

The Effects of Safety Behavior Directed Towards a Safety Cue on Perceptions of Threat

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Safety behavior involves precautions to prevent or minimize a feared outcome, and is involved in the maintenance of anxiety disorders. Earlier research has shown that safety behavior prevents the extinction of conditioned fear and maintains threat expectations. This study tested whether safety behavior directed towards an objectively safe stimulus increases the perceived threat of that stimulus when it is subsequently experienced in the absence of the safety measure. In a conditioning task, participants first learned that one "danger" cue (A) was followed by shock and two "safety" cues (B, C) were not. Then they learned to apply safety behavior during A trials, which prevented the shock. Next, the experimental group, and not the control group, was given the opportunity to display safety behavior to C trials, which had never been coupled with the shock. In a subsequent test phase, A, B, and C were presented without the opportunity for participants to engage in safety behavior. Results showed that safety behavior increased shock expectancy to C in the test phase and maintained a preexisting shock expectancy in the experimental group, but not in the control group. This is the first study to show that safety behavior can maintain threat appraisal to stimuli that

only ever acquired threat indirectly. This may be a possible mechanism for the origin of biased threat beliefs, superstitious behaviors, and irrational fears. It is also practically relevant: safety behavior reduces actual danger, but in relatively safe situations, its potential costs may outweigh the benefits.

Keywords: safety behavior; threat perceptions; anxiety disorders

SUPERSTITIONS ARE WIDESPREAD. For instance, many scholastic basketball players bounce the ball the same way before a free throw, and wear a lucky item of clothing (see [Vyse, 2013](#)). Or, in the case of air travel, passengers may pat or kiss a plane when boarding it; and if they look into the cockpit, they may see pilots' hats hanging with family pictures put inside for good luck. To take another example, many airlines avoid row 13 on their planes ([McCartney, 2013](#)). Such superstitions can be considered safety (seeking) behaviors and measures: precautions to prevent or minimize a feared outcome.

Safety behaviors and measures that actually reduce threat are, of course, essential for survival and people's well-being ([Diener, 2012](#)). For example, increases in home security appears to have reduced risks of domestic burglary in the Netherlands ([van Dijk & Vollaard, 2012](#)), and increases in car security were followed by declines in car theft in the United States ([Fujita & Maxfield, 2012](#)). However, in relatively safe situations, they may be maladaptive.

Safety behavior has been studied in research about the persistence of anxiety disorders ([Rachman, Radomsky, & Shafran, 2008](#)). These disorders are

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characterized by excessive and persistent fear of objectively nonthreatening stimuli and related behavioral disturbances (e.g., escape and avoidance). For instance, people with panic disorder may fear dizziness, because they expect to faint; people with obsessive-compulsive disorder may fear touching doorknobs, because they expect contamination; and people with social anxiety disorder may fear blushing, because they expect humiliation. Safety behavior is thought to play a crucial role in the persistence of such danger beliefs (Clark, 1999; Rachman et al., 2008; Salkovskis, 1991; Wells et al., 1995). It may involve sitting down when feeling dizzy (panic disorder), excessive hand washing (obsessive-compulsive disorder), and wearing hair in a certain way to cover blushing (social phobia). Although providing temporary relief, safety behavior is thought to preserve excessive danger beliefs, because the person will misattribute safety to this behavior (e.g., Clark, 1999; Salkovskis, 1991).

A well-controlled experiment by Lovibond and colleagues (2009) examined whether safety behavior indeed preserves threat beliefs. They used a "de novo" fear conditioning procedure with three colored shapes—A, B, or C—that were or were not followed by shock. Participants were told that a response button might light up while A, B, or C was on the screen, and that pressing the lit button may cancel a pending shock. There were four phases, and participants rated their shock expectancy on-line. In the first phase, Pavlovian acquisition took place: A and C (danger cues) were followed by shock, B (safety cue) was not. In the second phase, safety behavior was learned during A trials (i.e., A was presented with the lightened response button, and if participants pressed the button, shock was cancelled). In the third phase, the crucial manipulation was a shift of safety behavior from A to C. A was again followed by shock, B was not. In contrast to the earlier phases, C was never followed by shock, but during C trials the experimental group (and not the control group) was given the opportunity to avoid the shock by pressing the lightened button. This led to reductions in shock expectancy to C in both groups. Finally, in the Test phase, A, B, and C were presented once, without an opportunity to apply safety behavior. Results showed that shock expectancy to C in the Test phase was higher for the experimental group compared to the control group. Apparently, safety behavior had prevented fear extinction and maintained threat expectations for stimulus C. Similar findings have been obtained for the extinction of fear of movement-related pain (Volders, Meulders, De Peuter, Vervliet, & Vlaeyen, 2012).

