (16.25)
CCSimp	Pre	50.74 (15.10)	42.13 (18.32)	51.96 (20.79)	48.34 (18.53)
	Post	53.41 (20.36)	36.34 (18.32)	47.73 (22.75)	45.94 (21.55)
CCSlik	Pre	27.50 (12.60)	19.99 (13.99)	22.37 (13.81)	23.32 (13.69)
	Post	30.99 (16.70)	21.14 (15.64)	23.79 (15.53)	25.35 (16.33)
CCSsev	Pre	33.32 (15.49)	31.34 (20.10)	29.82 (15.26)	31.50 (16.92)
	Post	39.53 (18.80)	29.44 (20.20)	31.00 (16.06)	33.37 (18.74)
OBQ-44	Pre	36.57 (10.85)	34.45 (11.71)	35.30 (12.09)	35.45 (11.46)
	Post	36.90 (12.89)	34.21 (12.47)	32.93 (13.07)	34.69 (12.78)
BAI	Pre	9.27 (6.75)	6.83 (5.08)	9.03 (5.11)	8.39 (5.75)
	Post	9.57 (7.96)	4.62 (4.20)	8.13 (5.57)	7.47 (6.41)

Note. OCI-R = Obsessive-Compulsive Inventory-Revised; CCS = Checking Cognitions Scale; CCSimp = CCS importance subscale; CCSlik = CCS likelihood subscale; CCSsev = CCS severity subscale; OBQ-44 = Obsessive Beliefs Questionnaire-44 Responsibility/Threat estimation Scale; BAI = Beck Anxiety Inventory; Pre = Pre-test; Post = Post-test.

Main analyses[2]

Table 2 shows that there were moderate to strong significant correlations between most questionnaires at the pre-test. Correlations with the OCI-R checking cognitions subscale were added separately as an additional check of the validity of the CCS and Checklist. To test the study hypotheses, a series of 2 (Time: pre-test vs. post-test) x 3 (Condition: experimental vs. monitor vs. control) mixed ANOVAs[1] were conducted to examine the effect of the safety behavior manipulation on checking cognitions (CCS), obsessive beliefs (OBQ-44 RT), and general anxiety symptoms (BAI).

Checking cognitions scale (CCS)

There was no main effect of Time, $F(1,86) = 0.27$, $p = .60$, and a trend of Condition, $F(2,86) = 3.10$, $p = .05$, $\eta_p^2 = .07$. The crucial Time x Condition interaction was significant, $F(2,86) = 5.62$, $p = .005$, $\eta_p^2 = .12$, see Figure 1. Planned comparisons showed a pre- to post-test increase in the experimental group, $t(29) = 2.40$, $p = .02$, $d = 0.28$, a trend for a decrease in the monitor group, $t(28) = 1.97$, $p = .06$, $d = 0.14$, and no change in the control group, $t(29) = 0.56$, $p = .58$. The change in CCS scores differed between the experimental and monitor group, $t(49.11) = 3.08$, $p = .003$, $d = 0.80$; and the experimental and control group, $t(58) = 2.27$, $p = .03$, $d = 0.59$; but not between the monitor and control group, $t(57) = 0.89$, $p = .38$. Hence, consistent with our hypothesis, performing OCD-related checking behavior for one week increased participants' checking-related cognitions.

[2] Exploratively, it was examined whether the checking behavior manipulation would have an effect on general checking behavior in an unrelated task. The visual search task of Toffolo et al. (2013) was administered both at pre- and post-test, because this induced and measured checking behavior. In this task participants had to report whether a target was present or absent in a search field (see Toffolo et al., 2013 for details of the task). A 2 (Time) x 2 (Trial type: target-absent vs. target-present trials) x 3 (Condition) mixed ANOVA was performed to compare groups on pre- to post-test changes in search time (checking behavior) in both target-absent and target-present trials. Although overall, participants searched longer in absent- than present-trials, $F(1,82) = 572.94$, $p < .001$, $\eta_p^2 = .88$, and there was an overall decrease in search time from pre- to post-test, $F(1,82) = 14.48$, $p < .001$, $\eta_p^2 = .15$, the crucial interaction effects were not significant, *p*s > .26.

Table 2. Pearson *r* correlations between questionnaires at the pre-test. *Df* = 89.

	CCSimp	CCSlik	CCSsev	OCI-R	OCI-Rc	OBQ	BAI	Checklist
CCS	.80**	.86**	.87**	.31*	.26*	.28*	.24*	.52**
CCSimp		.48**	.47**	.26*	.29*	.12	.20	.54**
CCSlik			.77**	.27*	.22*	.28*	.23*	.42**
CCSsev				.26*	.13	.32*	.18	.35*
OCI-R					.56**	.48**	.66**	.30*
OCI-Rc						.22*	.26*	.26*
OBQ-44							.48**	.25*
BAI								.28*

*$p < .05$; **$p < .001$

Note. CCS = Checking Cognitions Scale; CCSimp = CCS importance subscale; CCSlik = CCS likelihood subscale; CCSsev = CCS severity subscale; OCI-R = Obsessive-Compulsive Inventory-Revised; OCI-Rc = Obsessive-Compulsive Inventory-Revised checking subscale; OBQ = Obsessive Beliefs Questionnaire-44 Responsibility/Threat estimation Scale; BAI = Beck Anxiety Inventory.

CCS subscale importance of checking showed a decrease over Time, $F(1,86) = 3.99$, $p = .049$, $\eta_p^2 = .04$, a main effect of Condition, $F(2,86) = 4.01$, $p = .02$, $\eta_p^2 = .09$, and a Time x Condition interaction, $F(2,86) = 4.52$, $p = .01$, $\eta_p^2 = .10$, see Figure 2, left panel. There was a pre- to post-test decrease in the importance of checking in the monitor group, $t(28) = 3.12$, $p = .004$, $d = 0.32$, a trend for decrease in the control group, $t(29) = 1.95$, $p = .06$, $d = 0.19$, and no change in the experimental group, $t(29) = 1.17$, $p = .25$. The likelihood subscale showed a trend for an increase over Time $F(1,86) = 3.48$, $p = .07$, $\eta_p^2 = .04$, a trend of Condition, $F(2,86) = 3.08$, $p = .05$, $\eta_p^2 = .07$, and no Time x Condition interaction, $F(2,86) = 0.47$, $p = .63$, see Figure 2, middle panel. On the severity subscale, there was a trend for an increase over Time, $F(1,86) = 3.44$, $p = .07$, $\eta_p^2 = .04$, no main effect of Condition, $F(2,86) = 1.23$, $p = .30$, and a Time x Condition interaction, $F(2,86) = 5.74$, $p = .005$, $\eta_p^2 = .12$, see Figure 2, right panel. Checking cognitions about the severity of threat increased from pre- to post-test in the

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experimental group, $t(29) = 2.72$, $p = .01$, $d = 0.36$, but did not change in the monitor, $t(28) = 1.43$, $p = .17$, and control group, $t(29) = 0.92$, $p = .37$.

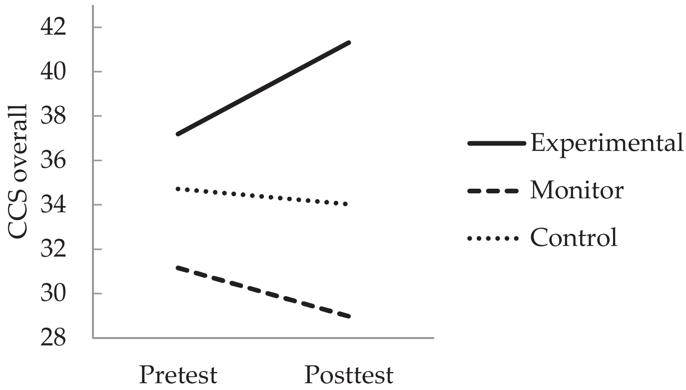

Figure 1. Checking Cognitions Scale (CCS) scores at pre- and post-test for each condition.

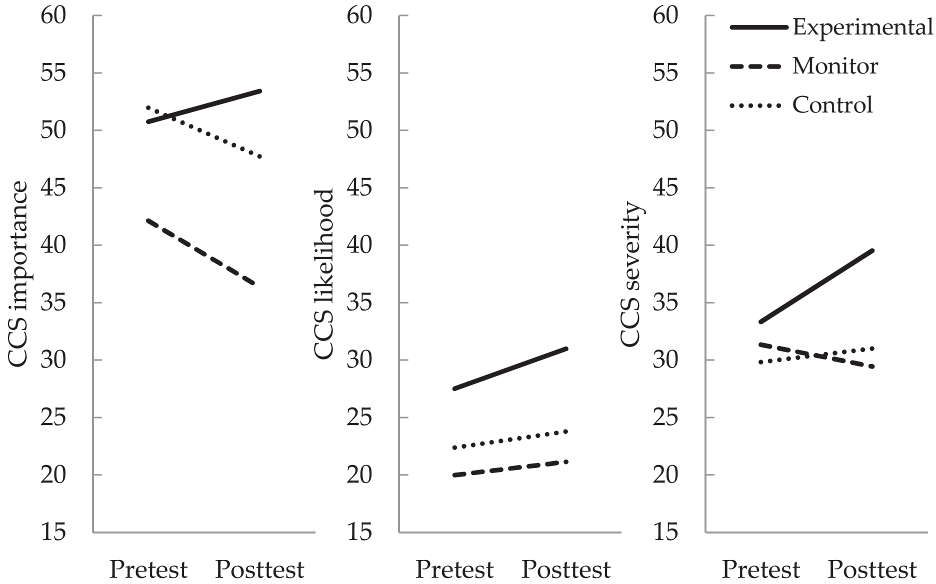

Figure 2. Checking Cognitions Scale (CCS) subscales importance of checking (left panel), likelihood of threat (middle panel), and severity of threat (right panel) at pre- and post-test for each condition.

Obsessive beliefs questionnaire-44 (OBQ-44) responsibility and threat estimation (RT) scale

There were no main effects of Time, $F(1,86) = 0.70$, $p = .41$, and Condition, $F(2,86) = 0.48$, $p = .62$, nor was the Time x Condition interaction significant, $F(2,86) = 0.83$, $p = .44$. Thus, in contrast with the findings on the CCS and with our expectations, the experimental group did not show a pre- to post-test increase in obsessive beliefs about inflated responsibility and exaggerated threat perceptions compared to the monitor and control group.

Beck anxiety inventory (BAI)

There was a main effect of Condition, $F(2,86) = 3.55$, $p = .03$, $\eta_p^2 = .08$, and an overall decrease in BAI scores between pre- and post-test, $F(1,86) = 4.79$, $p = .03$, $\eta_p^2 = .05$. There was a trend for this to differ between conditions, $F(2,86) = 2.85$, $p = .06$, $\eta_p^2 = .06$. This pattern of differences between conditions was further investigated with exploratory post-hoc tests. These indicated a decrease in the monitor group, $t(28) = 2.78$, $p = .01$, $d = 0.47$, but no change in the experimental, $t(29) = 0.35$, $p = .73$, and control group, $t(29) = 1.68$, $p = .10$, see Table 1. The change in BAI scores differed between the experimental and monitor group, $t(57) = 2.14$, $p = .04$, $d = 0.56$, but not between the experimental and control group, $t(48.58) = 1.19$, $p = .24$, and the monitor and the control group, $t(57) = 1.38$, $p = .18$. This was in line with the expectation that the effect of the checking behavior manipulation would be OCD-specific, and thus would not increase general anxiety.

DISCUSSION

Increasing daily checking behavior of everyday objects for one week increased overall checking-related cognitions measured with the CCS, which assessed cognitions about the importance of checking and the likelihood and severity of threat (i.e., threat overestimation). Moderate to strong correlations between these constructs of the CCS indicated that they were closely related, and the overall scale showed excellent internal consistency. Nonetheless, to gain insight in how checking behavior influenced the separate constructs, these were also analyzed individually. This showed that, although the data pattern of the experimental group seemed similar for all three constructs, the increase in overall checking-related cognitions was accounted for by an increase in cognitions about the severity of threat. Additionally, cognitions about the importance of checking decreased in the monitor group, but did not change in the experimental and control group. No changes in cognitions about the perceived likelihood of threat were found in any of the groups. There were no changes in general obsessive beliefs about inflated responsibility and exaggerated threat perceptions for any of the conditions. General anxiety decreased from pre- to post-test for all groups.

The finding that increasing one's daily checking behavior exacerbates checking-related cognitions about the severity of threat fits with previous studies showing that engaging in safety behavior increases anxiety and threat beliefs. Engaging in health-related safety behavior increased health anxiety and hypochondriacal beliefs (Olatunji et al., 2011), and cleaning-related safety behavior exacerbated threat perception and contamination anxiety (Deacon & Maack, 2008). Together, these findings suggest that safety behavior contributes directly to the exacerbation of anxiety and OCD symptoms, and may thus be involved in the development of anxiety disorders and OCD.

Engaging in checking behavior did not change participants' general obsessive beliefs about inflated responsibility and exaggerated threat perceptions, measured with the OBQ-44 RT scale. It seems likely that the checking behavior manipulation was not potent enough to influence these beliefs. In comparison with the CCS, which was designed to measure specific checking-related cognitions, the OBQ-44 RT scale addresses more overarching cognitions about responsibility and threat perceptions. This scale appears to be a more stable measure of beliefs that are related to trait anxiety and psychopathology in general, instead of specifically to OCD (Cougle &

Lee, 2014; Myers, Fisher, & Wells, 2008; Tolin, Worhunsky, & Maltby, 2006). Considering that the OBQ-44 has low sensitivity to treatment change (Beck, van Oppen, Cath, Emmelkamp, Smit, & van Balkom, 2010), it seems plausible that general beliefs about inflated responsibility and exaggerated threat perceptions were not affected by increasing checking behavior for one week. Perhaps if participants engaged in excessive checking behavior for many weeks, these beliefs would increase.

General anxiety did not increase in any of the groups, which suggests that engaging in checking behavior specifically increased OCD-related checking cognitions. However, it should be noted that some researchers argue that the BAI mainly assesses panic symptomatology rather than anxiety in general (Cox, Cohen, Direnfeld, & Swinson, 1996; Leyfer, Ruberg, & Woodruff-Borden, 2006), even though it continues to be widely used as a measure to assess general anxiety (e.g., Abramowitz, Khandker, Nelson, Rygwall, & Deacon, 2006) and was also administered in the studies of Deacon and Maack (2008) and Olatunji et al. (2011). Future studies could consider using other measures of anxiety such as the State Trait Anxiety Inventory (STAI; Spielberger, 1983) or Depression, Anxiety, and Stress Scale (DASS; Henry & Crawford, 2005) to further investigate the influence of checking behavior on general anxiety symptoms. The overall decrease in BAI scores seems to be caused by the monitor group. In addition to a decrease in general anxiety, the monitor group showed a pre- to post-test decrease in the amount of items they daily checked, and a decrease in cognitions about the importance of checking. In comparison, the control group did not show any changes. It thus appears that monitoring daily checking behavior decreased the amount of checking behavior participants engaged in, which in turn may have decreased cognitions about the importance of checking and general anxiety. This is in line with previous research, which suggests that self-monitoring causes a decrease in negative behavior and psychopathological symptoms (see Craske & Tsao, 1999). Additionally, when looking at the findings of Olatunji et al. (2011), it seems that monitoring safety behavior might have decreased threat perception and health anxiety, and increased approach behavior in their study as well.

A possible explanation of the present findings comes from recent studies that challenge the idea that compulsions are mainly a response to obsessions to reduce the likelihood that a feared outcome will take place (e.g., Cougle & Lee, 2014; Gillan & Robbins, 2014; Robbins, Gillan, Smith, de Wit, & Ersche, 2012). Based on theories of moral reasoning and cognitive dissonance, it is argued that obsessive beliefs may be an epiphenomenon of OC symptoms. Moral reasoning is the conscious mental activity of altering information about people and their behavior in order to come to a moral judgment or decision. This is usually a post-hoc process, in which one searches for evidence to support an initial intuitive reaction (Haidt, 2007). In addition, cognitive dissonance theory states that individuals are motivated to reduce a conflict that arises when their behavior is not in line with their belief, by altering their belief so that it corresponds with their behavior (Festinger, 1957; Festinger & Carlsmith, 1959). When translating these theories to OCD it was suggested that compulsions create cognitive dissonance (Cougle & Lee, 2014; Gillan & Robbins, 2014). Obsessive thoughts may then arise to resolve the discrepancy between the individuals' cognitions and their otherwise incomprehensible compulsive behaviors. Thus, obsessive beliefs could simply reflect post-hoc attempts to justify compulsive urges and behavior ("I am triple checking the electrical outlets and lights around the house, therefore I must be very responsible", or "I am checking the stove repeatedly, therefore it must be highly likely that something very bad will happen otherwise"). Individuals with OCD may thus come to overestimate threat or perceive themselves as having an exaggerated sense of responsibility to explain their compulsive urges and to put their cognitions in line with their behavior. This is in line with recent findings that anxiety patients use their own behavior as information about the safety of a situation (Gangemi, Mancini, & van den Hout, 2012, van den Hout et al., 2014). In the present study it is therefore possible that individuals in the experimental group began to perceive potential threat in the environment as more severe to justify their checking behavior. However, more research is needed to investigate this. The present study only involved checking many objects "once more than typical" in several situations, to create ritualistic behavior similar to checking behavior observed in patients with OCD (i.e., OCD checkers may display a ritual of checking many items once in a particular order before leaving the house for instance). However, many patients with OCD also perform more repetitive compulsive behavior, such as checking the stove or the light switches many times in a row. Therefore, future research could, for instance, focus on fewer checking tasks to check more often (e.g., the ones that are most frequently used by patients with OCD) to further investigate how compulsive checking behavior influences obsessive cognitions.

Our findings provide further insight into the role of checking behavior in the maintenance and development of OCD. The finding that increased checking behavior causes an increase in OCD-related cognitions about the severity of threat fits with Rachman's (2002) self-perpetuating mechanism of compulsive checking. It was recently found that people with OCD have the tendency to engage in more checking behavior in mildly uncertain situations (Toffolo et al., 2014; Toffolo et al., 2013). This may thus not only increase uncertainty levels (van den Hout & Kindt, 2003), but also directly increase threat beliefs. Because these results were obtained in a sample of healthy subjects, it seems plausible that pre-compulsive (i.e., normal) episodes of checking contribute to the development of compulsive checking by increasing uncertainty and perceived threat (Rachman, 2002).

A possible limitation of the study is that the main findings were measured with a self-constructed and therefore non-validated questionnaire (the CCS). The checking behavior manipulation and manipulation check (i.e., the items of the Checklist) were created for the present study as well. However, both lists were developed by the authors who have clinical and research expertise with OCD and anxiety disorders, and in close collaboration with a highly experienced clinical psychologist. The questions were based on cognitions frequently reported by patients with OCD in the clinical practice. Reliability of both measures was good: the CCS and Checklist showed good test-retest reliability, and the CCS and its subscales had very high internal consistency. Moderate to strong correlations between the CCS, CCS subscales, and Checklist, and validated scales (the OCI-R, OCI-R checking subscale, OBQ-44 RT, and BAI) suggest that the self-constructed measures are valid. Finally, a comparable self-constructed CCS was used by Deacon & Maack (2008), and they also devised their own safety behavior manipulation, as did Olatunji et al. (2011). However, future research is necessary to validate the self-constructed measures that were used in this study. A final limitation is that participants in the experimental group may have guessed the hypothesis and acted accordingly. However, post-test enquiry about the goal of the experiment did not reveal an expectancy bias.

