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The effects of safety behaviors on health anxiety: An experimental investigation

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ABSTRACT

The present study examined the extent to which safety behaviors exacerbate symptoms of hypochondriasis (severe health anxiety). Participants were randomized into a safety behavior ($n = 30$) or control condition ($n = 30$). After a baseline period, participants in the safety behavior condition spent one week actively engaging in a clinically representative array of health-related safety behaviors on a daily basis, followed by a second week-long baseline period. Participants in the control condition monitored their normal use of safety behaviors. Compared to control participants, those in the safety behavior condition reported significantly greater increases in health anxiety, hypochondriacal beliefs, contamination fear, and avoidant responses to health-related behavioral tasks after the safety behavior manipulation. In contrast, general anxiety symptoms did not significantly differ between the two groups as a function of the manipulation. Mediational analyses were consistent with the hypothesis that changes in the frequency of health-related thoughts mediated the effects of the experimental manipulation on health anxiety. These findings suggest that safety behaviors are associated with increases in health anxiety, perhaps by fostering catastrophic thoughts about health. The implications of these findings for the conceptualization of hypochondriasis as an anxiety disorder are discussed.

According to the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV-TR*; American Psychiatric Association, 2000), the cardinal feature of hypochondriasis is a preoccupation with the inaccurate belief that one has, or is in danger of developing, a serious medical condition based on misinterpretations of benign (or minor) bodily sensations. The *DSM-IV-TR* also emphasizes a "disease conviction" that persists despite appropriate medical evaluation and reassurance of good health. Preoccupation with medical illness in hypochondriasis might focus on specific signs or symptoms (e.g., sore throat), diseases (e.g., cancer), organs (e.g., heart), or vaguely defined somatic phenomena (e.g., "my aching veins"). Typically, the sufferer attributes unwanted bodily sensations to the possible disease (e.g., "this headache means I have a brain tumor") and is highly concerned with their cause and authenticity. Preoccupation with disease in hypochondriasis can be disruptive to social, occupational, and family functioning, and is associated with substantial economic costs (Katon & Walker, 1998).

Although hypochondriasis is currently classified as a somatoform disorder in the *DSM-IV* (American Psychiatric Association, 2000), the validity of this categorization is not without debate. It has been argued that hypochondriasis may be best conceptualized as an anxiety disorder (Olatunji, Deacon, & Abramowitz, 2009). This argument is based largely on empirical observations that symptoms of hypochondriasis overlap with certain anxiety disorders: namely, panic disorder (PD) and obsessive-compulsive disorder (OCD). Like those with hypochondriasis, patients with PD are hypervigilant to benign, arousal-related body sensations and often erroneously attribute them to organic causes such as heart attacks, strokes, and other serious medical conditions (Barsky, Barnett, & Cleary, 1995). Similarities have also been observed between hypochondriasis and certain presentations of OCD in terms of preoccupation with health and disease, and the repetitive and pervasive nature of such preoccupation (Abramowitz, 2005; Fallon, Javitch, Hollander, & Liebowitz, 1992). Much like PD and OCD, cognitive-behavioral models (Abramowitz, Schwartz, & Whiteside, 2002; Warwick & Salkovskis, 1990) posit that hypochondriasis is an extreme form of health anxiety that emerges from the misinterpretation of benign and normally occurring experiences (e.g., arousal-related sensations, intrusive thoughts about harm) that lead to anxiety and the use of safety behaviors which paradoxically maintains the anxiety (Abramowitz, Deacon, & Valentiner, 2007; Abramowitz, Olatunji, & Deacon, 2007).