These studies have shown that safety behavior maintains threat expectations for a stimulus that

was previously coupled with an unpleasant event. Few studies have tested whether it also contributes to the *development* of threat expectations. As noted by Deacon and Maack (2008), safety behavior is common in the general population, and many individuals are likely encouraged from a young age by parents or other sources to habitually engage in such behavior, such as frequent hand washing and avoidance of contact with potential contaminants. Yet this behavior may activate a threat concept and lead to a misattribution of safety. Therefore, it is possible that when safety behavior is directed towards an objectively *safe* stimulus, this may increase the perceived threat of that stimulus when it is later experienced in the absence of the safety measure.

Two field studies provide preliminary evidence for the threat-inducing properties of safety behavior. In an uncontrolled study, Deacon and Maack (2008) asked college students after a baseline period to spend 1 week applying contamination-related safety behaviors on a daily basis (e.g., washing and disinfecting hands after touching doors and money), followed by another baseline. After the safety behavior manipulation, participants showed increased contamination concerns and threat estimates. Olatunji and colleagues (2011) did use a control group that monitored their normal use of safety behavior, and found similar results. However, in these two studies, contact with objects may not have been an objectively safe stimulus before the manipulation due to prior knowledge. It also remains unclear whether it was perceived as more "dangerous" after the manipulation, because the studies did not use danger and safety reference stimuli for interpreting the effects of safety behavior.

The crucial question remains whether the effect found by Lovibond et al. (2009) is also observed when safety behavior is directed towards an objective safe stimulus that has never been paired with an unpleasant event when it is subsequently experienced in the absence of the safety measure (i.e., when safety behavior is no longer possible). To test this prediction, we used the conditioning paradigm developed by Lovibond et al. with one key difference: we used one danger cue (A) and two safety cues (B and C). That is, in our study, stimulus C was never paired with the shock and the experimental group was given the opportunity to display safety behavior to this safety stimulus, while the control group was not. We predicted that when safety behavior was subsequently absent during the test phase, shock expectancy ratings to safety cue C would be higher for the experimental group, compared to the control group, and compared to safety cue B, for which safety behavior was never carried out, but lower compared to danger cue A.

Table 1
Design of Study

Group	Phase			
	Pavlovian acquisition	Safety behavior acquisition	Safety behavior shift	Test
Experimental	A+ (2)	A*(+) (6)	A+ (2)	A+ (1)
	B- (4)	A+ (1)	B- (2)	B- (1)
	C- (2)	B- (2)	C* (6)	C- (1)
		C- (1)		
Control	A+ (2)	A*(+) (6)	A+ (2)	A+ (1)
	B- (4)	A+ (1)	B- (2)	B- (1)
	C- (2)	B- (2)	C- (6)	C- (1)
		C- (1)		

Note. A, B, and C refer to visual stimuli; + and - refer to presence and absence of subsequent shock; * refers to the availability of safety behavior; (+) indicates that shock only occurred if the person failed to apply safety behavior; numbers in parentheses give the number of trials.

Method

PARTICIPANTS AND GENERAL PROCEDURE

Participants were 101 undergraduate volunteers (M age = 21.3, SD = 2.7; 74 women, 27 men). They received €4 or partial course credit. After the informed consent process, they were randomly allocated to one of the two groups. The study was reviewed by the Institutional Review Board of the Faculty of Social and Behavioral Sciences of Utrecht University, and was carried out in accordance with the provisions of the World Medical Association Declaration of Helsinki. The sample size was set before data analysis, and all measures that were collected are reported.

APPARATUS

A computer with Python software and 19-inch color monitor presented the task and recorded responses and ratings. The 0.5-s shock (range 0.2–4.0 mA) was selected by each participant to be certainly annoying but not painful through a work-up procedure. It was delivered through electrodes attached to the second and third finger of the dominant hand, and generated by a Coulbourn Transcutaneous Aversive Finger Stimulator (E13-22) using a 9-V dry cell battery attached to an adjustable step-up transformer. Participants wore overear Sennheiser headphones that played 80-dB white noise to mask external sounds and presented a 0.5-s 95-dB tone during each shock to prevent habituation. Lovibond et al. (2009) used the headphones for these purposes, and reported that their previous experience had indicated that the tone reduces habituation to the shock across the course of an experiment.