In conclusion, checking behavior appears to increase OCD-related cognitions about the severity of threat, which, together with results from previous studies, suggests that safety behavior contributes directly to the exacerbation of anxiety and OCD symptoms, and may thus be involved in the development of anxiety disorders and OCD. Although future research should further examine the underlying mechanisms of how safety behavior increases threat perception (e.g. cognitive dissonance theory in relation to OCD (Cougle & Lee, 2014; Gillan & Robbins, 2014) and behavior as information (Gangemi et al., 2012; van den Hout et al., 2014), it seems possible that normal episodes of checking increase perceived threat and uncertainty, and in that way contribute to the development of compulsive checking.

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5

SAFETY BEHAVIOR AFTER EXTINCTION TRIGGERS A RETURN OF THREAT EXPECTANCY

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ABSTRACT

Safety behavior is involved in the maintenance of anxiety disorders, presumably because it prevents the violation of negative expectancies. Recent research showed that safety behavior is resistant to fear extinction. This fear conditioning study investigated whether safety behavior after fear extinction triggers a return of fear in healthy participants. Participants learned that two stimuli (A and C) were followed by an aversive loud noise ('threat'), and one stimulus (B) was not. Participants then learned to use safety behavior that prevented the loud noise. Next, A and C were no longer followed by the loud noise, which typically led to extinction of threat expectancy. Safety behavior then became available again for C, but not for A and B. All participants used safety behavior on these C trials. In a final test phase, A, B, and C were presented once without the availability to use safety behavior. At each stimulus presentation, participants rated threat expectancy by indicating to what extent they expected that the loud noise would follow. Compared to the last extinction trial, threat expectancy increased for C in the test phase, whereas it did not increase for A and B. Hence, safety behavior after the extinction of classically conditioned fear caused a partial return of fear. The findings suggest that safety behavior may be involved in relapse after exposure-based therapy for anxiety disorders.

INTRODUCTION

Cognitive behavioral therapy (CBT), in particular, exposure-based therapy is the treatment of choice for anxiety disorders (Hofmann, Asnaani, Vonk, Sawyer, & Fang, 2012). Patients are exposed to the feared, but innocuous stimulus (e.g., going to the supermarket) to learn that the threat they expect (e.g., getting a heart attack) does not follow. In classical, or Pavlovian, conditioning terms, the feared, but innocuous stimulus is a conditional stimulus (CS), and the expected threat is an unconditional stimulus (US). Threat expectancy is used as an index of fear in fear conditioning research (Boddez, Baeyens, Luyten, Vansteenwegen, & Hermans, 2013). The decrease in fear (conditional response or CR) following repeated exposure to the CS is called extinction, a process that is widely used as a model for exposure therapy (e.g., Milad & Quirk, 2012). During extinction learning, the original CS - US relationship is not unlearned, but the CS acquires an additional inhibitory association with the US (i.e., CS - no US). This inhibitory association exists alongside the original excitatory association (Bouton, 2016). Thus, after fear extinction, the CS has an ambiguous status. The context in which the CS is presented determines whether or not it evokes fear (Bouton, 2002), which poses a continuous risk for a return of fear.

Although exposure-based therapy is the treatment of choice, a substantial minority shows insufficient improvement from it (Barlow, Allen, & Choate, 2004) or relapses after initial recovery (e.g., Vervliet, Craske, & Hermans, 2013). Fear conditioning research has indicated several conditions that may trigger a return of fear after extinction, and which are likely involved in relapse (see Bouton, 2002; 2016; Vervliet et al., 2013). Extinguished fears can return with a change in the external context or person's internal state (that is different from the extinction context; renewal), with the passage of time (spontaneous recovery), and following an unsignaled US (reinstatement). Investigating other conditions that may trigger a return of experimentally conditioned fear can improve our understanding of the processes underlying return of fear in clinical practice.

There are various reasons to hypothesize that safety behaviors may also be involved in the return of fear. Safety behaviors are basically avoidance behaviors to minimize the feared outcome, such as a patient with panic disorder who may carry anxiolytics to feel safe going to the supermarket (e.g., Salkovskis, 1991). They function as safety signals and influence threat expectancy. They are common in individuals with anxiety disorders and can be problematic in treatment, because they can maintain threat expectancy. This was shown in a de novo fear conditioning experiment by Lovibond, Mitchell, Minard, Brady, and Menzies (2009), which entailed a mix of classical and instrumental conditioning. In a Pavlovian (i.e., classical) acquisition phase, participants learned that two neutral stimuli (A and C, which both served as CS+) were followed by shock (US), and one stimulus (B, which served as CS-) was not. Next, in an instrumental conditioning phase, participants learned to use safety behavior during presentation of stimulus A by pressing a button on a response box that effectively cancelled the shock. During a subsequent fear extinction phase, stimulus C was no longer followed by shock. The experimental group, but not the control group, was given the opportunity to use safety behavior during C trials. All participants in the experimental group used safety behavior on all C trials. In the following test phase, safety behavior was no longer available for any stimulus. Threat expectancy for C remained high in the experimental group, whereas it had decreased in the control group (Lovibond et al., 2009). Using safety behavior during unreinforced CS presentations thus preserved the subjective threat value of the CS. Because safety behaviors can prevent fear extinction, clinical guidelines recommend to motivate patients to drop all safety behaviors during exposure-based therapy (e.g., Abramowitz, Deacon, & Whiteside, 2011; Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014; Keijsers, van Minnen, & Hoogduin, 2011). However, if individuals continue to use safety behavior after exposure-based therapy, they may again misattribute safety to their own behavior rather than to innocuous properties of the CS.

A second reason to hypothesize that safety behavior may cause a return of fear is that besides signaling safety, it can signal potential threat, even in objectively safe situations. Using a design similar to Lovibond et al. (2009), Engelhard, van Uijen, van Seters, and Velu (2015) found that when safety behavior is used in response to a safety cue (i.e., a CS that has never been paired with shock; CS-), this paradoxically increases threat expectancy to that stimulus when it is subsequently presented without safety behavior. In line with this finding, Deacon and Maack (2008) found that cleaning-related safety behavior increases threat perceptions and contamination anxiety in healthy participants. Likewise, health-related safety behavior increases health anxiety and hypochondriacal beliefs (Olatunji, Etzel, Tomarken, Ciesielski, & Deacon, 2011), and increasing obsessive-compulsive-related checking behavior increases obsession-related threat beliefs (van Uijen & Toffolo, 2015) in healthy participants.

A third reason to hypothesize that safety behavior may cause a return of fear is that Vervliet and Indekeu (2015) recently found that safety behavior is resistant to fear extinction. Comparable to the Lovibond et al. (2009) and Engelhard et al. (2015) studies, participants learned that pressing a button (i.e., safety behavior) during CS+ presentation effectively cancelled a subsequent shock. Next, fear extinction was established: threat expectancy and skin conductance responses decreased after repeated unreinforced CS presentations during which safety behavior was unavailable to the participants. However, when safety behavior became available again after fear extinction, participants showed a significant return of safety behavior. Apparently, extinction of classically conditioned fear did not mitigate safety behavior. What is more, threat expectancy to the extinguished CS+ increased when safety behavior was subsequently made unavailable again (Vervliet & Indekeu, 2015).

In summary, previous research has shown (1) that safety behavior can signal safety and prevent fear extinction (Lovibond et al., 2009), (2) that safety behavior can signal threat (Engelhard et al., 2015), and (3) that extinction of classically conditioned fear does not eliminate safety behavior (Vervliet & Indekeu, 2015). However, it remains unclear whether safety behavior after fear extinction has detrimental effects on fear. This is not only theoretically, but also clinically relevant (Treanor & Barry, 2017). Using safety behavior after fear extinction logically again causes a misattribution of safety to the behavior instead of to the innocuous CS. Moreover, by signaling threat, safety behaviors may trigger a return of threat expectancy. Retention of safety behavior could then predict relapse. Accordingly, we tested whether using safety behavior after fear extinction triggers a return of fear. We used a within-subjects fear conditioning paradigm adapted from Lovibond et al. (2009) to investigate this hypothesis. Similar to Lovibond et al. (2009), the paradigm was a mix of classical and instrumental conditioning. Pavlovian acquisition took place with two CS+ (A and C) and one CS- (B). However, instead of shock, the US was a loud noise presented through headphones. Next, instrumental conditioning occurred in the Safety behavior acquisition phase. Participants learned to use safety behavior by unplugging the headphones during presentation of all three CSs, which cancelled the loud noise that would otherwise follow stimulus A and C. Then, during a fear Extinction phase, A and C were no longer followed by the US. After the Extinction phase, safety behavior was again made available during C trials, but not during A and B trials. We hypothesized that this would increase threat expectancy for C in a subsequent Test phase, in which C was presented without safety behavior. More specifically, we hypothesized that, compared to stimulus A and B, threat expectancy for stimulus C would increase from the final Extinction phase trial to the Test phase. Furthermore, we explored whether safety behavior affected evaluative conditioning in the current paradigm. Evaluative conditioning is the change in the valence of a CS after it has been paired with a US (De Houwer, Thomas, & Baeyens, 2001). A CS itself becomes more negative after it has been paired with an aversive US. Safety behavior may also directly make a stimulus more negative (see Centerbar & Clore, 2006). We therefore compared valence ratings of A, B, and C after the experimental task, and hypothesized that stimulus C would be rated more negative than stimulus A and B.

METHOD

Participants

Participants were 45 student volunteers (M_{age} = 22.38, *SD* = 2.38; 36 women, 9 men). They gave written informed consent and received €7 or course credit for their cooperation. The study was approved by the Ethics Review Board of the Faculty of Social and Behavioural Sciences of Utrecht University.

Apparatus and stimulus materials

The task was programmed in Python (Python Software Foundation) and presented on a 19-inch monitor. The US was 1-s 100 dB white noise presented through headphones (cf. Leer & Engelhard, 2015) that were connected to the computer with a sound amplifier. CSs were a black square, triangle, and circle.

Experimental task

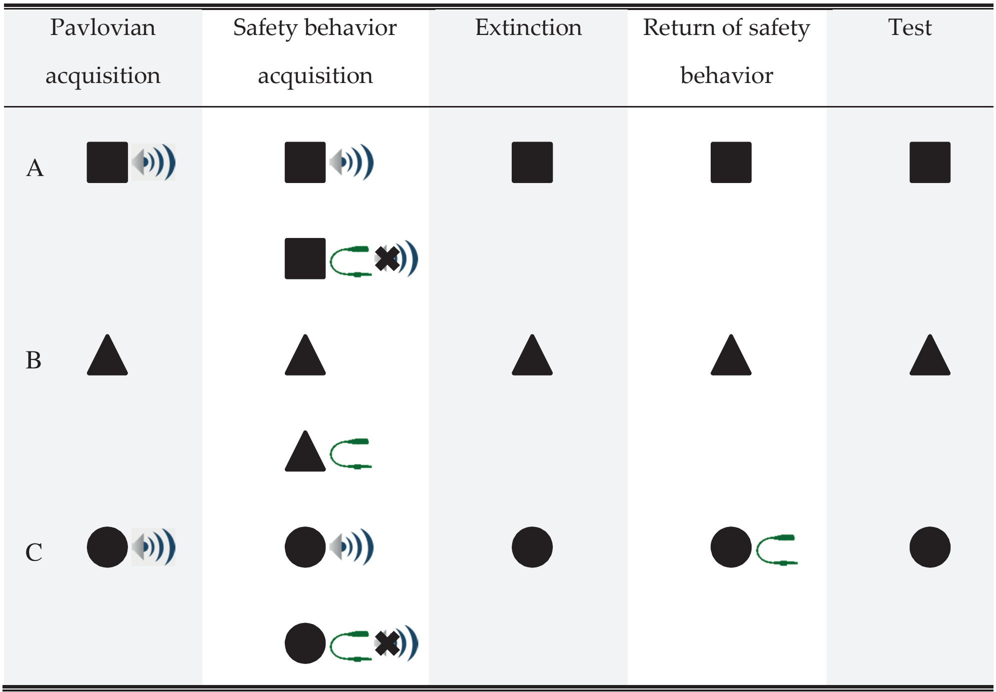
Each trial consisted of the presentation of a CS for 5 s, followed by a 5-s waiting period during which participants rated threat expectancy, immediately followed by either the US or no US. The inter-trial interval was 3 s. A picture of a plug was visible in the upper right corner of the screen during each CS presentation. The color of this plug indicated safety behavior availability. Safety behavior was unavailable to the participant if the plug was grey and available if the plug was green. During safety behavior available trials, participants could unplug the headphones from the sound amplifier, which prevented them from hearing the US. At the end of each safety behavior available trial, an instruction screen told participants to plug the headphones back into the sound amplifier. The design of the study is shown in Table 1. A, B, and C were randomly allocated to the different shapes for each participant. In the Pavlovian acquisition phase, A and C were followed by the US, and B was not. In the Safety behavior acquisition phase, safety behavior was available during presentation of A, B, and C. In this phase A, B, and C were also presented without safety behavior availability to remind participants of the CS-US contingencies. From the Extinction phase onwards, A and C were no longer followed by the US. In the Return of safety behavior phase, safety behavior was again available during C trials, but not for A and B. Finally, in the Test phase, A, B, and C were presented once without availability of safety behavior. The experimental task is graphically depicted in Table 2. The order of trial types was randomized within each phase, with the restriction that there were no more than two consecutive trials of the same type. Furthermore, the final three trials of the Extinction phase were A, B, and C, and C was always presented last in the Test phase.

Table 1. Design of the experimental task

Pavlovian acquisition	Safety behavior acquisition	Extinction	Return of safety behavior	Test
A+ (3)	A+ (1) A*(+) (2)	A- (7)	A- (6)	A- (1)
B- (6)	B- (1) B*- (2)	B- (4)	B- (3)	B- (1)
C+ (3)	C+ (1) C*(+) (2)	C- (7)	C*- (6)	C- (1)

Note. A, B, and C refer to visual stimuli (CSs); + and – refer to presence and absence, respectively, of a loud noise (US) following the CSs; * indicates the availability of the safety behavior; (+) indicates that participants only heard the loud noise if they did not use safety behavior; numbers in parentheses indicate the number of trials of each type.

Table 2. Graphical depiction of the experimental task



Note. The black square, triangle, and circle are the CS. A, B, and C were randomly allocated to the different shapes for each participant. The picture of a loudspeaker indicates the presence of a loud noise (US) following CS presentation. The picture of the plug indicates the availability of the safety behavior. A cross through the picture of the loudspeaker indicates that participants did not hear the loud noise if they unplugged the headphones (i.e., used safety behavior).

Measures

State-trait anxiety inventory (STAI)

The STAI (Spielberger, Gorusch, & Lushene, 1970) was included to measure state and trait anxiety, because they may affect fear learning (Grillon et al., 2006; Lissek et al., 2005). Each construct was measured by 20 items, rated on a scale from 1 (*not at all*) to 4 (*severely*). In this study, Cronbach's α = .87 and .94 for state and trait anxiety, respectively.

Threat expectancy

Immediately after each CS presentation, but before (possible) US presentation, participants rated to what extent they expected the loud noise to follow on a 0 (*certain no loud noise*) to 100 (*certain loud noise*) visual analogue scale (VAS) that was presented on the computer screen.

Valence and pleasantness

After the experimental task, participants rated the valence of each CS on a 100 mm VAS from *negative* (left) to *positive* (right) with *neutral* in the middle. Participants also rated the (un)pleasantness of the US and the safety behavior on two 100 mm VAS from *extremely unpleasant* (left) to *extremely pleasant* (right).

Procedure

After the informed consent procedure, participants filled out the STAI. Participants then received oral instructions from the experimenter, followed by written instructions on the computer screen. Participants were told that there was a relationship between the CS and the US, and that they should try to discover this relationship. Participants were told that there was a picture of a plug visible during each CS presentation, and that this picture could be grey or green. They were explained that they could unplug the headphones from the sound amplifier when the picture was green. They were shown how to unplug the headphones (i.e., safety behavior) and plug them back into the sound amplifier, but they were not told what the consequence of unplugging the headphones was. At the start of the experimental task, participants practiced rating threat expectancy twice and using safety behavior twice. After finishing the experimental task, participants filled out the questionnaire about valence and pleasantness. Next, they were debriefed, thanked, and rewarded.

Scoring and analysis

Drawing conclusions on the renewal of fear is only appropriate when both fear acquisition and fear extinction took place. We defined Pavlovian awareness as a higher threat expectancy for A and C than for B on the final trial of the Pavlovian acquisition phase, and extinction as threat expectancy ratings below 30 for A and C at the final Extinction phase trial (cf. Leer, Engelhard, Dibbets, & van den Hout, 2013). We used Statistical Package for the Social Science (SPSS; Version 24; IBM Corp, 2016) for the analyses. Data were analyzed with repeated measures ANOVAs ($\alpha = .05$), comparing threat expectancy ratings between Stimuli (A vs. B vs. C), or Stimuli and Trials (e.g., final Extinction phase trial vs. Test phase). Corrected values were reported in case the assumption of sphericity was violated. Planned comparisons were conducted with paired *t*-tests, which were tested one-tailed when we had a specific prediction for the direction of the effect.

RESULTS

Participants

Data of 15 participants were excluded from the analyses,[1] because 3 showed no fear acquisition, 11 showed no extinction, and 1 participant thought that the US would be audible from the computer's internal speaker when the headphones were unplugged. This resulted in a final sample of 30 participants ($M_{age} = 21.87$, $SD = 2.18$; 25 women, 5 men). All participants used safety behavior on all six C*- trials in the Return of safety behavior phase. Excluded participants did not differ from included participants in state ($M_{included} = 31.47$, $SD = 6.24$) or trait anxiety ($M_{included} = 35.27$, $SD = 8.99$) scores, both *t*s < 1.

[1] Results were comparable when all 45 participants were included in the analyses. The change in threat expectancy from the final Extinction phase trial to the Test phase differed between A, B, and C, $F(2,88) = 4.08$, $p = .02$, $\eta_p^2 = .09$. Threat expectancy decreased for B, $t(44) = 2.91$, $p = .006$, $d = 0.41$, and did not significantly change for A, $t(44) = 1.89$, $p = .07$. However, it did not significantly change for C either, $t(44) = 1.07$, $p = .15$ (one-tailed).