Safety behaviors include actions designed to detect a perceived impending threat, avoid it entirely, or endure it when avoidance is not an option (Helbig-Lang & Petermann, 2010). Although the use of safety behaviors in the presence of actual threat is essential for

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survival, excessive and inflexible use of safety behaviors has been observed to maintain anxiety disorder symptoms (e.g., Salkovskis, 1991). Common examples of safety behaviors include excessive hand washing and repetitive checking in OCD, avoidance of eye contact and social interactions in social phobia, and carrying “safety aids” such as a water bottle, cell phone, or prescription anti-anxiety medication in PD (Kamphuis & Telch, 1999). Safety behaviors readily observed in hypochondriasis include seeking reassurance from external sources (e.g., doctors, Internet, books), body checking (e.g., taking blood pressure, feeling for lumps, inspecting excretions) and avoidance of cues associated with disease (e.g., hospitals, cancer floors, funerals, Abramowitz, 2008). These behaviors may be employed in hypochondriasis to reduce the perception of threat, consequently producing a short-term reduction in health anxiety (Abramowitz & Moore, 2007). However, research has also shown that safety behaviors are negatively reinforcing in that they maintain anxiety symptoms in the long-term (Salkovskis, Thorpe, Wahl, Wroe, & Forrester, 2003).

Safety behaviors may maintain health anxiety by preventing the acquisition of information that disconfirms inaccurate threat beliefs through a misattribution of safety (Salkovskis, 1991; Tang et al., 2007) and/or by diverting attentional resources away from disconfirming information (Powers, Smits, & Telch, 2004; Sloan & Telch, 2002). These functional properties of safety behaviors are clearly shared by hypochondriasis and anxiety disorders such as OCD. Indeed, there are hypochondriac patients whose concerns are identical in quality to the intrusive thoughts of patients with OCD (Barsky, 1992). Thus the form and function of safety behaviors may also be identical in the subgroup of hypochondriacal patients who are closer in symptoms to the anxiety disorders in general and to OCD in particular. Contemporary cognitive-behavioral models of anxiety disorders also emphasize the role of safety behaviors in explaining why irrational fears do not self-correct in the face of repeated disconfirmation (Clark, 1999; Salkovskis, 1991; Thwaites & Freeston, 2005). Such behaviors may maintain the irrational beliefs that underlie the strong “disease conviction” in hypochondriasis by preventing the disconfirmation of such beliefs. Although excessive engagement in safety behaviors may *maintain* health anxiety, it remains unclear if safety behaviors also exert a *causal* influence on health anxiety. It has been observed that safety behaviors may give rise to hypochondriasis by transmitting illness threat information (Abramowitz et al., 2002). A recent study also found that the mere act of engaging in safety behaviors exacerbated contamination concerns that are commonly observed in OCD (Deacon & Maack, 2008). This finding is largely consistent with the concept of ex-consequentia reasoning (Arntz, Rauner, & van den Hout, 1995) where the act of engaging in relevant safety behaviors may lead the actor to experience health anxiety and infer the presence of danger.

Although safety behaviors are thought to maintain pathological anxiety by preventing the disconfirmation of inaccurate threat beliefs (Abramowitz & Moore, 2007; Salkovskis, 1991), the extent to which safety behaviors contribute to the development and exacerbation of health anxiety symptoms remains largely unknown. In fact, the negative impact of safety behaviors in general remains somewhat of a controversial issue. For example, some have recommended a more rigorous procedure of identifying safety behaviors and abandoning them throughout therapy (Helbig-Lang & Petermann, 2010), others contend that an unqualified rejection of safety behaviors should be reconsidered given research showing that the judicious use of safety behaviors, especially in the early stages of treatment, can be facilitative (Rachman, Radomsky, & Shafran, 2008). Thus, the widely asserted notion that safety behaviors are generally detrimental is questionable and the specific effects of safety behaviors on self-report and behavioral indicators of health anxiety remains untested.