EXPERIMENTAL TASK

Table 1 shows the design of this study. The design and the procedure by Lovibond et al. (2009) were used, but there were two main differences: in our study C was never followed by shock and physiological

responses were not recorded; therefore the trial duration and ITI were shorter in our study (see below). In the Pavlovian acquisition phase, A was paired with shock; B and C were not. In the Safety behavior acquisition phase, participants were given the opportunity to press the lightened response button during A trials with the exception of one A trial (as a reminder that A without safety behavior led to shock). In the Safety behavior shift phase, the experimental group was given the opportunity to press the button during each C trial. In the Test phase, A, B, and C were presented once. Each stimulus was presented for 3 s during which the button could light up and the avoidance response could be made, followed by a 5-s waiting period during which participants rated their expectancy of the shock, followed by a 0.5-s shock (0.5 sec) or no shock. The ITI was 2–4 s. Lovibond et al. used a pointer on a rotary dial to record shock expectancy, but in our study participants used the computer mouse to rate a visual analogue scale that was displayed on the screen, ranging from "certain no shock" (0) to "certain shock" (100) (these labels were also used by Lovibond et al.). In each phase, trial types were intermixed, but in the Test phase, C was always shown last. A trials were included in the study to maintain the participants' experience of the shock, and A and B trials were included as comparison stimuli, to provide reference points for interpreting the level of responding to stimulus C (cf. Lovibond et al.).

Participants were told that the experiment was about the role of attention in learning relationships between neutral and aversive stimuli. They were told that a series of colored squares would be shown, and some would be followed by shock together with a loud noise. They were also told that there would be a relationship between the block's color and shock, and they should figure out that relationship. They were instructed how to use the computer mouse to rate the shock expectancy scale, and then practiced rating the scale three times. Then they were told that a response

box button might light up, and “if you press that lighted button, this may cancel a shock.” After two practice trials, the task started.

A, B, and C were 6 x 6 cm blue, yellow, or pink squares (color was randomized for each participant) shown in the middle of the screen for 3 s. Lovibond et al. (2009) used blue, yellow, and green squares. Because green may correspond with safety, we used pink instead. The response box had 5 buttons and was placed in front of the monitor. During safety behavior trials one button lightened. In the 5-s interval between a stimulus and shock, the expectancy scale appeared.

SCORING AND ANALYSIS

Following Lovibond et al. (2009), Pavlovian contingency awareness was defined as a higher shock expectancy rating to A than to B in the Test phase, and successful safety behavior acquisition was defined by responding to at least three consecutive A*(+) trials. In addition, we defined successful safety behavior shift by responding to all C*- trials. Outliers were defined as more than 3 SD from the mean, and were replaced with M ± 3 SD. Expectancy ratings were analyzed for each phase by multivariate repeated measures (α = .05) and pairwise comparisons using Bonferroni correction.

Results

All participants pressed the button during A* trials; 94 (93%) responded on all 6 trials, 6 responded on 5, and 1 responded on 4 trials. Data of 27 participants were excluded, because 13 showed no safety behavior shift,

3 were unaware of the contingency, and 11 did not rate shock expectancy for one or more stimuli. Analyses included the remaining 74 participants (experimental group: n = 33; control group: n = 41).

Figure 1 shows that Pavlovian acquisition occurred: shock expectancy ratings differed between the last A (M = 79.50, SD = 19.79), B (M = 17.27, SD = 18.62), and C (M = 27.27, SD = 23.89) trial, F(1.79,128.93) = 164.66, p < .001, ηp² = .70, for both groups, F < 1. Ratings were higher for A vs. B and C, ps < .001, and for C vs. B, p = .005.

In the Safety behavior acquisition phase, expectancy ratings for response trials dropped straight-away (first A*(+), M = 47.17, SD = 35.52, vs. A, M = 87.57, SD = 17.99), F(1, 72) = 75.39, p < .001, ηp² = .51, and continued to decline in a quadratic trend, F(1, 72) = 26.04, p < .001, ηp² = .27, for both groups, Fs < 1.36, p = .25. There were no significant differences between the experimental and control condition in shock expectancy for A, t(72) = 0.91, p = .37, and B, t(49.42) = 1.24, p = .22, and C, t(72) = 1.87, p = .07.