Threat expectancy

Figure 1 shows that Pavlovian acquisition occurred. At the end of the Pavlovian acquisition phase, threat expectancy differed between A, B, and C, $F(1.41,41.01) = 706.30$, $p < .001$, $\eta_p^2 = .96$. Threat expectancy for B was lower than for A, $t(29) = 28.02$, $p < .001$, $d = 8.47$, and for C, $t(29) = 28.62$, $p < .001$, $d = 8.25$. It was comparable for A and C, $t < 1$. The introduction of safety behavior in the Safety behavior acquisition phase immediately decreased threat expectancy for A; A+ vs. first A*(+), $t(29) = 8.85$, $p < .001$, $d = 2.20$; and for C; C+ vs. first C*(+), $t(29) = 8.13$, $p < .001$, $d = 1.94$. In the Extinction phase, threat expectancy for A and C declined in a linear trend $F(1,29) = 421.36$, $p < .001$, $\eta_p^2 = .93$, with a quadratic component, $F(1,29) = 106.43$, $p < .001$, $\eta_p^2 = .79$. This trend did not significantly differ between A and C, $F < 1$. Threat expectancy for B initially increased in the Extinction phase: Safety behavior acquisition phase B- vs. first Extinction phase B-, $t(29) = 4.28$, $p < .001$, $d = 1.11$. Then it declined in a linear trend, $F(1,29) = 15.19$, $p = .001$, $\eta_p^2 = .34$. At the end of the Extinction phase, there were no significant differences in threat expectancy between A, B, and C, $F < 1$. At the beginning of the Return of safety behavior phase, threat expectancy increased for A: final Extinction phase A- vs. first Return of safety behavior phase A-, $t(29) = 2.55$, $p = .02$, $d = 0.60$; and for B: final Extinction phase B- vs. first Return of safety behavior phase B-, $t(29) = 2.13$, $p = .04$, $d = 0.40$; but not for C: final Extinction phase C- vs. first Return of safety behavior phase C*-, $t < 1$. Threat expectancy subsequently declined in a linear trend for A, $F(1,29) = 9.00$, $p = .005$, $\eta_p^2 = .24$, but not significantly for B, $F(1,29) = 2.16$, $p = .15$. However, at the end of the Return of safety behavior phase there were no significant differences between A, B, and C, $F(2,58) = 1.31$, $p = .28$. Finally, the change in threat expectancy from the final Return of safety behavior trial to the Test phase differed between A, B, and C, $F(2,58) = 5.49$, $p = .007$, $\eta_p^2 = .16$. There were no main effects of Trial and Stimulus, both Fs < 1. Threat expectancy did not change for A, $t < 1$, and B, $t(29) = 1.02$, $p = .31$, but it increased for C, $t(29) = 2.67$, $p = .01$, $d = 0.70$.

From the final Extinction phase trial to the Test phase, the change in threat expectancy differed between A, B, and C, $F(1.94,43.34) = 4.68$, $p = .02$, $\eta_p^2 = .14$. There were no main effects of Trial, $F < 1$, and Stimulus, $F(1.57,45.46) = 2.23$, $p = .13$. From the final Extinction phase trial to the Test phase, threat expectancy did not significantly change for A, $t < 1$, and decreased for B, $t(29) = 2.69$, $p = .01$, $d = 0.33$. Crucially, however, threat expectancy increased for C, $t(29) = 1.89$, $p = .03$, $d = 0.47$ (one-tailed), which was in line with our hypothesis.

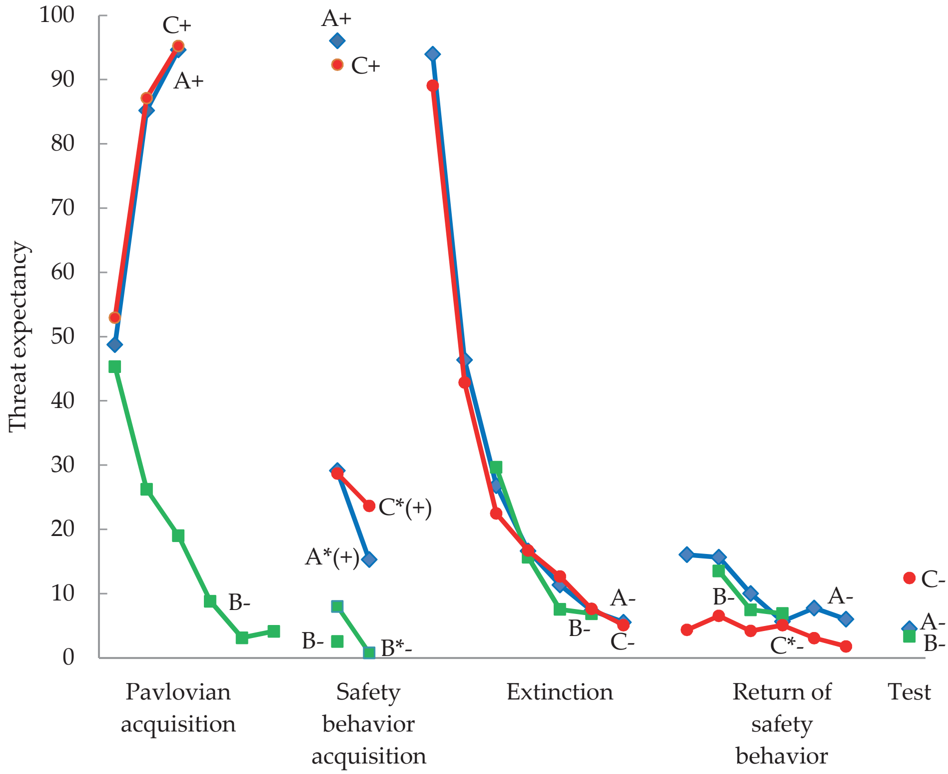


Figure 1. Mean threat expectancy for A, B, and C. See Table 1 for explanation of trial types.

Valence and pleasantness

Valence ratings after the experimental task differed between A, B, and C, $F(2,58) = 59.92$, $p < .001$, $\eta_p^2 = .66$. Stimulus B ($M = 78.80$, $SD = 17.08$) was rated more positively than A ($M = 34.07$, $SD = 17.60$), $t(29) = 8.40$, $p < .001$, $d = 2.54$, and C ($M = 37.80$, $SD = 16.32$), $t(29) = 8.43$, $p < .001$, $d = 2.46$. A and C did not significantly differ, $t < 1$, which suggests that safety behavior did not affect evaluative conditioning.[2] Participants rated the US as unpleasant ($M = 19.53$, $SD = 11.98$), and the safety behavior as pleasant ($M = 69.07$, $SD = 17.81$).

DISCUSSION

We investigated whether extinguished fears can return as a result of safety behavior. Our main findings are twofold. First, in line with Vervliet and Indekeu's (2015) findings, safety behavior did not diminish after the extinction of classically conditioned fear. Second, subsequent removal of safety behavior availability increased threat expectancy compared to the last extinction trial. Previous studies showed that safety behavior maintains pre-existing threat expectancy (Engelhard et al., 2015; Lovibond et al., 2009). The current findings and those of Vervliet and Indekeu (2015) add that safety behavior after fear extinction causes a partial return of threat expectancy. There are several potential explanations for our findings.

First, Vervliet and Indekeu (2015) argued that residual threat expectancy may have motivated individuals to use safety behavior after fear extinction. In their study, threat expectancy and skin conductance responses remained higher for the CS+ than

[2] Additionally, after the experimental task participants rated the safety of each CS on a 100 mm VAS from *dangerous* (left) to *safe* (right) with *uncertain* in the middle. The results for dangerous ratings showed a similar pattern to valence ratings: they differed between A, B, and C, $F(2,58) = 85.33$, $p < .001$, $\eta_p^2 = .75$. B ($M = 89.67$, $SD = 12.43$) was rated safer than A ($M = 42.30$, $SD = 23.54$), $t(29) = 10.05$, $p < .001$, $d = 2.52$, and C ($M = 44.03$, $SD = 20.07$), $t(29) = 11.18$, $p < .001$, $d = 2.73$. A and C did not significantly differ, $t < 1$.

for the CS- at the end of the Extinction phase. In the current study, participants who showed insufficient fear extinction were excluded. Although this does not eliminate the possibility that there was residual threat expectancy, at the end of the Extinction phase threat expectancy was low (see Figure 1), and comparable for A, B, and C. We therefore consider it unlikely that residual threat expectancy explains the current findings.

Second, the *availability* of safety behavior may have signaled threat and activated alarm mechanisms (Sloan & Telch, 2002). People engage in safety behavior to avert a feared outcome, and therefore safety behavior is meaningfully linked to perceived threat (Salkovskis, Clark, & Gelder, 1996). In this study, participants learned to use safety behavior to prevent the expected US in the Safety behavior acquisition phase, and thereby safety behavior became meaningfully linked to the threat. Hence, the availability of safety behavior may have increased threat expectancy, and motivated safety behavior use after fear extinction.

Third, participants may have inferred threat from their *use* of safety behavior. Gangemi, Mancini, and van den Hout (2012), and van den Hout et al. (2014; 2017) found that individuals may infer threat from safety behavior, “I avoid, so there must be danger” (akin to ‘emotional reasoning’; see Engelhard & Arntz, 2005). Although ‘behavior as information’ effects are mainly found in anxious individuals and not in healthy control participants, using safety behavior in an objectively safe situation may have induced cognitive dissonance. Participants may have reduced this dissonance by bringing their threat expectancy in line with their behavior (Festinger & Carlsmith, 1959).

Fourth, participants may have perceived different contexts within the experimental task based on CS - US contingencies and safety behavior availability and unavailability, which may explain the findings (see Bouton, 2002; 2016; Vervliet et al., 2013). In the Pavlovian acquisition phase and the Safety behavior acquisition phase, stimulus A and C were always followed by the US, and when safety behavior was available it was effective in preventing the US. Participants may have perceived these two phases as a similar context (context A; signaling [potential] danger). Participants may have perceived the Extinction phase as a different context (context B; signaling safety), because A and C were no longer followed by the US, and safety behavior was not available. The reintroduction of safety behavior availability for C in the Return of safety behavior phase may have given participants the impression that they had returned to context A. This may explain why threat expectancy for A and B initially increased in the Return of safety behavior phase. Our data do not show whether threat expectancy increased for C, because all participants used safety behavior on all C*- trials. However, this safety behavior use may have been motivated by increased threat expectancy for C. Threat expectancy for A and B re-extinguished during the Return of safety behavior phase. However, using safety behavior during C*- trials may have prevented this for C (i.e., protection from re-extinction), which may explain the relatively high threat expectancy for C in the Test phase. To recapitulate, reintroducing safety behavior availability after fear extinction may have triggered a return of threat expectancy, which was protected from re-extinction for C by safety behavior use.

It remains unclear whether the return of threat expectancy was caused by the *availability* or *use* of safety behavior, or by both. To investigate the direct threat signaling properties of safety behavior availability, future studies could assess whether safety behavior availability (i.e., the green plug) alone (i.e., without simultaneous CS presentation) increases threat expectancy. If that is the case, then the inclusion of extinction trials in which the green plug is present (but the use of safety behavior is prevented) might extinguish the potential threat signaling properties of safety behavior availability. Vervliet and Indekeu (2015), however, found that using a visual cue to indicate safety behavior (un)availability, and verbally instructing participants about the (un)availability of the safety behavior response resulted in comparable returns of safety behavior use after fear extinction. This suggests that safety behavior’s resistance to fear extinction cannot be attributed to the threat signaling properties of a cue that indicated the availability of safety behavior (i.e., the green plug).

After the experimental task, A and C (the two CS+) were rated comparably negative, which indicates that safety behavior did not affect evaluative conditioning. The finding that stimulus B (the CS-) was still rated more positively than A and C after the experimental task suggests that evaluative conditioning was resistant to fear extinction, which is in line with previous findings (e.g., Engelhard, Leer, Lange, & Olatunji, 2014). Negative valence is related to behavioral avoidance tendencies (Rinck & Becker, 2007), and activates avoidance behavior (Krieglmeyer, Deutsch, De Houwer, & De Raedt, 2010). Future research should investigate whether negative valence motivates safety behavior use after fear extinction, and whether changing negative valence (e.g., via counterconditioning; Engelhard et al., 2014) can enhance the extinction of safety behavior and can prevent the return of threat expectancy.

Operant conditioning research indicates ways in which instrumentally conditioned behavior may be extinguished (Bouton, 2016). First, behavior decreases when it is associated with negative consequences. In a recent study by Rattel, Miedl, Blechert, and Wilhelm (2016), avoidance decreased when it was associated with cost for participants (i.e., they had to take a lengthy detour to avoid a potential shock). Avoidance and safety behaviors are often costly for patients with anxiety disorders. Among other things, these behaviors can make patients miss out on the positive consequences of approach behavior and impede achieving aspired goals. Future studies may investigate whether safety behavior in the current paradigm can be extinguished by introducing negative consequences for the behavior, for example, by presenting an aversive stimulus (e.g., mild electrical stimulation) when participants use safety behavior after fear extinction. In addition to increasing the negative consequences of safety behavior, rewarding approach behavior decreases avoidance (Bublatzky, Alpers, & Pittig, 2017; Pittig, Brand, Pawlikowski, & Alpers, 2014). Hence, introducing a reward for not using safety behavior after fear extinction may extinguish safety behavior in the current paradigm. Finally, safety behavior may extinguish when the perceived positive consequences of the safety behavior are removed. For example, in an instrumental extinction phase, participants may learn that safety behavior no longer prevents them from hearing the aversive loud noise, which may reduce their use of safety behavior. Investigating the extinction of instrumentally conditioned safety behavior can provide insights for the improvement of the long-term effects of exposure-based therapy.

Furthermore, future studies may include more extinction trials to increase extinction learning and fully diminish threat expectancy. This could also reduce the exclusion rate for insufficient extinction. Note that previous studies used similar exclusion procedures, which resulted in comparable exclusion rates. For instance, Leer et al. (2013) excluded 29 out of 109 participants (i.e., 27%) based on acquisition and extinction, and Dibbets, Poort, and Arntz (2013) excluded 22 out of 70 participants (i.e., 31%). Similarly, we excluded 14 out of 45 participants (i.e., 31%) based on acquisition and extinction criteria, and one additional participant who had misinterpreted the experimental task (i.e., a total of 33%). Finally, we cannot eliminate the possibility that participants were engaged in reasoning that was specific to the laboratory setting. Although the fear conditioning model has proven to be a robust and valid preclinical laboratory model for the return of fear (Milad & Quirk, 2010; Vervliet et al., 2013), research that investigates whether safety behavior is resistant to fear extinction, and whether safety behavior is involved in the return of fear in a clinical setting is needed.

In sum, the current findings imply that safety behavior is resistant to extinction of classically conditioned fear, and can trigger a return of fear. This suggests that safety behavior may be involved in relapse. The current data were collected in healthy participants using a fear conditioning paradigm. Future studies should investigate whether safety behavior is resistant to fear extinction during exposure-based therapy in clinical samples, and whether safety behavior after fear extinction causes a return of clinical fear. Investigating how the extinction of safety behavior can be improved, and the return of fear can be diminished, might provide ways to enhance the long-term effects of exposure-based therapy.

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APPROACH BEHAVIOR AS INFORMATION

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ABSTRACT

Background and objectives: Anxious individuals infer danger from information about physiological responses, anxiety responses, and safety behaviors. This study investigated whether anxious individuals also infer safety from approach behavior.

Methods: 325 students rated the danger they perceived in general and spider-relevant scenarios in which information about objective safety versus objective danger, and approach behavior versus no approach behavior, was varied. A high and low spider fearful group was created with a median split on spider fear.

Results: Participants with a high fear of spiders, compared to participants with low spider fear, rated spider scenarios with approach behavior as safer than spider scenarios without approach behavior. This effect was similar for objectively dangerous and safe spider scenarios. No behavior as information effects were found for general scenarios.

Limitations: The data were collected in a non-clinical student sample.

Conclusions: Spider fearful individuals infer safety from approach behavior in spider-relevant scenarios. For spider fearful individuals, approach behavior may add to the beneficial effects of exposure therapy. Future research is needed to investigate whether patients with anxiety disorders also show a tendency to infer safety from approach behavior.

INTRODUCTION

Patients with anxiety disorders experience fear and display avoidance behavior in the absence of actual danger. According to cognitive theory, this is because they misinterpret a situation or stimulus as a sign of threat and expect that a catastrophe will follow (Salkovskis, Clark, & Gelder, 1996). Additionally, there is increasing evidence that anxious individuals infer danger from physiological, subjective, and behavioral (e.g., avoidance) anxiety response information. This study assessed whether anxious individuals also infer *safety* from opposing behavioral response information, in other words, from approach behavior.

To start with, studies have shown that patients with anxiety disorders tend to use physiological responses as information. Ehlers, Margraf, Roth, Taylor, and Birbaumer (1988) found that false feedback of an increased heart rate induced anxiety and physiological arousal in patients with panic disorder, but not in healthy controls. Additionally, individuals with a fear of snakes showed more approach to a live snake after Valins and Ray (1967) led them to believe that their heart rate did not increase while viewing pictures of snakes.

Furthermore, anxious individuals infer danger on the basis of a subjective fear response, that is, they tend to engage in emotional reasoning. In a study by Arntz, Rauner, and van den Hout (1995), four groups of patients with anxiety disorders and a group of healthy controls rated the danger they perceived in scenarios. The scenarios described situations in which information about objective safety versus objective danger and information about an anxiety response versus no anxiety response were varied. Patients with anxiety disorders, but not healthy controls, perceived more danger in scenarios with an anxiety response than in scenarios without an anxiety response. This effect was not disorder-specific and was similar for scenarios with objective danger information and objective safety information (Arntz et al., 1995). Emotional reasoning has been associated with posttraumatic stress disorder (PTSD; Engelhard, Macklin, McNally, van den Hout, & Arntz, 2001), fear of contamination (Verwoerd, de Jong, Wessel, & van Hout, 2013), and social anxiety (Mansell & Clark, 1999). Emotional reasoning may be a general vulnerability factor that predisposes people to develop anxiety disorders (see Engelhard & Arntz, 2005). Longitudinal research showed that emotional reasoning shortly after trauma predicts later PTSD symptoms (Engelhard, van den Hout, Arntz, & McNally, 2002). Moreover, experimental research found that reducing emotional reasoning in spider fearful individuals reduces threat beliefs (Lommen, Engelhard, van den Hout, & Arntz, 2014).

Finally, patients with anxiety disorders infer danger from information about safety behaviors. Safety behaviors are actions aimed at detecting, avoiding, escaping, or minimizing a feared outcome (e.g., Salkovskis, 1991; Deacon & Maack, 2008). Gangemi, Mancini, and van den Hout (2012) and van den Hout et al. (2014) performed vignette studies similar to the Arntz et al. (1995) and Engelhard et al. (2002) studies. Instead of information about an anxiety response versus no anxiety response, the protagonist did or did not display safety behavior. The presence of safety behaviors increased the perception of danger in patients with anxiety disorders, but not in healthy controls. This was especially so in objectively safe scenarios (Gangemi et al., 2012; van den Hout et al., 2014; see also van den Hout et al., 2016).

In this study, we investigated whether anxious individuals also infer safety from approach behavior. The previously mentioned findings by Valins and Ray (1967) suggest that anxious individuals also infer safety from response information. When anxious individuals falsely believed that snake stimuli did not affect them internally (i.e., their heart rate did not increase), they showed more approach to a live snake compared to individuals who had no information about their physiological response. Research into the role of behavioral response information on safety estimations can provide further insight into the way anxious individuals make danger estimations. In turn this may increase our understanding of the beneficial effects of exposure and response prevention (ERP). ERP is a highly effective treatment for anxiety disorders (Hofmann, Asnaani, Vonk, Sawyer, & Fang, 2012). It aims to violate excessive threat expectancies by repeatedly exposing the patient to the feared, but innocuous, stimulus. Exposure is often established by asking the patient to approach the stimulus. Possibly, approach behavior decreases danger estimations and thereby adds to the beneficial effects of ERP.