In the present study, participants engaged in a large number of health-related safety behaviors each day for one week, thereby simulating the behavior of individuals with health anxiety. Week-long baseline periods during which participants behaved as they typically do occurred immediately before and after the safety behavior manipulation. It was predicted that compared to a control condition, participants in the safety behavior manipulation would evidence significantly greater health anxiety, hypochondriacal beliefs, and behavioral avoidance. It was also hypothesized that responses to the manipulation would be specific to health anxiety symptoms rather than anxiety symptoms in general. As a preliminary step toward a comprehensive cognitive-behavioral model, the present study also examined whether changes in the frequency of health-related thoughts mediate the effects of the safety behavior manipulation on changes in health anxiety.

Method

Participants

Sixty undergraduate participants were randomly assigned to either a control ($n = 30$; 73.3% female) or safety behavior ($n = 30$; 80.0% female) group. The mean age of the total sample was 19.33 ($SD = 1.11$) and 84.7% of participants described themselves as Caucasian. Mean age, percent female, and distribution of ethnicity did not significantly differ between the two groups.

Experimental design

This study utilized a simple phase change A/B/A design (Hayes, Barlow, & Nelson-Gray, 1999) between subjects. For those in the safety behavior condition the three-week study period consisted of the following week-long phases (described in further detail below): (a) baseline phase during which participants monitored their normal frequency of health-related safety behaviors, (b) safety behavior phase, during which participants were instructed to engage in (and monitor) a high frequency of health-related safety behaviors each day, and (c) return to baseline phase, during which participants once again were instructed to engage in (and monitor) their normal frequency of safety behaviors. Those in the control condition monitored their normal use of safety behaviors at each phase. Study assessments included self-report and behavioral measures and were conducted before and after each phase, yielding a total of four assessment time points.

Measures

Short-Form Health Survey (SFHS; McHorney, Ware, & Raczek, 1993)

The general health perceptions subscale of the SFHS consists of four items assessing participants' perceptions about their general health status. The subscale was administered only during the initial assessment. The scale had good internal consistency in the present study ($\alpha = .83$).

Short Health Anxiety Inventory (SHAI; Salkovskis, Rimes, Warwick, & Clark, 2002)

The SHAI contains 18 items that assess health anxiety and other symptoms of hypochondriasis independently of physical health status. Items assess worry about health, awareness of bodily sensations or changes, and feared consequences of having an illness. The SHAI has demonstrated good reliability and validity in clinical and nonclinical samples (Abramowitz, Deacon, et al., 2007; Abramowitz, Olatunji, Deacon, Abramowitz, & Valentiner, 2007; Salkovskis et al., 2002). The SHAI had good internal consistency at each assessment time point in the present study ($\alpha s = .84, .89, .89,$

.86) and adequate test–retest reliability before and after the baseline week (.87).

Whiteley Index (WI; Pilowsky, 1967)

The WI is a widely used 14 item measure of hypochondriacal beliefs. Items assess disease fear, disease conviction, and bodily preoccupation that make up the symptom cluster of clinical hypochondriasis. The WI has demonstrated good internal consistency, test–retest reliability, convergent validity, and concurrent validity in prior research (Stewart & Watt, 2001). The WI had adequate internal consistency at each assessment time point in the present study (αs = .74, .77, .80, .81) and adequate test–retest reliability before and after the baseline week (.86).

Safety Behavior Checklist (SBC)

Participants completed a safety behavior checklist at the end of each day during the three-week study period. Respondents were asked to note whether or not they performed each of 34 health-related safety behaviors that day by indicating "Yes" or "No." A third option, "N/A" was provided in case participants did not have the opportunity to perform a particular behavior that day. Table 1 presents each health-related safety behavior on the checklist. A wide array of items was included on the SBC to adequately capture the safety behavior construct and to increase the likelihood of compliance with engagement in safety behavior usage. Total scores were derived by calculating the weekly sum of "Yes" responses on the checklist across each of the seven days of a given study phase (baseline, safety behavior, return to baseline). As part of the SBC, participants also responded to the question "*how often did thoughts about your health enter your mind today*" on a scale from 0 to 4 (0 = "never", 2 = "sometimes", 4 = "all the time"). The SBC was developed for the purposes of this study by the first and fifth author who have clinical and research expertise in health anxiety. It has not been validated and there was no outside consultation with other health anxiety experts in developing the SBC.