In the Safety behavior shift phase, shock expectancy for the first C trial was higher in the experimental group (M = 22.41, SD = 22.10) than in the control group (M = 7.78, SD = 13.74), t(51.07) = 3.32, p = .002. Ratings for C declined in a quadratic trend for both groups, F(1,72) = 5.00, p = .03, ηp² = .07, but overall remained higher in the experimental group vs. control group, F(1,72) = 6.77, p = .01, ηp² = .09.

In the Test phase, the crucial Stimulus × Condition interaction was significant, F(1.48, 106.30) = 11.92, p < .001, ηp² = .14. Shock expectancy ratings were

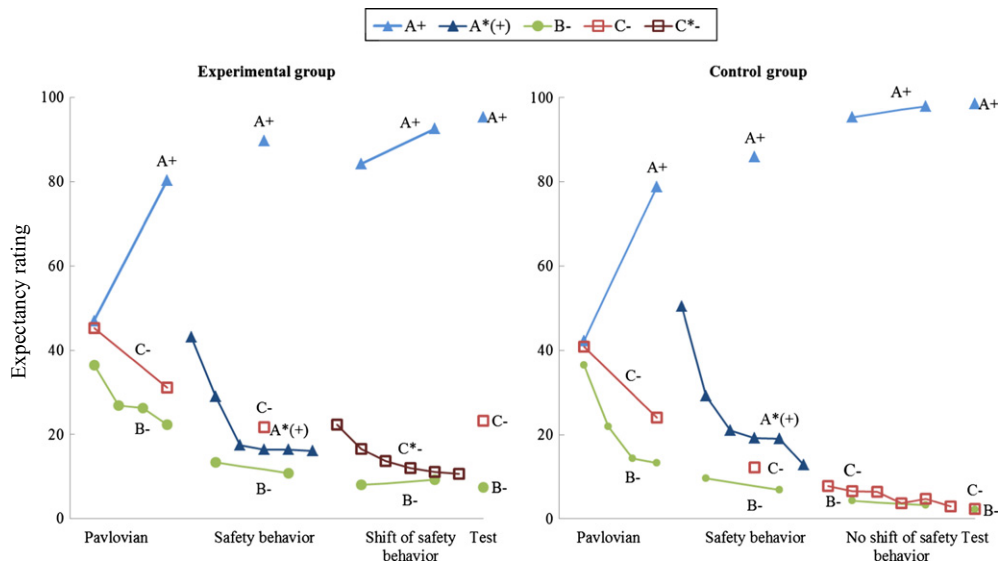


FIGURE 1 Mean shock expectancy ratings during A, B, and C.

higher for A (experimental group $M = 95.36$, $SD = 9.23$; control group $M = 98.53$, $SD = 3.31$) than for B (experimental group $M = 7.45$, $SD = 14.16$; control group $M = 2.12$, $SD = 4.56$) and C (experimental group $M = 23.29$, $SD = 33.05$; control group $M = 2.30$, $SD = 6.09$), for both groups, $ps < .001$. Most important, as predicted, the experimental group had higher ratings for C compared to the control group, $t(33.75) = 3.60$, $p = .001$, and compared to B, $t(32) = 2.75$, $p = .01$, while the control group had similar ratings for C and B, $t < 1$. Ratings did not change from the last trial of the preceding phase to the Test phase for any stimulus for the control group, $F_s < 1.93$, $p = .17$, but for the experimental group, they increased for A (last A Shift phase $M = 92.57$, $SD = 11.57$), $F(1, 32) = 6.17$, $p = .02$, $\eta_p^2 = .16$, decreased for B (last B Shift phase $M = 9.30$, $SD = 14.86$), $F(1, 32) = 4.45$, $p = .04$, $\eta_p^2 = .12$, and, crucially, increased for C (last C Shift phase $M = 10.73$, $SD = 20.19$), $F(1, 32) = 6.57$, $p = .02$, $\eta_p^2 = .17$. A comparison of ratings to C before and after the Shift of safety behavior phase (i.e., Safety behavior acquisition phase vs. Test phase) showed no change in shock expectancy in the experimental group, $t(32) = 0.23$, $p = .82$, and a decrease in the control group, $t(40) = 2.89$, $p = .006$, which suggests that safety behavior maintained a preexisting appraisal of threat.