We therefore asked a large sample of students to rate the danger they perceived in scenarios with objective danger versus safety information, in which the protagonist did or did not display approach behavior. We hypothesized that highly anxious participants, compared to participants with low anxiety, would rate scenarios with approach behavior as safer than scenarios without approach behavior. On average, anxiety among students is relatively low (Lovibond & Lovibond, 1995a; de Beurs, Van Dyck, Marquenie, Lange, & Blonk, 2001), whereas fear of spiders is quite common (34%, Seim & Spates, 2010). We therefore also investigated whether this hypothesis holds true for participants with high versus low spider fear. Arntz et al. (1995) and Engelhard et al. (2001; 2002) found emotional reasoning effects in anxious individuals for objectively dangerous and safe scenarios, but Gangemi et al. (2012) and van den Hout et al. (2014) found larger behavior as information effects in objectively safe versus dangerous scenarios. Therefore, we explored whether the hypothesized approach behavior as information effect was larger in scenarios with objective danger information or in scenarios with objective safety information.

METHOD

Participants and procedure

The sample consisted of 325 students from Utrecht University and the University of Applied Sciences Utrecht (226 women, M_{age} = 21.44, SD = 2.32, range 17–31), who received course credit or could join a raffle for a gift certificate. All materials were presented to participants as an internet-based questionnaire using Limesurvey software (Schmitz, 2012) that they could fill out on their own computer or smartphone. Participants gave written informed consent, filled out questionnaires,[1] and gave danger ratings for twelve scenarios (see Materials).

Materials

Depression anxiety stress scale (DASS)

The DASS (Lovibond & Lovibond, 1995b) was administered to measure anxiety. It also measures depression and stress. Each subscale consist of 14 items measured on a 0 (*never*) to 3 (*usually*) scale (range 0-42), e.g., “I felt terrified”. Cronbach’s alphas for these subscales were .91, .82, and .90, respectively, in this study. The DASS maintains its good internal consistency and inter-scale correlations when it is administered online (Zlomke, 2009).

Fear of spiders questionnaire (FSQ)

The FSQ (Szymanski & O'Donohue, 1995) measures self-reported spider fear. It consists of 18 statements that are rated on a 0 (*completely disagree*) to 7 (*completely agree*) scale (range 0-126), e.g., “Spiders are one of my worst fears”. Cronbach’s alpha in this study was .97.

Scenarios

Participants were asked to evaluate the danger of 12 scenarios on 0 (*extremely safe*) to 100 (*extremely dangerous*) Visual Analogue Scales (VAS). Scenarios described three situations: public speaking, spiders (cf. Arntz et al., 1995), and general anxiety (cf. Engelhard et al., 2002). They were adapted for the purpose of this study. Scenarios started with the same stem, for example, the spider scenarios started with “You just came back from the supermarket”. They continued with (1) objective danger information, e.g., “You bought a cluster of bananas. You know that poisonous spiders are imported with bananas. You have just seen a documentary on television about this, where those spiders were shown. At home you notice a 1-inch spider in

[1] Additionally, the Fear of public speaking subscale of the Personal Report of Communication Apprehension (PRCA-24; McCroskey, 1982; see also McCroskey, Beatty, Kearney, & Plax, 1985) was administered, but these data were not used in this study.

your shopping bag, the kind of spider you have seen on television. You think: A tropical spider!"; or (2) objective safety information, e.g., "At home you see a big house spider in your shopping bag". The objective information was followed by (3) approach behavior, e.g., "You grab a jar to catch the spider"; or (4) no approach behavior, in which case nothing followed the objective information. Participants were asked to evaluate the events as if they were happening to them at this moment and to identify themselves with the description as much as possible. Each scenario was presented on a new page in a randomized order, with the restriction that scenarios about the same situation were never presented in succession. A validation study prior to the experiment showed that the approach manipulation was unsuccessful in the public speaking scenarios. They were therefore used as filler scenarios in the experiment and not included in the analyses.[2]

Data analysis

Our hypotheses consisted of specific expectations that could be formulated in terms of equality and inequality constraints (i.e., informative hypotheses; Mulder et al., 2009), and were therefore evaluated using Bayesian model selection (see Klugkist, van Wesel, & Bullens, 2011). Results of Bayesian model selection are expressed in term of Bayes factors (BF; Kass & Raftery, 1995), which represent to what extent the data support the hypothesis (i.e., the constrained model) compared to the unconstrained model (Mulder, Hoijtink, & de Leeuw, 2012). BF < 1 indicates that there is no support for the hypothesis. BF > 1 means that the hypothesis is supported by the data, with a higher BF indicating more support. BFs of competing hypotheses can be compared to obtain the relative support for each hypothesis. The data were analyzed with BIEMS (see Mulder et al., 2012) software.

We expected that scenarios with objective danger information would on average (μ) receive higher danger ratings than scenarios with objective safety

[2] Public speaking scenarios, general scenarios, and information about the validation study are available on request from the first author.

information (i.e., main effect of Information type), and that highly fearful participants would give higher danger ratings than participants with low fear (i.e., main effect of Group; cf. Arntz et al., 1995; Engelhard et al., 2001, 2002; Gangemi et al., 2012; van den Hout et al., 2014). Model 1 (see Table 1) contained these two main effects. Model 2 contained these two main effects and the hypothesized effect that, compared to participants with low fear, danger ratings of highly fearful participants would be lower when approach behavior was described than when no approach behavior was described. The BF for model 2 compared to model 1 (i.e., $BF_{2,1}$: $BF_{model\ 2}$ / BF_{model1}) gives the amount of evidence for the hypothesized Group x Behavior type interaction effect. Additionally, we explored whether this interaction effect was larger for scenarios with objective danger versus safety information (Model 3; i.e., a Group x Information type x Behavior type interaction effect), was similar for scenarios with objective danger and safety information (Model 4), or was larger for scenarios with objective safety versus danger information (Model 5).

RESULTS

Groups

We were unable to create a low and high anxious group based on the DASS anxiety subscale, because few participants (n = 9) had scores above the moderate range (>14; Lovibond & Lovibond, 1995b). A median split resulted in a low (M = 0.96, SD = .77, median = 2) and high (M = 6.56, SD = 3.74) anxious group that both fell, on average, in the normal range (0–7). Therefore, we created a low (M = 1.64, SD = 2.21, n = 169) and high (M = 37.42, SD = 26.71, n = 156) spider fearful group with a median split on the FSQ score (median = 7). The mean FSQ score in the spider fearful group is lower than the mean of a clinical sample (e.g., M = 89.10, SD = 19.60; Muris & Merckelbach, 1996), but higher than that of non-phobic individuals (M = 3.00, SD = 7.80).

Table 1. The informative hypotheses expressed as constrained models for danger ratings.

Model	Constraints
Model 1	$\mu_{\text{high fear}} > \mu_{\text{low fear}}$ $\mu_{\text{OD}} > \mu_{\text{OS}}$
Model 2	Model 1 and $\left(\mu^{\text{high fear}}_{\text{no approach}} - \mu^{\text{high fear}}_{\text{approach}}\right) > \left(\mu^{\text{low fear}}_{\text{no approach}} - \mu^{\text{low fear}}_{\text{approach}}\right)$
Model 3	Model 2 and $\left(\mu^{\text{high fear}}_{\text{OD + no approach}} - \mu^{\text{high fear}}_{\text{OD + approach}}\right) -$ $\left(\mu^{\text{low fear}}_{\text{OD + no approach}} - \mu^{\text{low fear}}_{\text{OD + approach}}\right) >$ $\left(\mu^{\text{high fear}}_{\text{OS + no approach}} - \mu^{\text{high fear}}_{\text{OS + approach}}\right) - \left(\mu^{\text{low fear}}_{\text{OS + no approach}} - \mu^{\text{low fear}}_{\text{OS + approach}}\right)$
Model 4	Model 2 and $\left(\mu^{\text{high fear}}_{\text{OD + no approach}} - \mu^{\text{high fear}}_{\text{OD + approach}}\right) -$ $\left(\mu^{\text{low fear}}_{\text{OD + no approach}} - \mu^{\text{low fear}}_{\text{OD + approach}}\right) =$ $\left(\mu^{\text{high fear}}_{\text{OS + no approach}} - \mu^{\text{high fear}}_{\text{OS + approach}}\right) - \left(\mu^{\text{low fear}}_{\text{OS + no approach}} - \mu^{\text{low fear}}_{\text{OS + approach}}\right)$
Model 5	Model 2 and $\left(\mu^{\text{high fear}}_{\text{OD + no approach}} - \mu^{\text{high fear}}_{\text{OD + approach}}\right) -$ $\left(\mu^{\text{low fear}}_{\text{OD + no approach}} - \mu^{\text{low fear}}_{\text{OD + approach}}\right) <$ $\left(\mu^{\text{high fear}}_{\text{OS + no approach}} - \mu^{\text{high fear}}_{\text{OS + approach}}\right) - \left(\mu^{\text{low fear}}_{\text{OS + no approach}} - \mu^{\text{low fear}}_{\text{OS + approach}}\right)$

Note. μ = mean; high fear = highly spider fearful participants; low fear = participants with low spider fear; OD = objective danger information; OS = objective safety information; approach = approach behavior information; no approach = no approach behavior information.

General scenarios

The data most strongly supported Model 1 (i.e., main effects of Information type and Group) and did not show evidence for the hypothesized Group x Behavior type interaction effect, $BF_{2,1} = 0.04$, see Figure 1. Of the explorative models, the data most strongly supported model 4 (i.e., no Group x Information type x Behavior type interaction effect), $BF_{4,3} = 2.95$ and $BF_{4,5} = 20.30$. The data thus did not show evidence

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that spider fearful participants inferred safety from approach behavior in objectively dangerous or safe general scenarios.

Spider scenarios

Participants with a high fear of spiders, compared to participants with low spider fear, rated spider scenarios with approach behavior as safer than scenarios without approach behavior, $BF_{2,1} = 3.77$, see Figure 1. Comparison of the explorative models showed support for model 4, $BF_{4,3} = 2.54$ and $BF_{4,5} = 5.45$, which means that the Group x Behavior type interaction effect was similar for objectively dangerous and safe scenarios.

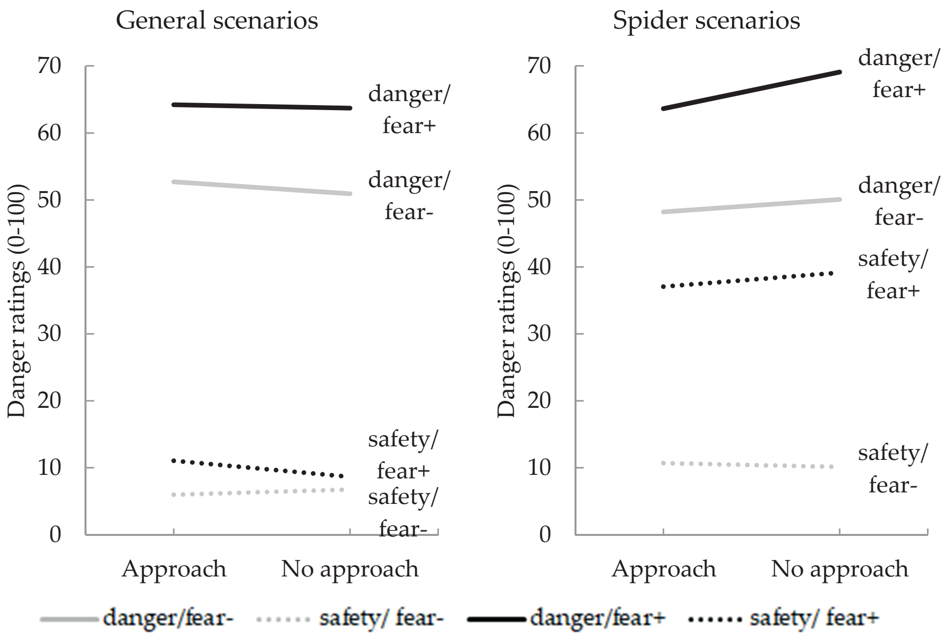

Figure 1. Mean danger ratings for general (left panel) and spider (right panel) scenarios with objective danger and objective safety information, and in which the protagonist showed approach behavior or no approach behavior for participants with low (fear-) and high (fear+) fear of spiders.

DISCUSSION

Spider fearful participants, compared to participants with low spider fear, rated spider scenarios with approach behavior as safer than spider scenarios without approach behavior. This effect was similar for objectively dangerous and safe spider scenarios. The $BF_{2,1}$ of 3.77 implies that the empirical support for this Group x Behavior type interaction effect (i.e., model 2) was 3.77 times stronger than the support for model 1 (i.e., no interaction effect). Participants with low and high spider fear did not rate general scenarios with approach behavior as safer than general scenarios without approach behavior. Spider fearful participants thus inferred safety from approach behavior, but only in scenarios relevant for spider fear. Participants with low spider fear did not show this tendency.

Anxious individuals infer danger from information about physiological responses (e.g., Ehlers et al., 1988), anxiety responses (e.g., Arntz et al., 1995), and safety behaviors (Gangemi et al., 2012; van den Hout et al., 2014). The current study shows that spider fearful individuals infer safety from approach behavior in spider relevant scenarios. A parsimonious explanation comes from cognitive dissonance theory: individuals are motivated to decrease the conflict that occurs when their behavior is not in line with their belief, by changing their belief so that it corresponds with their behavior (Festinger, 1957; Festinger & Carlsmith, 1959). Fearful individuals may change their danger estimations in accordance with their behavior. Another possible explanation comes from Lang (1977), who conceptualizes emotions such as fear as associative networks of network-nodes comprised of *stimulus* (here: spider), *meaning*, (here: danger) and *response* (here: approach) information. Activation of one of these components activates the network, and thus the other components. A fear response consists of three elements: the subjective experience of fear, physiological, and overt behavioral responses (Rachman, 1990). These elements are loosely coupled (Lang & Cuthbert, 1984) and change de-synchronously (Rachman & Hodgson, 1974). Response information about the subjective experience of fear (Arntz et al., 1995), physiological response (Ehlers et al., 1988; Valins & Ray, 1967), overt safety behavior (Gangemi et al., 2012; van den Hout et al., 2014), and approach behavior (this study) may have altered the meaning information in the fear network. Although it will not be easy to derive and test competing hypotheses from Festinger's and Lang's positions, pathological anxiety is such a severe clinical and societal problem that efforts to solve this explanatory issue are warranted.

ERP derives its positive effects from extinction: learning that the previously avoided (phobic) stimulus is not followed by feared outcomes (Vervliet, Craske, & Hermans, 2013). Intrinsically, ERP involves approach behavior. The current data suggest that for spider fearful individuals, apart from extinction, ERP may yield its positive clinical effects in part from the very act of approaching. Our findings are limited to spider fearful individuals and spider scenarios. Whether patients with anxiety disorders also show a tendency to infer safety from approach behavior is an empirical issue that needs testing. Moreover, the current data were collected in a non-clinical student sample. The spider fearful group was, on average, less fearful than a clinical sample. Still, there is no a priori reason to suppose that the effects are absent in clinical groups. Compared to non-patients, anxiety patients are more prone to make danger estimations based on response information (Arntz et al., 1995; Engelhard et al., 2001; Gangemi et al., 2012; van den Hout et al., 2014). Furthermore, we adapted the vignette method developed by Arntz et al. (1995) and used by Engelhard et al. (2001; 2002), Gangemi et al. (2012), Lommen et al. (2013), Verwoerd et al. (2013), and van den Hout et al. (2014). This method assumes that danger ratings of a scenario in which someone else is the key character reflect how danger evaluations are made about oneself in real life. Research is needed that investigates whether patients with anxiety disorders will infer safety from approach behavior in real life situations.

We found a situation-specific approach behavior as information effect: spider fearful participants inferred safety from approach behavior in spider scenarios, but not in general scenarios. Gangemi et al. (2012) found that patients with obsessive-compulsive disorder (OCD) and social phobia showed stronger safety behavior as information effects in OCD- and social phobia-relevant scenarios, respectively, than in other scenarios. However, OCD, social phobia, and panic disorder patients also inferred danger from safety behavior in other scenarios, irrespective of the content. Likewise, Arntz et al. (1995) and Engelhard et al. (2001) found that emotional reasoning was not limited to disorder-relevant scenarios. A possible explanation for these situation-general effects may be that patients with anxiety disorders report high levels of neuroticism, compared to healthy controls (Weinstock & Whisman, 2006). This reflects the fact that they tend to be anxious overall, also in situations that are not relevant to their particular disorder. Compared to other anxiety disorders, specific phobias are not associated with elevated scores on neuroticism (Trull & Sher, 1994; Mulkens, de Jong, & Merckelbach, 1996) or less (Bienvenu et al., 2001; Bienvenu et al., 2004; Weinstock & Whismann, 2006). Moreover, trait anxiety is not significantly related to emotional reasoning (Engelhard et al., 2001). Further research looking into the role of neuroticism in the tendency to infer safety from information about approach behavior is needed.

Typically, the tendency to infer danger from response information has been held to have a negative impact on the development and maintenance of anxiety disorders (see Engelhard & Arntz, 2005). However, the current data suggest that the tendency to use behavior as information about danger may, in a different context, have positive results. During ERP, besides emphasizing the violation of threat expectancies (Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014), it may be beneficial to stress that patients have not been avoiding, but *approaching* feared situations.

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7

ACTIVE APPROACH DOES NOT ADD TO THE EFFECTS OF *IN VIVO* EXPOSURE

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ABSTRACT

In exposure therapy, anxiety patients actively approach feared stimuli to violate their expectations of danger and reduce fear. Prior research has shown that stimulus evaluation and behavior are reciprocally related. This suggests that approach behavior itself may decrease fear. This study tested whether approach behavior adds to the beneficial effects of exposure. Spider fearful women were randomly assigned to one of three groups: repeated exposure to a spider by pulling a cart with a jar containing the spider toward them (Exposure + approach) or by having the experimenter do this (Exposure only), or no exposure. Exposure decreased self-reported and behavioral spider fear, compared to no exposure. The decrease was similar for exposure with and without the approach manipulation. No effects were found on affective priming. Our results did not show an added effect of approach by pulling a feared stimulus toward you to exposure. However, the mere visual impression of approach, and/or the decision to approach may have reduced fear.

INTRODUCTION

Cognitive behavior therapy (CBT), in particular, Exposure and Response Prevention (ERP) is a highly effective treatment for anxiety disorders (Gunter & Whittal, 2010; Shafran et al., 2009). The defining element of ERP is repeated confrontation with the feared, but innocuous, stimulus (exposure) without avoidance/escape (response prevention). The beneficial effects can be explained in terms of extinction: Patients learn that an anticipated catastrophe does not occur after exposure to a feared stimulus, e.g., people with spider phobia may learn that a spider will not attack them, and people with agoraphobia may learn that busy places do not result in fainting. Exposure to a feared stimulus is regularly established by the patient actively *approaching* it. There are various reasons to believe that approach behavior may be relevant to the understanding of the beneficial effects of ERP, which is an empirical issue that will be tested in the current experiment.