Table 1
Suggested health-related behaviors to be used each day during the safety behavior manipulation.

1. Carrying anti-bacterial hand sanitizer with you throughout the day.
2. Cleaning and disinfecting surfaces in your home with anti-bacterial wipes.
3. Washing or disinfecting your hands *each time* before eating.
4. Washing or disinfecting your hands *each time* after eating.
5. Washing or disinfecting your hands *each time* after handling raw meat.
6. Washing or disinfecting your hands after using workout equipment.
7. Avoid touching public door handles or stairway railings.
8. If you did touch public door handles or stairway railings, *always* washing or disinfecting your hands afterward.
9. Avoid touching money.
10. If you did touch money, *always* washing or disinfecting your hands afterward.
11. Avoid touching foods that might have pesticides on them (e.g., unwashed produce).
12. If you did touch foods that might have pesticides on them, *always* washing or disinfecting your hands afterward.
13. Eating organic or health foods.
14. Drinking eight 8 oz. glasses of water.
15. Asking your family, friends, or doctor if something about your body (inside or out) is abnormal.
16. Females: Doing a breast self-exam./Males: Doing a testicular self-exam.
17. Taking 2 or more showers daily.
18. If you did take 2 or more showers today, making sure they lasted for 20 min or more.
19. Asking for medical advice from family, friends, or doctor.
20. Taking an aspirin tablet.
21. Taking a daily multivitamin.
22. Taking 2 pain reliever tablets at first onset of a headache.
23. Making a phone call or visit to a doctor.
24. Using WebMD or other health-related Internet resources to look up health information.
25. Checking your body in the mirror for moles, freckles, bumps, blemishes, etc.
26. Weighing yourself at least once.
27. Exercising for more than one hour
28. Checking your lymph nodes by palpation (touch).
29. Examining your urine for blood.
30. Examining your mucus for blood or signs of infection (thick mucus with yellow or greenish color).
31. Checking your throat by repeatedly swallowing.
32. Using a tongue depressor to check for throat inflammation.
33. Taking your body temperature.
34. Monitoring your pulse rate—radial (wrist)/carotid (neck).

Behavioral Avoidance Tasks (BATs)

Three BATs were administered to assess the behavioral features of health anxiety. The BATs were selected and employed as a more objective assessment of sensitivity to various disease processes. The order of administration for each participant was determined by the roll of a die, with one of the six possible permutations corresponding to a given number on the die. Each BAT consisted of five steps (scores for each BAT ranged from 0 to 5) which participants were encouraged to complete. The BATs included (1) exposure to a tissue supposedly used by someone who has the common cold, (2) exposure to an oral thermometer supposedly used to measure the temperature of someone with the flu, and (3) exposure to a plastic water bottle from which a student infected with mononucleosis supposedly drank. For each BAT, the steps included touching the bag containing item, opening the bag containing item, touching the item, touching lips with the hand used to touch the item, and touching lips with the item. Participants were instructed that the tasks were "designed to test your ability to approach potential health hazards and proceed as far as you can. However, they are not tests of courage, and you are free to refuse to do all or any part of the tasks or to do them only partially".

The experimenter recorded whether or not participants refused any steps and participants provided estimations of the likelihood of contracting an illness from each completed step on a 0–10 scale (0 = "not likely", 5 = "possibly", 10 = "completely likely"). The following indices were calculated for each BAT: (a) avoidance, measured by the number of steps the participant refused to complete, and (b) illness likelihood, assessed by the average estimate of the likelihood of contracting an illness for each completed step.