Discussion

This is the first study to show that safety behavior directed towards a stimulus that was never paired with an unpleasant stimulus paradoxically increases threat expectations to that stimulus when it is subsequently experienced in the absence of the safety measure. Performing the safety behavior during C maintained the preexisting shock expectancy for the experimental group that was present before the Shift of safety behavior phase. This demonstrates that safety behavior can maintain threat appraisal to stimuli that only ever acquired threat indirectly. As argued by Rachman (1991) and others (e.g., Askew & Field, 2008; Mineka & Zinbarg, 2006), this is likely to be a common route of fear acquisition for anxious patients. These findings extend the study by Lovibond et al. (2009) that showed that safety behavior maintains threat expectations to a stimulus that has directly been paired with an unpleasant stimulus. Because stimulus C was never paired with shock in our experiment, the moderate level of shock expectancy to C must have arisen indirectly via generalization from reinforcement of the other stimuli, or from the overall presence of shock in the situation. A likely explanation of the increase of shock expectancy when safety behavior was no longer available is that safety behavior led to misattribution of safety in the presence of safety cue C.

An important conceptual issue is whether the influence of safety behavior depends on a prior history with danger (A trials in our study). It seems likely that the introduction of a safety behavior in itself (without prior danger learning) can also increase threat appraisals. For instance, safety behavior may become associated with threat through verbal information or observation of others. Moreover, safety behavior without prior danger learning may increase threat appraisals because people may use their behavior as a source of information about a situation (Gangemi, Mancini, & van den Hout, 2012), just like using emotional reactions as information to guide judgment and decision making (Engelhard & Arntz, 2005; Schwarz & Clore, 1988). Nevertheless, this is an empirical question that awaits future research.

The present and earlier findings (Deacon & Maack, 2008; Olatunji et al., 2011) suggest that safety behavior may play a role in the development or maintenance of excessive threat beliefs and fear. Potential harmful effects of safety behavior may be particularly salient in individuals who already have somewhat elevated threat beliefs in safety situations. Future research is needed that tests whether reducing safety behavior in relatively safe situations prevents the development of clinical fears. Interestingly, in the clinical context, the judicious use of safety behaviors may be facilitative especially in the early stages of treatment, for instance, because it may make treatment more tolerable (see Rachman et al., 2008; Rachman et al., 2011; van den Hout et al., 2011).

Over the years, safety and security precautions have increased substantially (van Dijk, Tseloni, & Farrell, 2012). This seems to be a main reason that crime rates have dropped steadily in many countries over the last 20 years (van Dijk et al., 2012). Nevertheless, public polls in various countries show that many people believe that their national crime rate is stable or rising (e.g., Beam, 2011; Brennan, 2011; Davis & Dossetor, 2010; Duffy, Wake, Burrows, & Bremner, 2008; Jones, 2010). Risk perception is not only the result of rational analysis (e.g., Jackson, 2011), but is also influenced by, for instance, intuitive processes (Slovic & Peters, 2006). It is also possible that overt safety and security precautions are paradoxically involved in such misperceptions, because they serve as reminders of threat. This is another empirical issue that can be addressed in future experimental research.

This study had strengths and limitations. On the one hand, we used a well-controlled experimental method that included novel stimuli and objective danger and safety reference points. On the other hand, we did not assess arousal or discomfort, which may be shaped by perceived threat potential.

Therefore, it remains unclear whether increased threat expectations led to increased arousal. Furthermore, rigorous experimental control allows causal inference, but is limited by reduced ecological validity. Yet given that two less controlled field studies yielded comparable results (Deacon & Maack, 2008; Olatunji et al., 2011), it appears plausible that our findings generalize outside of the laboratory.

To conclude, safety behavior in the presence of actual threat is essential for survival, but in the presence of relative safety, it may have disadvantages. It may lead to the development or maintenance of threat beliefs. Safety behavior may not only be a maintaining factor in anxiety disorders, as proposed by the influential cognitive theory (Clark, 1999; see Rachman et al., 2011; van den Hout et al., 2011), but may also be a possible mechanism for the origin of biased threat beliefs, superstitious behaviors, and irrational fears.

Conflict of Interest Statement

All authors report no financial relationships with commercial interests.

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