Several lines of research indicate a reciprocal influence between motor behavior and cognition, stimulus evaluation, and affect (see Neumann, Förster, & Strack, 2003; Strack & Deutsch, 2004). Positive evaluations lead to approach tendencies, and negative evaluations lead to avoidance tendencies (Chen & Bargh, 1999). Conversely, perceived movements away from a stimulus trigger the avoidance system and thereby facilitate the processing of negative affective concepts, whereas perceived movements toward a stimulus trigger the approach system and thereby facilitate the processing of positive affective concepts (Neumann & Strack, 2000). For example, arm flexion or having the impression of moving toward a computer screen led to faster categorization of positive words compared to negative words, whereas arm extension or moving away from the computer screen had the opposite effect (Neumann & Strack, 2000).

This reciprocal influence can be explained by an implicit, or automatic (De Houwer, 2006), bidirectional link between behavior and motivational orientation (Strack & Deutsch, 2004). Motivational orientation is determined by the valence of processed information, affect, and the direction of behavior (i.e., approach or avoidance). When in an approach orientation, the processing of positive information, the experience of positive affect, and the execution of approach behavior are facilitated. In an avoidance mode, the opposite applies (Strack & Deutsch, 2004). These are implicit cognitive processes, which means that they may occur unintentionally or outside conscious awareness, and are difficult to control (Moors & De Houwer, 2006). Approach toward a fearful stimulus may contribute to the fear-decreasing effects of exposure by modifying motivational orientation.

The effect of approach and avoidance behavior on stimulus evaluation has been widely investigated. Firstly, the valence of previously *neutral* stimuli is changed by approach and avoidance behavior. Pushing the palm of one's hand up against the bottom of a table, which activates the flexor muscle of the arm (associated with 'pulling'; i.e., approach), led to positive evaluations of a previously neutral stimulus, whereas pressing the hand against the top of the table, which activates the extensor muscle (associated with 'pushing', i.e., avoidance) led to more negative evaluations (Cacioppo, Priester, & Berntson, 1993). Additionally, a similar manipulation of avoidance behavior decreased palatable food intake, whereas approach increased consumption (Förster, 2003). On the other hand, a study in which approach (manipulated by pulling a joystick) toward pictures of faces with a neutral expression led to a more positive evaluation of these faces, whereas avoidance (pushing the joystick away) induced a negative evaluation (Woud, Becker, & Rinck, 2008), was not replicated (Vandenbosch & De Houwer, 2011).

Secondly, avoidance behavior and behavioral inhibition change the response to, and evaluation of, *positive* stimuli. Avoidance-retraining of an approach bias to alcohol stimuli in people with drinking problems, using a joystick, changed automatic action tendencies to approach alcohol, decreased the amount of alcohol consumed in a subsequent taste test (Wiers, Rinck, Kordts, Houben, & Strack, 2010), and improved treatment outcome one year later (Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011). In a theoretically similar line of studies, behavioral inhibition, i.e., not responding to a positive picture, led to devaluation of the valence of that picture (Veling, Holland, & van Knippenberg, 2008).

However, when it comes to reducing the negative valence of stimuli by approach behavior, matters are somewhat complex. Veling and colleagues (2008) reasoned that the devaluation effect would not occur for negative stimuli, because negative stimuli can elicit both fight (approach) and flight (avoidance) behavior. Yet an approach training to photographs of black people decreased racial bias to black people on an implicit and a behavioral measure (Kawakami, Phills, Steele, & Dovidio, 2007), suggesting a decrease in negative valence.

Whether approach behavior can also reduce fear, an issue that is highly relevant for the understanding of ERP effects, is the aim of the current study. Approach to a fearful stimulus inevitably causes exposure, which leads to extinction. Therefore the *additional* effect of approach behavior during exposure was investigated. Spider fearful individuals were randomly assigned to one of three conditions: (1) Exposure + approach, (2) Exposure only, or (3) no exposure (Control). Approach was operationalized as activation of the flexor muscle of the arm (cf. Cacioppo et al., 1993; Förster, 2003; Kawakami et al., 2007; Neumann & Strack, 2000; Wiers et al., 2010; Wiers et al., 2011), by pulling a cart with a jar containing a live spider toward you. This operationalization enabled repeated exposure trials without the participant moving away from the spider (i.e., avoidance). Additionally, it ensured a maximum amount of activation of the arm flexor muscle during each trial for participants in the Exposure + approach group. To prevent the approach manipulation from resulting in more exposure in the Exposure + approach group than in the Exposure only group, the only difference between these conditions was that in the Exposure only group during exposure trials *the experimenter* pulled cart with the spider toward the participant. Effects on spider fear were measured with a self-report, behavioral, and implicit measure. It was expected that exposure would lead to a decrease in spider fear on all measures, compared to no exposure, and that Exposure + approach would lead to more decrease than Exposure only. Perceived control may be increased by the approach manipulation, and was measured at various time points during exposure trials to control for its potential effects on fear. At the end of the experiment, pleasantness of the procedure was assessed to investigate whether this was affected by the approach manipulation.

METHOD

Participants

Participants were recruited through posters, flyers, online advertisements on the University network, and during lectures. 454 students were screened for spider fearfulness using the Spider Anxiety Screening (SAS; Rinck et al., 2002; see Measures). Of the 206 individuals who scored 11 or higher, all 143 women (cf. Huijding & De Jong, 2006) who indicated willingness to participate were invited to participate, of whom 79 volunteered. Exclusion criteria were past or current psychiatric disorders other than spider phobia, uncorrected visual impairment, and use of medication that might alter attention, reaction time, memory, or concentration ($n = 0$). If the distance between the participant and spider in an opened jar was less than 50 cm (step 6) in the initial behavioral approach test (BAT), the participant was excluded from further testing to ensure a sufficiently high level of spider fear at the start of the experiment and prevent a floor-effect on the BAT ($n = 3$). This resulted in a final sample of 76 women (mean age 21.78; $SD = 2.95$) who participated in exchange for money or course credit after giving written informed consent.

Measures

Spider anxiety screening ("Spinnenangst screening"; SAS)

The SAS (Rinck et al., 2002) is a four item (rated on a scale from 0 [does not apply at all] to 6 [completely applies]) self-report measure created and used for screening individuals on fear of spiders. The scale shows good reliability (Cronbach's α = .91) and validity (Rinck et al., 2002). In this sample, Cronbach's α = .77.

Fear of spiders questionnaire (FSQ)

The FSQ (Szymanski & O'Donohue, 1995) was used as a dependent variable and to check for pre-test differences in spider fear. It consists of 18 statements measuring self-reported spider fear that are rated on a 0 (completely disagree) to 7 (completely agree) scale (range 0-126). It shows good internal consistency (Cronbach's α = .92; Szymanski & O'Donohue, 1995; in this sample Cronbach's α = .90). It differentiates between phobic and non-phobic subjects, is sensitive to therapeutic change, and correlates with other measures of spider fear, such as a BAT (Muris & Merckelbach, 1996).

Disgust scale revised (DS-R)

The DS-R (Haidt, McCauley, & Rozin, 1994; revised by Olatunji et al., 2007) is a 27 item (rated on a 0 [completely disagree/not disgusting at all] to 4 [completely agree/extremely disgusting] scale) self-report measure for individual differences in disgust sensitivity. It shows good internal consistency (Cronbach's α = .87) and validity (Van Overveld, de Jong, Peters, & Schouten, 2011). In this sample, Cronbach's α = .71. It was used to check for pretest group differences in disgust sensitivity, because this is an important feature of spider fear (Mulkens, de Jong, & Merckelbach, 1996).

Behavioral approach test (BAT)

As a dependent variable and behavioral measure of spider fear, participants were instructed to pull the cart with the jar with the spider from the starting point (3.17 m from the participant) to a "non- or hardly frightening" distance, where they would tolerate it for 90 sec without feeling much distress (cf. De Jong, Merckelbach, & Arntz, 1991; see also Nelissen, Muris, & Merckelbach, 1995) using the construction described in the Procedure. Before each step, the experimenter asked: "Would you feel fearful if you would perform [description of step]?". If not, the participant was asked to execute the step (De Jong, Vorage, & van den Hout, 2000). If they indicated that they would feel fearful, no further steps were performed. Fear at that step was rated on a 0 - 100 scale.

The BAT steps consisted of leaving the cart at the starting point (0), pulling the cart to various distances (1-6) and all the way toward the participant (7), touching, lifting, and opening the jar (8-10), touching the spider with a pen (11), with a finger (12), and taking the spider out of the jar (13). If, during the initial BAT, the participant was able to pull the spider to step 6 (50 cm), the BAT was repeated from the start with the jar opened.

Affective priming task (APT)

E Prime 2.0 software (Schneider, Eschman, & Zuccolotto, 2002) on a laptop (17" screen) was used to present the APT. Participants were asked to categorize 12 different words (targets; six positive [e.g., humor] and six negative [e.g., liar] as used in an APT by Engelhard, Leer, Lange, and Olatunji [2014]) as quickly and accurately as possible by pressing 'p' for a positive word, and 'q' for a negative word (Fazio, Sanbonmatsu, Powell, & Kardes, 1986). Targets were presented 100 ms after offset of a picture (prime), which was shown for 200 ms. Participants were told that the pictures were included to make the task more difficult, and to focus on the word. Primes were four pictures of neutral objects (outlet, iron, key ring, and light bulb) and four pictures of spiders selected from a pilot study[1]. Targets and primes were semi-randomly presented, so that no similar combination of picture type (e.g., spider) and word type (e.g., negative word) was presented on two consecutive trials. Each picture preceded each word once, leading to a total of 96 trials, with a break in the middle. Before the actual APT, the task was practiced with three other negative and positive targets and a neutral prime. Target categorization speed was used as a dependent variable and implicit measure of spider fear (De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009), because it gives an indirect index of the prime's valence. Target categorization is relatively fast after a prime with a congruent valence

[1] More detailed information is available on request from the first author.

(Klauer & Musch, 2003). Participants wore a sound-attenuating headphone to prevent distraction due to background noise.

Word and picture evaluation task

An additional computer task was performed before the pre-test APT to enable a manipulation check of the primes and targets used in the APT. Participants rated target valence on a negative (0) to positive (100) visual analogue scale (VAS). Prime valence and arousal were rated using the 7-point Self-Assessment Manikin (Bradley & Lang, 1994).

Perceived control

To check whether the approach manipulation affected perceived control, participants in both exposure groups were asked to rate perceived control on a 0 (no control) to 100 (total control) scale at exposure trial 1, 5, 10, 15, and 20 (see Procedure).

Procedure

Participants were shown how pulling a rope could drive a cart (at approximately 20 cm/s) in a straight line from one end of two tables set together (length 3.53 m) toward the other end, where the participant was seated. The experimenter could pull the cart back to its starting point while remaining seated next to the participant, by pulling the other end of the rope (see Figure 1).

A closed glass jar containing an average sized house spider (*Tegenaria Atrica*) was then put at 1.77 m from the participant, who rated on a 0 (not at all) to 100 (extremely) scale how scary and how disgusting they thought the spider was. The experimenter put the jar with the spider on the cart at the starting point, and the BAT was performed. The spider was put out of sight, and the FSQ and DS-R were completed, followed by the word- and picture evaluation task, and the APT.

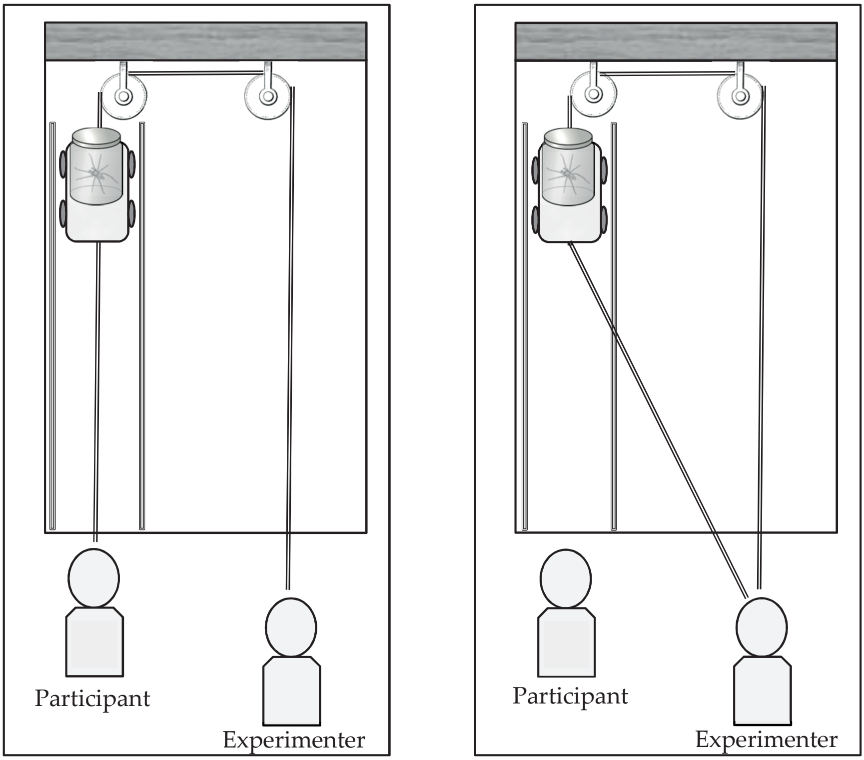

Figure 1. The experimental set-up (not to scale) in the Exposure + approach condition (left) and the Exposure only condition (right).

Next, 20 exposure trials were performed. Exposure trials were performed with the jar open if that was how the initial BAT had been performed (Exposure + approach n = 1; Exposure only n = 1). The experimenter put the jar with the spider on the cart at the starting point. In the Exposure + approach condition, participants were asked: “Please pull the spider toward the closest point that would make you feel a little frightened, but of which you are sure you can handle it”. Participants were free to choose any distance. After doing so, they rated their fear (0-100). The experimenter subsequently pulled the cart back to its starting point. If fear was rated 25 or higher, the trial was repeated. If fear was lower than 25, the participant was asked to pull the spider somewhat closer on the next trial to ensure fear was activated at each trial. If the cart had been pulled all the way toward the participant, BAT steps 8 to 13 were suggested. The Exposure only procedure was similar to Exposure + approach, except that the experimenter pulled the spider toward the participant. Participants in the control condition completed a filler task (reading magazines) for 15 minutes, with the spider out of sight.

Next, the APT, FSQ, and final BAT were administered. Finally, participants were asked to rate the pleasantness of the procedure on a 0 (very unpleasant) to 100 (very pleasant) scale, and were debriefed, thanked, and rewarded.

Data analysis

Due to a technical error, APT data were not collected for one participant. Incorrect responses (2.50%) and reaction times below 200 ms or above 1500 ms (5.12%) were discarded. APT evaluation scores were calculated by subtracting the mean reaction time (ms) of the positive target words from the mean reaction time of the negative targets for each prime type (Engelhard et al., 2014; cf. Kerkhof, Vansteenwegen, Baeyens, & Hermans, 2011). Higher evaluation scores indicate a more positive evaluation of the prime, but the scores should not to be interpreted as absolute values, with zero indicating a neutral evaluation, because reaction times for positive and negative targets may differ overall (Kerkhof et al., 2011).

Outliers were replaced by $M \pm 3SD$. Effects on outcome measures were analyzed using 2 (Time; pre-test and post-test), and, in case of APT analyses, x 2 (Evaluation score; spider or neutral) x 3 (Condition) mixed ANOVAs; pairwise comparisons of pre- to posttest difference scores using Bonferroni correction; and paired t-tests. For all analyses, $\alpha = .05$.

RESULTS

Participant characteristics and baseline differences

Groups did not differ in age, disgust sensitivity (DS-R), and spider fear at screening (SAS) and pretest (FSQ), largest $F(2,73) = 1.14$, $p = .33$, see Table 1. The mean pretest FSQ score of 70.31 ($SD = 19.03$) indicates a subclinical sample, as participants with spider phobia in other studies obtained FSQ scores of 83.74 ($SD = 20.78$), 83.56 (SD = 20.48; Milosevic & Radomsky, 2013), and 89.10 (SD = 19.60; Muris & Merckelbach, 1996), compared to healthy controls with 3.00 ($SD = 7.80$). Groups did not differ in the extent participants thought the spider used in the experiment was scary or disgusting, largest $F(2,73) = 2.27$, $p = .11$. No pretest differences were found on any of the outcomes measures, Fs < 1.

Outcome measures

FSQ

There was a significant effect for Time, $F(1,73) = 64.32$, $p < .001$, $\eta_p^2 = .47$, power = 1.00, and for Time x Condition, $F(2,73) = 5.95$, $p = .004$, $\eta_p^2 = .14$, power = .87, indicating an overall decrease in self-reported spider fear that differed between conditions, see Figure 2 left panel. The pre- to posttest decrease was significant for the Exposure + approach and Exposure only conditions, smallest $t(24) = 5.96$, $p < .001$, $r = .77$, power = 1.00, but not for the Control condition, $t(24) = 1.74$, $p = .10$. Pairwise comparisons showed a larger decrease in FSQ scores for Exposure + approach compared to the Control condition, $p = .004$, power = .76, and a trend for the Exposure only compared to the Control condition, $p = .06$, power = .47. In contrast with the hypothesis that Exposure + approach would outperform Exposure only, these conditions did not differ, $p > .99$.

Table 1. Mean (*SD*) participant characteristics by condition.

	Condition			
	Exposure + approach (n = 26)	Exposure only (n = 25)	Control (n = 25)	Total (N = 76)
Age	21.15 (2.92)	22.40 (3.40)	21.80 (2.43)	21.79 (2.95)
SAS	16.81 (3.39)	16.52 (4.12)	16.24 (3.37)	16.53 (3.60)
DS-R	51.15 (8.65)	51.44 (10.89)	52.44 (11.64)	51.67 (10.33)
Scary	60.31 (23.17)	63.72 (18.60)	51.60 (20.14)	58.57 (21.11)
Disgust	71.69 (21.71)	71.76 (22.63)	61.08 (26.10)	68.22 (26.10)
FSQ	72.23 (19.79)	68.28 (18.42)	70.36 (19.39)	70.32 (19.03)

Note. SAS = Spider Anxiety Screening, DS-R = Disgust Scale Revised, Scary = How scary participants rated the spider, Disgust = How disgusting participants rated the spider, FSQ = Fear of Spiders Questionnaire, pretest.

7

BAT

There was an overall pre- to posttest increase in BAT-steps, $F(1,73) = 73.15$, $p < .001$, $\eta_p^2 = .50$, power = 1.00, which differed between conditions, $F(2,73) = 4.70$, $p = .01$, $\eta_p^2 = .11$, power = .77, see Figure 2 middle panel. It was significant for all conditions, smallest $t(24) = 3.44$, $p = .002$, $r = .57$, power = .91. The only significant difference between conditions was a larger increase for Exposure only compared to the Control condition, $p = .01$, power = .74. Exposure + approach did not differ from the Control condition, $p = .21$, or from Exposure only, $p = .65$. This was not in line with the hypothesis that Exposure + approach would show greater improvement than Exposure only.

The degree of fear participants reported at the furthest BAT-step decreased from pre- to posttest, $F(1,73) = 19.79$, $p < .001$, $\eta_p^2 = .21$, power = .99, and differed between conditions, $F(2,73) = 7.51$, $p = .001$, $\eta_p^2 = .17$, power = .94, see Figure 2 right panel. There was a significant decrease for the Exposure + approach and Exposure only conditions, smallest $t(24) = 3.10$, $p = .005$, $r = .53$, power = .85, but not for the

Control condition, $t < 1$. Compared to the Control condition, the decrease was larger for Exposure + approach, $p = .001$, power = .93, and Exposure only, $p = .02$, power = .58, but again, in contrast with the hypothesis, Exposure + approach did not outperform Exposure only, $p > .99$. It seems that participants in all conditions felt motivated to show more approach to the spider on the post-test BAT compared to the pre-test BAT, but only in the Exposure + approach and Exposure only conditions this was accompanied by a decrease in fear.

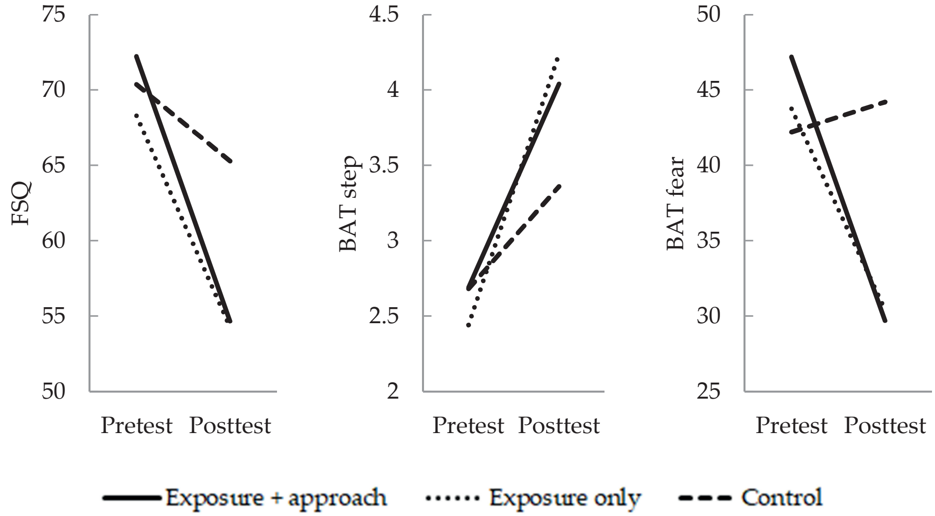

Figure 2. Pre- and posttest Fear of Spiders Questionnaire (FSQ) score (left panel), Behavioral Approach Test (BAT) step (middle panel), and the amount of fear participants experienced at the furthest step of the BAT (BAT fear; right panel) for each condition.

APT

Before the pre-test APT, positive targets were rated more positively ($M = 88.16$, $SD = 8.54$) than negative targets ($M = 10.55$, $SD = 8.64$), $F(1,73) = 1772.39$, $p < .001$, $\eta_p^2 = .96$. Neutral primes were generally rated as neutral (i.e., 4 on SAM), $M = 4.02$, $SD = 0.58$, $t < 1$, and were rated more positively than spider primes ($M = 1.43$, $SD = 0.47$), $F(1,73) =$

812.53, $p < .001$, $\eta_p^2 = .92$. Spider primes were rated as more arousing ($M = 5.73$, $SD = 0.97$) than neutral primes ($M = 1.66$, $SD = 0.98$), $F(1,73) = 647.56$, $p < .001$, $\eta_p^2 = .90$. None of this differed between conditions, all Fs < 1.

There was an APT effect at pretest, indicated by a more negative evaluation score for spider primes ($M = -13.48$, $SD = 64.19$) than for neutral primes ($M = 20.29$, $SD = 63.19$), $F(1,72) = 12.39$, $p = .001$, $\eta_p^2 = .15$, power = .94, which did not differ between conditions, $F(2,72) = 1.44$, $p = .24$. This effect did not change from pre- to posttest, $F < 1$, nor was the crucial Time x Evaluation score x Condition interaction significant, $F(2,72) = 1.25$, $p = .29$. The difference between spider and neutral prime evaluation scores did not change for any of the conditions, which was not in line with the hypothesis that the Exposure conditions would outperform the Control condition, and Exposure + approach would show the largest effect.

Pleasantness

There were no differences between the conditions in how (un)pleasant the experimental procedure was rated, $F < 1$ ($M = 57.33$, $SD = 19.73$). A more positive evaluation was related to a greater improvement on the BAT, $r = .28$, $p = .02$, and a lower score on the FSQ at posttest, $r = -.25$, $p = .04$.

Exposure trials: time course of effects and perceived control

Figure 3 depicts the time course of the steps performed during the exposure trials, and corresponding fear for Exposure + approach and Exposure only. Trend analysis indicates a linear trend for the steps performed, $F(1,49) = 52.86$, $p < .001$, $\eta_p^2 = .52$, power = 1.00. For fear, the trend had a quadratic shape, $F(1,49) = 7.92$, $p = .007$, $\eta_p^2 = .14$, power = 1.00, with a cubic aspect to it, $F(1,49) = 21.81$, $p < .001$, $\eta_p^2 = .31$, meaning that the line has two inflection points (it changes direction twice). Trends are similar for the two conditions, as neither interactions were significant, both Fs < 1.

Perceived control did not change over time, $F(3.43,168.16) = 1.32$, $p = .27$, and there was no interaction with Condition, $F(3.43,168.16) = 2.06$, $p = .10$. However, there was a trend for Condition, $F(1,49) = 3.31$, $p = .08$, $\eta_p^2 = .06$, power = .43. Participants in the Exposure + approach condition tended to perceive more control (M = 76.78, SD = 15.23) during exposure trials than participants in Exposure only (M = 67.06, SD = 22.37).

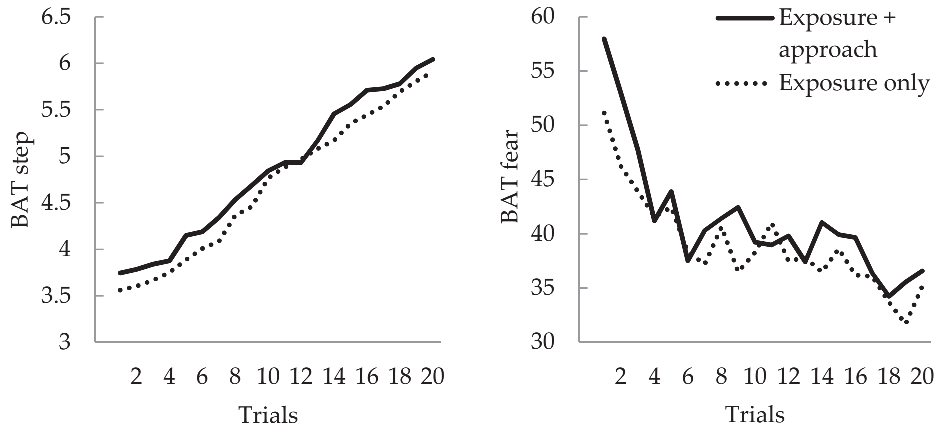

Figure 3. Exposure + approach and Exposure only time course of steps performed (left) and corresponding fear (right) during exposure trials.

DISCUSSION

This study aimed to investigate the role of approach behavior during exposure by testing the effect of pulling a feared stimulus, i.e., a spider, toward you during exposure on spider fear. Compared to a no-exposure control condition and in line with our hypothesis, repeated exposure to a spider led to a decrease in spider fear on a self-report and behavioral measure. However, in contrast to the hypothesis, the approach manipulation did not show an additional effect on any of the spider fear measures: Repeated exposure to the spider by pulling it toward you and by having the experimenter pull it toward you caused similar drops in spider fear. No effects were found on the implicit (affective priming) measure of spider fear. There was a trend for participants who pulled the spider toward them during exposure to report more control than participants who did not. There were no differences between conditions in pleasantness of the procedure.

The pre- to posttest increase in steps performed on the BAT did not differ between the Exposure + approach and the Control group. All groups showed an increase in steps performed on the BAT from pre-test to posttest, which means that all participants pulled the cart with the spider closer toward them at the posttest than at the pre-test. However, this was only associated with a pre- to posttest decrease in self-reported fear at the closest step in the BAT in both Exposure groups, but not in the Control group. Apparently, participants did not adhere to the BAT instructions, namely to pull the cart with the spider to a "non- or hardly frightening" distance, where they would tolerate it for 90 sec without feeling much distress. Even though self-reported spider fear decreased in both Exposure groups, but not in the Control group, there was only a trend for this difference to be larger in the Exposure only group than in the Control group. This may mean that mere exposure and no exposure had similar effects on self-reported spider fear. However, because the effect of exposure is substantial (Gunter & Whittal, 2010; Shafran et al., 2009), it seems more likely that this was due to a lack of power because of the Bonferroni correction that was applied to pairwise comparisons.

Various lines of research indicate a reciprocal influence between motor behavior and cognition and affect (see, for example, Neumann et al., 2003), but this study did not indicate that motor approach behavior, i.e., activation of the flexor muscle of the arm by pulling a fearful stimulus toward you, is relevant to the explanation of the beneficial effects of ERP. Why did the approach manipulation not add to the effects of exposure? First, there may be a theoretical explanation. Veling and colleagues (2008) suggested that approach behavior does not reduce anxiety for threat stimuli, because threat stimuli may cause both fight (approach) and flight (avoidance) behavior. However, earlier research has shown that spider fearful individuals react to spider pictures more quickly by pushing a joystick away than by pulling it toward them, compared to non-anxious controls and control pictures

(Rinck & Becker, 2007). This implies a behavioral avoidance tendency for spider stimuli, and not a “fight” response.

Second, the sense of approach may not have been different for the two exposure conditions: Merely observing the spider moving closer in the Exposure only condition may have induced a sense of approach. Note that, besides actual motor behavior, visual cues are also used as a source of information about one’s movement (Neumann & Strack, 2000), and the decrease of spatial distance toward the spider may have been interpreted as approach. Neumann and Strack (2000) showed that the mere impression of moving toward or away from a computer screen led to similar results as *actual* approach or avoidance behavior in a word categorization task. It seems that the effect of approach is not merely due to motor behavior (activation of the flexor muscle of the arm), but also to other cues of movement.

Furthermore, perhaps similar cognitive processes played a role in both exposure conditions. The participants’ *decision* to pull the spider toward them or to have the experimenter pull the spider toward them may have been used as a source of information about the safety of the situation (Gangemi, Mancini, & van den Hout, 2012). Gangemi and colleagues showed that fearful individuals derive information about the safety of the situation from both objective danger information and, crucially, from their own avoidance and escape behavior: “I avoid, so there must be danger”. Additionally, in a recent experiment, participants who were allowed to use avoidance behavior during presentation of a safety cue (a stimulus that had never been paired with an unpleasant stimulus) subsequently had higher threat beliefs about that safety cue than participants who were not allowed to avoid that cue (Engelhard, van Uijen, van Seters, & Velu, 2014). Avoidance behavior thus generated threat beliefs about an objectively safe stimulus. The opposite may have occurred in this study: consenting to be approached by the spider may have decreased threat beliefs about the spider, “I decide to be approached, therefore the spider must not be that dangerous”. This would imply that the effect of approach may be due to the *decision* to decrease the distance to the spider.

It remains unclear whether the approach manipulation was effective. Participants in the Exposure + approach condition literally "pulled the strings", but, contrary to what was expected, there was only a trend for perceived control to be higher in this group. Additionally, there were no differences on any measures in the decrease in spider fear between Exposure conditions, not even when looking at the time course effects during exposure trials. Even if the manipulation did work, then any potentially beneficial effects may have been overshadowed by ERP's strong and robust effects (Gunter & Whittal, 2010; Shafran et al., 2009).

Future studies could investigate the effect of a different approach manipulation during exposure, and compare this to a different exposure only condition, in which participants receive no visual information of approach. Additionally, the role of the decision to approach could be investigated, for example by testing whether effects on stimulus evaluation obtained with approach and avoidance motor behavior (e.g., as in Cacioppo et al., 1993; Förster, 2003; Kawakami et al., 2007; Wiers et al., 2010; Wiers et al., 2011) can also be obtained with the mere decision to approach or avoid. This could improve our understanding of the bidirectional link between behavior and cognition and affect, and the relevance of approach to ERP's procedure.

The APT effect did not change from pre- to posttest for any of the conditions, which indicates that the negative valence of the spider primes did not decrease because of exposure or the approach manipulation. This can be explained by the finding that negative stimulus evaluations are resistant to extinction (Engelhard et al., 2014). Negative evaluations remained existent on an affective priming task, even after learning that the evaluated stimulus was no longer followed by an unpleasant stimulus.

This study has several limitations. Participants in the Exposure conditions may have guessed the hypothesis and acted accordingly. However, post-test enquiry about the goal of the experiment did not reveal an expectancy bias. Due to the nature of the procedure, it was impossible for the experimenters to be blind to the experimental condition. All instructions were formulated in detail in an experimental protocol to prevent experimenter's bias. Rejection of our main hypothesis suggests that it is unlikely that this affected our data.

In conclusion, although our results did not show an effect of pulling a feared stimulus toward you compared to having it pulled toward you by the experimenter during exposure, this does not necessarily imply that approach behavior is not relevant to the understanding of the beneficial effects of ERP. The mere visual impression of approach, and/or the decision to approach may be of influence on fear reduction.

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8

DISCUSSION

The current dissertation applied an experimental psychopathology approach to investigate the role of safety behaviors in the persistence of irrational fears. In this final chapter, I discuss the main results regarding the role of safety behavior in the maintenance of threat beliefs, the exacerbation and return of threat beliefs, and the effect of approach behavior on danger perceptions and exposure outcomes. Additionally, I review the potential clinical implications of these findings, and present suggestions for future research.

SAFETY BEHAVIOR AND THE MAINTENANCE OF THREAT BELIEFS

In **chapter 2**, we tested whether the negative effects of safety behavior on exposure outcomes depend on whether safety behavior precludes the occurrence of threat in a fear conditioning study (van Uijen, Dalmaijer, van den Hout, & Engelhard, 2017). Participants underwent fear acquisition, learned to use safety behavior that precluded the occurrence of threat, and safety behavior that minimized the severity of threat, but did not preclude its occurrence. Next, participants used safety behavior that precluded the occurrence of threat, safety behavior that minimized threat severity, or no safety behavior during an extinction procedure. The results showed that safety behavior that precluded the occurrence of threat prevented extinction learning, and that safety behavior that minimized the severity of threat allowed extinction learning for several participants, but prevented extinction learning for other participants (van Uijen, Dalmaijer, et al., 2017). Additionally, in **chapter 3**, we investigated whether using cleaning safety behavior during exposure to a contaminant prevented a decrease in threat beliefs related to feelings of contamination, fear, danger, and disgust (van Uijen, van den Hout, Klein Schiphorst, Knol, & Engelhard, 2017). Healthy participants were randomly assigned to one of three groups: (1) repeated exposure to a contaminant whilst abstaining from safety behavior, (2) repeated exposure to a contaminant with the use of disinfectant wipes (safety behavior) after each instance of exposure, or (3) no exposure or safety behavior. Participants rated their threat belief associated with the contaminant before and after the experimental manipulation. Cleaning safety behavior, which may preclude the occurrence of contamination and illness (i.e., threat), did not prevent a decrease in threat beliefs about contamination and illness (van Uijen, van den Hout, Klein Schiphorst, et al., 2017). Together, the findings of chapter 2 and 3 suggest that the negative effects of safety behavior on exposure outcomes may not depend critically on whether safety behavior prevents the occurrence of threat: Safety behavior that allows threat occurrences may prevent extinction learning, and safety behavior that precludes threat occurrences can allow extinction learning. How can we explain these findings?

It may be helpful to explain the finding that safety behavior that precluded the occurrence of threat and safety behavior that minimized the severity of threat prevented extinction learning (chapter 2, van Uijen, Dalmaijer, et al., 2017) in terms of learning theory (Blakey & Abramowitz, 2016; Treanor & Barry, 2017). Exposure therapy derives its positive effects from extinction (Vervliet, Craske, & Hermans, 2013), during which a conditional stimulus (CS) acquires a second, inhibitory association with an unconditional stimulus (US; i.e., CS – no US), which is then available alongside the first, excitatory association (i.e., CS – US; Bouton, 2002, 2004, 2016; Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014). The extent to which inhibitory learning occurs depends on the discrepancy between the expected outcome (i.e., the feared catastrophe) and the actual outcome (i.e., the nonoccurrence of this catastrophe; Bouton, 2004). A larger violation of negative expectancies results in more inhibitory learning (Baker et al., 2010). When safety behavior reduces the perceived likelihood or severity of the expected catastrophe, it decreases this discrepancy, which may hamper inhibitory learning (Blakey & Abramowitz, 2016; Craske et al., 2014).

First, safety behavior that precluded the occurrence of threat prevented extinction learning in chapter 2 (van Uijen, Dalmaijer, et al., 2017), and in the study by Lovibond, Mitchell, Minard, Brady, and Menzies (2009), which may be explained by conditional inhibition (Krypotos, Effting, Kindt, & Beckers, 2015). A conditional inhibitor is a stimulus that directly predicts the nonoccurrence of the US (see Figure 1; Treanor & Barry, 2017). When a conditional inhibitor is present during an extinction procedure (i.e., exposure), the expected outcome becomes similar to the actual outcome (i.e., no threat), which prevents inhibitory learning. An example is quickly leaving the supermarket when feeling dizzy to prevent fainting in panic disorder. Explaining the negative effects of safety behavior on extinction learning in terms of conditional inhibition seems similar to explaining them by a misattribution of safety to the behavior ("I did not faint, because I left the supermarket"; Salkovskis, 1991).

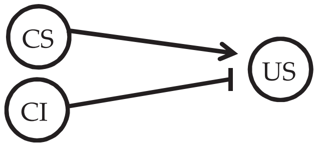


Figure 1. A conditional inhibitor predicts the nonoccurrence of a US. It thereby prevents the CS from acquiring an inhibitory association with the US (Treanor & Barry, 2017). The circle with CS indicates the conditional stimulus, the circle with CI the conditional inhibitor (e.g., safety behavior), and the circle with US the unconditional stimulus. The arrow indicates an excitatory association, and the line with a bar at the end an inhibitory association.

Second, the finding that safety behavior that minimized the severity of threat, but did not preclude its occurrence prevented extinction in chapter 2 (van Uijen, Dalmaijer, et al., 2017) may be explained by negative occasion setting. An occasion setter is a cue that does not directly influence the occurrence of threat, but provides information about whether a CS will be followed by a US (i.e., it "sets the occasion" for whether a CS will be followed by a US; Treanor & Barry, 2017). A negative occasion setter is a cue that inhibits the association between the CS and US (Bouton, 2016; see Figure 2). Individuals may learn that in the presence of this cue, the CS does not predict the US. An example is carrying safety aids, such as a mobile phone, in panic disorder. Although a mobile phone does not prevent fainting, patients may consider it less likely that dizziness will have catastrophic effects if they are carrying a mobile phone. A negative occasion setter hampers inhibitory learning, because it decreases the discrepancy between the expected and feared outcome. In chapter 2, safety behavior that minimized threat severity may have functioned as a negative occasion setter for participants who did not show extinction learning (van Uijen, Dalmaijer, et al., 2017). These participants may have learned that the CS was not followed by the US in the presence of the cue that indicated safety behavior availability.

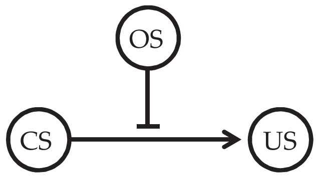
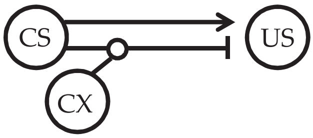


Figure 2. A negative occasion setter inhibits the CS – US association (Treanor & Barry, 2017). The circle with OS indicates an occasion setter.

Third, the finding that safety behavior that minimized the severity of threat, but did not preclude its occurrence prevented extinction in chapter 2 (van Uijen, Dalmaijer, et al., 2017) may also be explained by contextual renewal. Inhibitory learning is context-specific (Bouton, 2004), which means that the inhibitory association is (only) active in the context (e.g., external surrounding or the individual's internal physical state) in which it was learned, see Figure 3. Safety behavior may function as a contextual feature (Treanor & Barry, 2017; Vervliet & Indekeu, 2015), for instance, by evoking relief. When inhibitory learning occurs in the presence of safety behaviors, removal of safety behavior availability may represent a context shift, and cause contextual renewal. An example is the use of anxiolytic medication during exposure therapy. This may create an internal context in which inhibitory learning occurs. If a patient stops using medication after exposure therapy, this may cause a shift in the internal context, and cause a return of fear. In chapter 2, removal of the availability of safety behavior after extinction learning may have caused contextual renewal. It remains unclear whether negative occasion setting or contextual renewal explains the finding that safety behavior that minimized the severity of threat prevented extinction learning in chapter 2 (van Uijen, Dalmaijer, et al., 2017).



The role of context after extinction

Figure 3. Inhibitory learning is context-dependent (Vervliet et al., 2013). The circle with CX indicates the context in which the inhibitory association was learned. In the extinction context, the inhibitory association is active.

Furthermore, it remains unclear why safety behavior that minimized the severity of threat prevented extinction for several participants, yet allowed extinction for other participants in chapter 2 (van Uijen, Dalmaijer, et al., 2017). Although this finding was obtained from a small (*n* = 21), and specific (i.e., undergraduate students) sample and should therefore be interpreted with caution, it suggests that safety behaviors that minimize threat severity, but do not prevent the occurrence of threat, may have negative effects on exposure outcomes for some, but not all, individuals. Animal fear conditioning studies found individual differences in extinction (Galatzer-Levy, Bonanno, Bush, & LeDoux, 2013) and avoidance learning (Galatzer-Levy et al., 2014) in rats. These individual differences are analogous to the heterogeneous patterns of change in posttraumatic stress disorder (PTSD) symptoms after trauma in humans (Bonanno, 2004, 2005): after an aversive event, some individuals adapt rapidly and completely, others adapt slowly, and others fail to adapt. Prospective research has shown that impaired extinction learning before trauma predicts later PTSD symptoms (Lommen, Engelhard, Sijbrandij, van den

Hout, & Hermans, 2013). Furthermore, in recent a study by Duits et al. (2017), patients with anxiety disorders more often showed impaired extinction learning than healthy controls. Notably, impaired extinction learning predicted poorer treatment outcomes. There are numerous individual difference factors that impact fear conditioning processes (see Lonsdorf et al., 2017), and that may affect avoidance learning (see Krypotos et al., 2015). Future research that investigates individual differences in the interference of safety behavior with extinction learning in humans is needed.

Finally, the findings presented in chapter 3, in which cleaning safety behavior did not prevent the extinction of contamination, fear of contamination, danger, disgust, and contamination-related threat beliefs, suggests that it may be relevant to distinguish between stimuli that give rise to disgust, and stimuli that evoke fear (van Uijen, van den Hout, Klein Schiphorst, et al., 2017). In the case of fear, a stimulus (e.g., dizziness in panic disorder) activates the representation of a future catastrophe (e.g., fainting). A contaminating object (e.g., doorknobs in obsessive-compulsive disorder [OCD]), however, may not (only) activate the representation of a future catastrophe (e.g., getting contaminated and becoming ill), but may directly evoke disliking and motivate avoidance of the stimulus. Disgust can be conditioned (Borg, Bosman, Engelhard, Olatunji, & de Jong, 2016) and can be decreased by habituation (Mason & Richardson, 2012). Habituation is a non-associative mechanism of response reduction that plays a role in extinction in addition to inhibitory learning (Myers & Davis, 2007). It entails a reduction in responding to the stimulus, and can be achieved by repeated physical contact with the disgust-eliciting stimulus (Bosman, Borg, & de Jong, 2016). Safety behavior that prevents the occurrence of a feared future catastrophe, but allows confrontation with the disgust-eliciting stimulus (e.g., cleaning safety behavior) may allow habituation. This may explain the positive effects of cleaning safety behavior during exposure to a contaminant in the studies by Rachman, Shafran, Radomsky, and Zysk (2011), van den Hout, Engelhard, Toffolo, and van Uijen (2011), and van den Hout, Reininghaus, van der Stap, and Engelhard

(2012). It also fits with the findings of Goetz and Lee (2015). Based on a functional classification of safety behavior proposed by Helbig-Lang and Petermann (2010), Goetz and Lee (2015) compared the effect of restorative safety behavior (aimed at restoring safety and reducing distress, e.g., using a hygienic wipe or hand sanitizer after touching a contaminant), preventive safety behavior (aimed at preventing contact with a contaminant; e.g., using a tissue or wearing gloves while touching a contaminant) and no safety behavior during exposure to a contaminant in healthy participants. Exposure with restorative safety behavior resulted in greater reductions of contamination fear and behavioral avoidance than exposure with preventive safety behavior and exposure without safety behavior, whereas exposure without safety behavior outperformed exposure with preventive safety behavior (Goetz & Lee, 2015). In contrast to preventive safety behavior, restorative safety behavior may have allowed habituation.

However, the positive effects of cleaning safety behavior during exposure to a contaminant were mainly investigated in healthy participants, and no long-term effects were assessed. Levy and Radomsky (2016a) argued that the beneficial effects of cleaning safety behavior may be due to the novelty of the safety behavior: safety behavior that has never been used before has not been associated with prevention or avoidance of feared outcomes, and may therefore not cause a misattribution of safety to the behavior. Levy and Radomsky (2016a) found that, in patients with OCD and contamination fear, one session of exposure to a contaminant with safety behavior that the patients had never used before resulted in a greater reduction of contamination fear than exposure with safety behavior patients routinely used, or than exposure without the use of safety behavior. However, Levy and Radomsky's (2016a) line of reasoning suggests that when the never-used safety behavior loses its novelty and becomes associated with the avoidance of feared outcomes, the positive effects may disappear. Hence, clinical trials that investigate long-term effects of the incorporation of cleaning safety behavior in exposure therapy for contamination fear are needed.

SAFETY BEHAVIOR AND THE EXACERBATION AND RETURN OF THREAT BELIEFS

In **chapter 4**, we investigated the causal influence of safety behavior on anxiety by examining whether checking safety behavior exacerbates OCD-related threat beliefs. Healthy participants spent a week between a pre- and post-test either performing clinically representative checking behavior on a daily basis, monitoring their normal checking behavior, or received no instructions on checking behavior. Checking safety behavior exacerbated cognitions about the severity of threat (van Uijen & Toffolo, 2015). Checking behavior may thus directly contribute to the severity of fears in OCD. Along with previous studies showing that contamination-related safety behavior increases contamination fear (Deacon & Maack, 2008), health-related safety behavior increases health anxiety (Olatunji, Etzel, Tomarken, Ciesielski, & Deacon, 2011), and safety behavior displayed in response to a safety cue increases threat expectations to this cue (Engelhard, van Uijen, van Seters, & Velu, 2015), this suggests that safety behavior contributes to the exacerbation of pathological anxiety symptoms. This is in line with findings presented in **chapter 5**, in which we investigated the effect of safety behavior on the return of fear after extinction in a fear conditioning experiment (van Uijen, Leer, & Engelhard, 2017). The results showed that safety behavior was resistant to fear extinction, and promoted a partial return of fear (van Uijen, Leer, et al., 2017). This, together with the findings of Vervliet and Indekeu (2015) suggests that safety behavior may be involved in relapse after exposure therapy.

Together, the findings presented in chapter 4 and 5 suggest that safety behavior itself can provide information about the danger of a situation. Safety behavior increased the perceived severity (van Uijen & Toffolo, 2015) and likelihood of threat (i.e., threat expectancy; Engelhard et al., 2015; van Uijen, Leer, et al., 2017). The extent to which a stimulus (CS) evokes fear (CR) depends on the strength of the CS – US association (i.e., the perceived likelihood of threat), and the evaluation of the US (i.e., the perceived severity of threat; Davey, 1997). Hence, safety behavior may contribute to the overestimation of threat that is hallmark to psychopathological anxiety.

The finding presented in chapter 5, that safety behavior after fear extinction caused a return of fear, may be explained by contextual renewal (Treanor & Barry, 2017; van Uijen, Leer, et al., 2017; Vervliet & Indekeu, 2015). In chapter 5, inhibitory learning occurred without the availability of safety behavior. However, when safety behavior was available again after fear extinction, this may have caused a context shift and renewed fear (Vervliet & Indekeu, 2015). Clinical guidelines recommend eliminating all safety behaviors during exposure therapy (e.g., Abramowitz, Deacon, & Whiteside, 2011; Craske et al., 2014; Keijsers, van Minnen, & Hoogduin, 2011). Extinction learning during exposure therapy therefore occurs while patients inhibit their safety behaviors, which may represent a context for inhibitory learning. However, when safety behaviors are available again to the patient after exposure therapy, this may represent a context shift and cause contextual renewal.

Apart from explanations in terms of learning theory, it may be noted that three other related explanations can be put forward for the causal effect of safety behavior on anxiety symptoms. First, safety behavior may directly activate the fear network (Lang, 1977), and thereby trigger danger perceptions. Second, individuals may infer danger from their use of safety behavior (safety behavior as information; Gangemi, Mancini, & van den Hout, 2012; van den Hout et al., 2014, 2017). Third, using safety behavior in relatively safe situations may induce cognitive dissonance, because the behavior is not in line with the perception of danger in that situation (Festinger, 1957; Festinger & Carlsmith, 1959). Individuals may reduce this dissonance by bringing their danger perception in line with their behavior. A discussion of the conceptual relatedness of these explanations and their commensurability with learning theory is beyond the scope of this chapter.

APPROACH BEHAVIOR

Yet another finding that warrants attention was reported in **chapter 6**. In that chapter, we studied whether spider fearful individuals infer safety from approach behavior in objectively dangerous and safe scenarios. The findings presented in chapter 6 suggest that approach itself may signal safety in anxious individuals (van Uijen, van den Hout, & Engelhard, 2017). The tendency to use response information as information (*ex-consequentia* reasoning, e.g., emotional reasoning; Arntz, Rauner, & van den Hout, 1995; and behavior as information; Gangemi et al., 2012; van den Hout et al., 2014, 2016) has been held to have a negative impact on the development and maintenance of anxiety disorders (see Engelhard & Arntz, 2005). The findings presented in chapter 6 suggest that this tendency may, in a different context, have positive results (van Uijen, van den Hout, & Engelhard, 2017).

However, in **chapter 7**, approach did not add to the beneficial effects of exposure (van Uijen, van den Hout, & Engelhard, 2015). Repeated exposure to a spider by pulling it toward you and by having the experimenter pull it toward you caused similar reductions in spider fear. The beneficial effects of approach on exposure outcomes may have been overshadowed by the robust effects of exposure, which suggests that the potential additional effects of approach to exposure may not be clinically significant. However, the exposure conditions were similar regarding the visual impression of the decrease in distance to the spider, and the decision to decrease the distance to the spider, which may have caused similar experiences of approach in both conditions (van Uijen et al., 2015). Future research is needed to investigate whether safety behavior that motivates approach adds to the beneficial effects of exposure.

CLINICAL IMPLICATIONS

The findings presented in the current dissertation do not provide a straightforward solution to the ongoing discussion about whether safety behavior may be allowed or should be eliminated during exposure therapy (see, for example, Blakey & Abramowitz, 2016; Goetz, Davine, Siwiec, & Lee, 2016; Meulders, Van Daele, Volders, & Vlaeyen, 2016; Ten Broeke & Rijkeboer, 2017; Treanor & Barry, 2017), nor do they specify *which* safety behaviors should be eliminated or may be allowed, and for whom. Nevertheless, based on the current findings, I will discuss several recommendations for the incorporation and removal of safety behavior in exposure therapy, and suggestions for the treatment of safety behavior in Cognitive Behavioral Therapy (CBT). I want to emphasize that an investigation of these suggestions in a clinical sample, with a real exposure setting, and including the assessment of long-term effects is warranted.

ALLOW OR ELIMINATE?

In chapter 2, safety behavior that precluded the occurrence of threat prevented extinction learning (van Uijen, Dalmaijer, et al., 2017), which suggests that in the context of stimuli that evoke fear, safety behavior that functions as a conditional inhibitor (i.e., precludes the occurrence of threat) should be eliminated during exposure therapy. This recommendation fits with empirical (e.g., Lovibond et al., 2009), and theoretical (Salkovskis, 1991) justifications for the removal of safety behavior during exposure therapy. Patients may thus be motivated to inhibit the full avoidance of feared situations, and subtle behavioral tricks or aids that prevent threat. Examples are quickly leaving the supermarket to prevent fainting, avoiding giving presentations for colleagues to prevent getting rejected, and opening doors with a tissue to prevent contamination.

In the context of stimuli that give rise to disgust, safety behaviors that preclude the occurrence of threat, but allow confrontation with the disgust-eliciting stimulus (e.g., using a hygienic wipe or hand sanitizer after touching a contaminant) may be allowed during the early stages of exposure therapy. Cleaning safety behavior did not hamper the beneficial effects of exposure to a contaminant in chapter 3 (van Uijen, van den Hout, Klein Schiphorst, et al., 2017), and previous studies (Goetz & Lee, 2015; Rachman et al., 2011; van den Hout et al., 2011, 2012). However, these positive effects may be specific to the early stages of treatment, and to the novelty of the cleaning behavior (Levy & Radomsky, 2016a). Recent findings suggest that incorporating cleaning safety behavior in the early stages of exposure therapy, and letting patients determine when safety behavior is faded in the course of treatment increases treatment effectivity and acceptability in the context of contamination fear (Levy & Radomsky, 2016b).

Furthermore, the findings presented in chapter 2 suggest that safety behavior that does not preclude the occurrence of threat may be allowed during exposure therapy for certain individuals, but should be eliminated for others (van Uijen, Dalmaijer, et al., 2017). It remains unclear for whom safety behavior that allows the occurrence of threat has detrimental effects on exposure outcomes. Therefore, if safety behavior that allows threat occurrences is incorporated in exposure exercises, it is advised to make an individual assessment of whether this hampers extinction learning for a patient.

Safety behaviors that motivate approach may increase access to disconfirmatory evidence, and thereby have positive effects on exposure outcomes (e.g., Milosevic & Radomsky, 2008, 2013). Additionally, anxious individuals may infer safety from approach behavior (chapter 6, van Uijen, van den Hout, & Engelhard, 2017), although it remains unclear if this adds to the beneficial effects of exposure (chapter 7, van Uijen et al., 2015). Approach-supportive behaviors may not be considered safety behaviors, but adaptive coping strategies (Thwaites & Freeston, 2005).

Nevertheless, incorporating approach-supportive behaviors in exposure therapy could have positive effects on the acceptability and effectivity of exposure therapy.

THE TREATMENT OF SAFETY BEHAVIOR IN COGNITIVE BEHAVIORAL THERAPY (CBT)

The implicit assumption of exposure therapy has been that safety behavior would decrease following fear extinction (Treanor & Barry, 2017). However, fear extinction does not diminish safety behavior (chapter 5, van Uijen, Leer, et al., 2017; Vervliet & Indekeu, 2015). Additionally, fear acquisition results in avoidance tendencies (Krypotos, Effting, Arnaudova, Kindt, & Beckers, 2014), which are also resistant to fear extinction and may act as a precursor of overt avoidance (Krypotos, Arnaudova, Effting, Kindt, & Beckers, 2015). Instructing patients to inhibit their safety behavior during exposure therapy may thus not extinguish safety behavior, and the return of safety behavior after treatment may promote relapse. The long-term effects of exposure therapy might be improved by directly targeting the extinction of safety behavior.

Operant conditioning research indicates several ways in which behavior may be extinguished (Bouton, 2016). Operant conditioning is a type of learning in which the strength of a behavior is modified by the behavior’s consequences, such as reward or punishment. Positive consequences (reinforcements) make it more likely that the individuals will perform the behavior again, whereas negative consequences (punishments) make it less likely that individual will perform the behavior again (Korrelboom & Ten Broeke, 2014; Ten Broeke & Rijkeboer, 2017). For a panic disorder patient, quickly sitting down when experiencing dizziness is reinforced by the nonoccurrence of fainting, and by an immediate decrease of dizziness and fear. On the long term, however, the negative consequences of this safety behavior may be the persistence of the irrational fear of fainting, and the functional impairment that may be caused by the inability to remain standing for longer periods of time. Theoretically, decreasing the positive consequences (reinforcements), and increasing the negative consequences (punishments) of a behavior may make it less likely that an individuals will perform that behavior again. Hence, increasing and/or emphasizing the negative consequences of safety behavior for patients may stimulate the extinction of safety behavior. In line with this, Rattel, Miedl, Blechert, and Wilhelm (2016) found that avoidance decreased when there was cost associated with avoidance for participants (i.e., they had to take a lengthy detour to avoid a potential shock). Additionally, Bublatzky, Alpers, and Pittig (2017), and Pittig, Brand, Pawlikowski, and Alpers (2014) found that rewarding approach decreased avoidance behavior. Future research may investigate if punishing safety behavior and rewarding approach behavior during exposure therapy can increase short- and long-term treatment outcomes. For example, the beneficial effects of exposure might be improved if a patient applies punishments (e.g., doing extra chores around the house) and/or rewards (e.g., having a relaxing bath) for his use of safety and approach behavior, respectively, during exposure exercises.

Furthermore, safety behavior may directly trigger danger perceptions and increase threat expectancy (Gangemi et al., 2012; Engelhard et al., 2015; chapter 4, van Uijen & Toffolo, 2015; chapter 5, van Uijen, Leer, et al., 2017; van den Hout et al., 2014, 2016; Vervliet & Indekeu, 2015). Future research may investigate if targeting the idiosyncratic meaning of safety behavior for a patient, for example by cognitive techniques, can increase treatment effectivity and prevent relapse after treatment.

Additionally, to prevent that safety behavior after extinction may promote a return of fear (chapter 5, van Uijen, Leer, et al., 2017; Vervliet & Indekeu, 2015) Treanor and Barry (2017) proposed to incorporate safety behavior in the later stages of exposure. They argued that the occasional availability of safety behavior during exposure may allow the safety behavior to become a feature of the extinction context, which might prevent a return of fear due to contextual renewal. In other words, patients might perform exposure exercises with and without safety behaviors, because this could prevent relapse. For example, a patient might practice going to the supermarket with and without taking his anxiolytic medication, bringing his mobile phone or partner, and quickly sitting down when he feels dizzy. When these safety behaviors become part of the extinction context, their availability after therapy may not present a context shift after treatment and trigger a return of fear. Treanor and Barry (2017) proposed to incorporate safety behaviors in the *later* stages of exposure, because the discrepancy between the expected and actual outcome of exposure is expected to be smaller in later stages than in the early stages of exposure therapy. Therefore, the negative effects of a conditional inhibitor on inhibitory learning may be reduced. Future research that investigates the effect of incorporating safety behavior in the final stages of exposure therapy on the long-term effects on treatment outcomes is needed.

FUTURE RESEARCH

The studies presented in the current dissertation include healthy and subclinical samples, and are performed in a laboratory setting. As is more often the case with experimental psychopathology research, this may raise questions about whether the findings generalize to real-world settings (van den Hout, Engelhard, & McNally, 2017). We chose this approach, however, because we aimed to investigate the learning principles of safety behavior in the persistence of irrational fears. The fear conditioning model has proven to be a robust and valid preclinical laboratory model for the exposure and the return of fear (Milad & Quirk, 2010; Vervliet et al., 2013). Additionally, results obtained in subclinical samples are often informative for clinical populations (van den Hout et al., 2017). For example, studies with analogue samples are useful for understanding obsessive-compulsive (OC) related phenomena, because OC symptoms are prevalent in nonclinical populations, and the maintenance factors are similar to those in clinical populations (Abramowitz et al., 2014). Nevertheless, the clinical relevance of the findings presented in the current dissertation should be examined.

Furthermore, future research may take into account that the studies in the current dissertation mainly included self-report measures of fear, threat expectancy, and disgust. Previous studies showed that participants who verbalized their emotional experience during exposure to a feared stimulus showed a greater reduction in physiological fear responses than participants who did not label their affect during exposure (Tabibnia, Lieberman, & Craske, 2008; Kircanski, Lieberman, & Craske, 2012; Niles, Craske, Lieberman, & Hur, 2015). Reporting emotional experiences alters the perception of emotion (Lindquist, 2017), and might add to the beneficial effects of exposure. Future studies may, for example, replicate the experiment presented in chapter 3 (van Uijen, van den Hout, Klein Schiphorst, et al., 2017), and add a control condition in which participants repeatedly touch the contaminant without reporting their feelings of contamination, fear, danger, and disgust (CFDD) at each exposure trial, or in which participants repeatedly report CFDD, but do not touch the contaminant at each trial.

CONCLUSION

Safety behaviors are generally considered ubiquitously deleterious and dysfunctional, and are assumed to contribute to the persistence of irrational fears. In line with these assumptions, the research presented in the current dissertation indicates that safety behavior can prevent extinction learning and thereby maintain excessive threat beliefs and irrational fears. Moreover, it shows that safety behavior can contribute to the development of pathological anxiety by directly exacerbating threat beliefs. Furthermore, it suggests that safety behavior is resistant to fear extinction, and may promote a return of fear. Hence, the findings of the current dissertation indicate several ways in which safety behaviors contribute to the maintenance of psychopathological anxiety, and suggest novel ways of treating safety behavior in the context of CBT. In contrast to the assumption that safety behavior is ubiquitously deleterious, however, safety behavior that allows threat occurrences may not hamper extinction learning for certain individuals and cleaning safety behavior may not be detrimental to the beneficial effects of exposure in the context of disgust. Additionally, exposure therapy might benefit from safety behavior that motivates approach, because this promotes confrontation with the feared, but innocuous stimulus, and anxious individuals may infer safety from approach. Pathological anxiety is a severe clinical and societal problem; therefore efforts to translate the current findings to clinical applications are warranted.

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SAMENVATTING

(Dutch summary)

VEILIGHEIDSGEDRAG EN DE VOLHARDING VAN IRRATIONELE ANGSTEN

Veiligheidsgedrag is gericht op het voorkómen en minimaliseren van gevreesde uitkomsten. Vaak is het functioneel gedrag, zoals het dragen van een autogordel om de kans op lichamelijk letsel bij een ongeluk te verkleinen en het goed schoonmaken van je handen na het bereiden van kip om salmonellabesmetting te voorkomen. Veiligheidsgedrag komt echter ook veel voor bij angstgerelateerde psychopathologie, zoals angststoornissen, obsessief-compulsieve stoornis (OCS), posttraumatische stressstoornis (PTSS) en ziekteangststoornis. Wanneer veiligheidsgedrag wordt uitgevoerd in reactie op de irrationale angsten en overmatige gevaarverwachtingen die kenmerkend zijn voor deze stoornissen wordt het gezien als disfunctioneel en schadelijk. Een voorbeeld is een patiënt met paniekstoornis die vreest dat duizeligheid zal leiden tot flauwvallen en daarom steeds snel gaat zitten als hij of zij licht in het hoofd wordt. De angst voor duizeligheid kan hierdoor in stand worden gehouden, omdat het veiligheidsgedrag (snel gaan zitten) de correctieve leerervaring dat duizeligheid níet leidt tot flauwvallen belemmert.

Zulke correctieve leerervaringen zijn essentieel voor exposure therapie. Exposure therapie is een belangrijk onderdeel van Cognitieve gedragstherapie (CGT), de meest effectieve behandeling van angststoornissen. Tijdens exposure therapie wordt een patiënt herhaaldelijk blootgesteld aan de gevreesde, maar ongevaarlijke stimulus of situatie, bijvoorbeeld duizeligheid bij paniekstoornis of een presentatie geven bij sociale fobie. Hierdoor leert de patiënt dat de gevreesde gebeurtenis, bijvoorbeeld flauwvallen bij paniekstoornis of uitgelachen worden bij sociale fobie, niet optreedt, waardoor de angst kan verminderen. Omdat veiligheidsgedrag deze correctieve leerervaring kan belemmeren, wordt door klinische richtlijnen aanbevolen om patiënten te motiveren hun veiligheidsgedrag tijdens exposure oefeningen achterwege te laten.

Wetenschappelijk onderzoek laat echter verschillende effecten zien van het gebruik van veiligheidsgedrag tijdens exposure. In sommige studies verminderde veiligheidsgedrag de positieve effecten van exposure, terwijl veiligheidsgedrag in andere studies deze positieve effecten niet in de weg stond of zelfs versterkte. Een mogelijke verklaring voor deze inconsistente bevindingen is dat sommig veiligheidsgedrag het optreden van een gevreesde gebeurtenis voorkomt en daarmee een correctieve leerervaring in de weg kan staan, terwijl dit bij ander veiligheidsgedrag niet het geval hoeft te zijn. In hoofdstuk 2 en 3 werd daarom onderzocht of de negatieve effecten van veiligheidsgedrag afhangen van of veiligheidsgedrag het optreden van een gevreesde gebeurtenis voorkomt.

Hoofdstuk 2 beschrijft twee angstconditioneringsexperimenten. Participanten leerden in een computertaak dat twee neutrale stimuli (A en C) gevolgd werden door een vervelend hard geluid dat ze hoorden via een koptelefoon. Een derde neutrale stimulus (B) werd niet gevolgd door het harde geluid. Het aanleren van associaties tussen neutrale en vervelende stimuli wordt acquisitie genoemd en is een veelgebruikte manier om in een experimentele setting 'angst' aan te leren. Participanten leerden ook veiligheidsgedrag te gebruiken dat het harde geluid voorkwam (uitpluggen van de koptelefoon) en dat het harde geluid niet voorkwam, maar wel minder vervelend maakte (afzetten van de koptelefoon). Hierna volgde de zogenaamde extinctiefase, waarin stimulus C niet langer gevolgd werd door het harde geluid. Tijdens deze fase mochten sommige participanten de koptelefoon uitpluggen als ze C zagen. Andere participanten mochten de koptelefoon afzetten bij C. Weer andere participanten mochten geen veiligheidsgedrag gebruiken. Dit zorgde ervoor dat hun verwachting dat na C het harde geluid zou volgen (de gevaarverwachting) daalde. Het uitdoven van een gevaarverwachting (en de bijbehorende angst) door het herhaaldelijk aanbieden van de neutrale stimulus zonder dat deze gevolgd wordt door de vervelende gebeurtenis (het harde geluid) wordt extinctie genoemd. Dit wordt gezien als het werkzame mechanisme van exposure. Bij participanten die de koptelefoon uitplugden trad echter geen extinctie

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op: hun gevaarverwachting bij C bleef hoog. Mogelijk schreven zij het uitblijven van het harde geluid toe aan het uitpluggen van de koptelefoon, in plaats van aan de (inmiddels) veilige stimulus C. Bij participanten die de koptelefoon afzetten tijdens C gebeurde iets opmerkelijks: bij de helft van hen trad extinctie op (de gevaarverwachting nam af), maar bij de andere helft niet (de gevaarverwachting bleef hoog). Veiligheidsgedrag dat het optreden van de gevreesde gebeurtenis niet voorkwam, belemmerde dus toch extinctie voor een aantal participanten.

Daarnaast onderzochten we in **hoofdstuk 3** of het schoonmaken van je handen na het aanraken van een (gefingeerd) vies object, zoals een vuil uitziende po, extinctie voorkomt. Handen schoonmaken na aanraking van een vies object kan voorkomen dat je besmet raakt en ziek wordt en zou hierdoor het uitdoven van irrationele gevaarverwachtingen kunnen belemmeren. Participanten raakten herhaaldelijk een object aan dat gevoelens van besmetting, angst, gevaar en walging opriep en waarvan ze verwachtten dat het aanraken kon resulteren in besmetting en ziekte. Een deel van de participanten mocht na iedere aanraking de handen schoonmaken met een hygiënisch doekje (veiligheidsgedrag), terwijl andere participanten geen veiligheidsgedrag kregen aangereikt. Ter controle raakte een derde groep participanten het object niet herhaaldelijk aan, maar las een tijdschrift tussen de voor- en nameting. Participanten die herhaaldelijk het object aanraakten rapporteerden een grotere daling in gevoelens van besmetting, angst, gevaar en walging dan participanten die tijdschriften lazen. Ook daalde de geloofwaardigheid dat aanraking van het object zou resulteren in besmetting en ziekte bij hen meer dan bij participanten in de controle groep. De daling in besmetting, angst, gevaar, walging en de geloofwaardigheid van de gevaarverwachting verschilde niet tussen participanten die hun handen wel en niet hadden schoongemaakt na iedere aanraking. Het veiligheidsgedrag had extinctie dus niet belemmerd. De bevindingen van hoofdstuk 2 en 3 suggereren dat de negatieve effecten van veiligheidsgedrag niet alleen bepaald worden door het wel of niet kunnen optreden van de gevreesde gebeurtenis: het afzetten van de koptelefoon voorkwam extinctie voor sommige participanten in hoofdstuk 2 en er trad wél extinctie op na het schoonmaken van de handen in hoofdstuk 3.

Naast het in stand houden van angst door het belemmeren van extinctie kan veiligheidsgedrag ook direct gevaarwaarnemingen vergroten. Eerder onderzoek liet zien dat angstige mensen geneigd zijn veiligheidsgedrag te gebruiken als bron van informatie over gevaar: “ik vlucht, dus er dreigt gevaar”. Ook bleek dat wanneer veiligheidsgedrag wordt ingezet in veilige situaties, dit de perceptie van gevaar vergroot en angst kan doen toenemen. In hoofdstuk 4 en 5 werd daarom de directe bijdrage van veiligheidsgedrag op gevaarwaarnemingen onderzocht. In het onderzoek dat beschreven wordt in **hoofdstuk 4** vroegen we een groep gezonde studenten om een week lang zoveel mogelijk OCS-achtig checkgedrag uit te voeren. Een andere groep vroegen we hun normale checkgedrag te monitoren en weer een andere groep gaven we geen instructies omtrent hun checkgedrag. Zo onderzochten we of checkgedrag, het meest voorkomende veiligheidsgedrag bij patiënten met OCS, bijdraagt aan de ontwikkeling van OCS problematiek. Ten opzichte van de participanten die monitorden of geen instructies kregen, rapporteerden participanten die zoveel mogelijk hadden gecheckt een toename in de verwachte ernst van gevaar dat zou kunnen ontstaan als ze niet zouden checken. Deze bevinding suggereert dat checkgedrag OCS-klachten kan verergeren. Samen met bevindingen uit eerder onderzoek lijkt het er daarom op dat veiligheidsgedrag irrationele angsten kan versterken.

In **hoofdstuk 5** onderzochten we of veiligheidsgedrag ná exposure kan bijdragen aan een terugkeer van angst. Dit toetsten we in een conditioneringsexperiment dat vergelijkbaar was met de experimenten van hoofdstuk 2. In hoofdstuk 5 mocht echter geen van de participanten veiligheidsgedrag gebruiken tijdens de extinctiefase (waarin stimulus C niet langer gevolgd werd door het harde geluid), waardoor bij iedereen extinctie optrad (de gevaarverwachting voor C nam af). Na de extinctiefase werd veiligheidsgedrag (uitpluggen van de koptelefoon) beschikbaar bij stimulus C. Ondanks dat de gevaarverwachting voor C was afgenomen, gebruikten alle participanten het veiligheidsgedrag. Hierdoor nam de gevaarverwachting voor C toe toen de mogelijkheid om veiligheidsgedrag te gebruiken vervolgens weer verdween. Deze bevindingen suggereren dat veiligheidsgedrag resistent is tegen extinctie: het dooft niet uit als de gevaarverwachting afneemt. Daarnaast kan het leiden tot een terugkeer van angst na extinctie. Het is daarom mogelijk dat veiligheidsgedrag een rol speelt bij terugval na exposure therapie.

Alhoewel het meeste veiligheidsgedrag gericht is op vermijding, is er ook veiligheidsgedrag dat toenaderingsgedrag bevordert. Een voorbeeld hiervan is het gebruik van beschermende kleding, zoals handschoenen, een schort en bril tijdens exposure therapie voor spinnenangst. Dit veiligheigsgedrag kan ervoor zorgen dat patiënten meer toenadering durven te vertonen naar een spin, waardoor ze correctieve leerervaringen opdoen en er extinctie kan optreden. Naast het bevorderen van extinctie is toenaderingsgedrag geassocieerd met positieve beoordelingen en met de perceptie van veiligheid. In hoofdstuk 6 en 7 hebben we daarom onderzocht of veiligheidsgedrag dat toenadering bevordert kan bijdragen aan de positieve effecten van exposure. In **hoofdstuk 6** onderzochten we of angstige individuen veiligheid afleiden uit informatie over toenaderingsgedrag. Participanten beoordeelden het door hen waargenomen gevaar in scenarios over objectief veilige en gevaarlijke situaties waarin wel of geen toenaderingsgedrag werd beschreven. We vonden dat participanten die bang waren voor spinnen objectief gevaarlijke en veilige scenarios als veiliger beoordeelden wanneer hierin toenadering naar een spin werd beschreven dan wanneer in deze scenarios geen toenadering werd beschreven. Niet-spinangstige participanten lieten dit effect niet zien.

In **hoofdstuk 7** toetsten we of toenaderingsgedrag tijdens exposure aan een spin het positieve effect van exposure versterkt. Spinangstige participanten werden herhaaldelijk blootgesteld aan een spin. Eén groep participanten deed dit door de spin die in een pot op een karretje stond naar zich toe te trekken (actieve toenadering), terwijl bij een andere groep participanten de onderzoeker de spin naar de participant toetrok (geen actieve toenadering). Ter controle was er ook een groep participanten die niet herhaaldelijk aan de spin werd blootgesteld, maar tussen de voor- en nameting een tijdschrift las. Ten opzichte van deze controlegroep lieten beide exposure groepen een grotere daling in spinnenangst zien. Deze daling verschilde niet tussen de exposuregroepen. Het naar je toe trekken van de spin tijdens exposure vergrootte dus niet het effect van exposure.

De bevindingen van dit proefschrift beschrijven verschillende manieren waarop veiligheidsgedrag bijdraagt aan de volharding van irrationele angsten: veiligheidsgedrag kan irrationale angsten in stand houden door extinctie te belemmeren, het kan angst direct verergeren en kan bijdragen aan de terugkeer van angst na exposure. We vonden echter ook dat veiligheidsgedrag niet altijd disfunctioneel en schadelijk is: veiligheidsgedrag dat het optreden van een gevreesde gebeurtenis niet in de weg staat en schoonmaakgedrag in de context van besmetting en walging verminderden de positieve effecten van exposure niet. Daarnaast zou veiligheidsgedrag dat toenadering bevordert kunnen bijdragen aan de positieve effecten van exposure.

De behandeling van pathologische angstproblematiek kan profiteren van een goed begrip van de rol van veiligheidsgedrag in de volharding van irrationale angsten. Bij het optimaliseren van exposure therapie moet daarom gekeken worden op welke manier veiligheidsgedrag ingezet kan worden tijdens exposure oefeningen en hoe disfunctioneel en schadelijk veiligheidsgedrag verminderd kan worden. Pathologische angst is een ernstig klinisch en maatschappelijk probleem. Pogingen om de huidige bevindingen te vertalen naar klinische toepassingen zijn daarom nodig.

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ABOUT THE AUTHOR

Sophie van Uijen was born on 14 January 1986 in Eindhoven. She spent the first 18 years of her life in Waalre and then moved to Utrecht to study Clinical psychology. After an Erasmus exchange to Manchester, U.K., she obtained her Bachelor's degree and started Utrecht University's research Master's program Social and Health Psychology in 2008. She graduated cum laude in 2010 and was awarded the Best student prize. She started the Master's program Clinical and health psychology in 2009 and did an internship at the Altrecht specialized outpatient clinic in Utrecht. She graduated cum laude in 2011. During and after her studies, she was a research assistant at Utrecht University by day, ninja by night, and worked as a teacher at VU University, Amsterdam. After she was awarded a Research Talent grant by the Netherlands Organization for Scientific Research (NWO), she started her PhD project on the role of safety behaviors in the persistence of irrational fears in 2012, supervised by Prof. dr. Iris Engelhard and Prof. dr. Marcel van den Hout. In addition to her research, she worked as a teacher, was an active member of the PhD council of the Faculty of Social Sciences, and was chair of the PhD Network Utrecht (Prout). Additionally, she worked as a psychologist at Altrecht Academic Anxiety center, Utrecht, and at the youth and adolescent clinic and eHealth clinic of GGZ inGeest, Amsterdam. After finishing her PhD, she started her training to become a licenced mental health care psychologist (GZ-psycholoog) at GGZ inGeest. There she will also continue her scientific career as a postdoctoral researcher.

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