Padua Inventory Contamination Fear subscale (PI; Burns, Keortge, Formea, & Sternberger, 1996)

The PI is a 10-item measure of contamination obsessions and washing compulsions. The scale has demonstrated adequate internal consistency and test–retest reliability in prior research (Burns et al. 1996). The PI contamination fear subscale evidenced adequate internal consistency at each assessment time point in the present study (αs = .88, .83, .86, .88) and adequate test–retest reliability before and after the baseline week (.86).

Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988)

The BAI assesses 21 common symptoms of clinical anxiety (e.g., sweating, fear of losing control). Respondents indicate the degree to which they have recently been bothered by each symptom during the past week. The BAI was designed to assess anxiety symptoms independently from depression symptoms and has good reliability and validity (Beck et al., 1988). The BAI evidenced good internal consistency at each assessment time point in the present study (αs = .87, .86, .92, .90) and adequate test–retest reliability before and after the baseline week (.75).

Procedure

During the first laboratory meeting (denoted below as Pre1) and following the informed consent process, participants completed the study measures and the three BATs. These assessments were repeated during the second, third, and fourth laboratory meetings. Lastly, participants were asked to complete the SBC each day during the three-week study period. For the first week of the study, participants were instructed that the researcher was interested in normal day to day behaviors and not to change their behavior in any way and to "just do what you would normally do and record it on this form each day".

During the second laboratory visit (Pre2), participants were randomly assigned to either a safety behavior or control condition following the symptom and behavioral assessment. Those in the safety behavior condition were told that the researcher was interested in if people can engage in more of these behaviors than they normally do, and were instructed to engage in each safety behavior identified in Table 1, at every possible opportunity, on a daily basis for the upcoming week. To increase compliance, participants in both groups received daily e-mail reminders to complete the SBC each night. To facilitate this task, the experimenter demonstrated some of the more novel items (i.e., checking your lymph nodes by palpation) on the SBC. Diagrams were provided to the participants for other items (i.e., breast and testicular self-exam). Participants were also given 2 trial-size bottles of Germ-X hand sanitizer to be carried with them at all times, a container of Clorox surface disinfectant wipes, and 7 tongue depressors to check their throats for inflammation each day of the week. Participants were instructed to use the anti-bacterial Clorox wipes to disinfect certain objects at home (i.e., telephone receivers, toilet seats and handles, bathroom doorknobs and faucets, and kitchen countertops) that might be particularly likely to harbor germs. Participants were also encouraged to avoid touching anything they thought might be contaminated by germs and to disinfect their hands immediately when contact was unavoidable. Those in the control condition were instructed to continue monitoring what they normally do.

During the third assessment (Post1), participants were encouraged to spend the following week returning to their normal, baseline frequency of health-related safety behaviors. As the fourth assessment (Post2) took place following the final week of the study, no further instructions regarding safety behaviors were provided. Participants were then debriefed with information regarding the research question/hypotheses and any lingering effect of heightened health anxiety that was expressed was addressed with psycho-educational material.

Data analytic overview

The primary dependent variables were scores on the SHAI, WIQ, PI, and BAI, as well as participants' illness likelihood judgments and avoidance on the BAT. Repeated measures analyses of covariance (ANCOVAs) were conducted to assess the effects of the safety behavior intervention on the continuous dependent measures. The second pre-intervention time point (Pre2) was used as the covariate for analyses that assessed the effects of the intervention (Safety Behavior vs. Control) on measures assessed at the two post-intervention time points (Post1/Post2). The second pre-intervention point was used as the covariate for three primary reasons: (1) It was the pre-intervention assessment closest in time to the actual intervention and the post-intervention assessments; (2) Unlike Pre1, Pre2 occurred after participants had monitored their daily symptoms for one week. Given that participants continued such monitoring during the post-intervention phase, using Pre2 as a covariate allowed for the adjustment for individual differences in the effects of symptom monitoring per se; and, (3) Relative to the first pre-intervention time point (Pre1), the second was more highly correlated with the post-intervention time points across all measures.[1] Correlations between Pre2 scores and Post1 and Post2 scores were quite high across all measures (*r*s ranged from .70 to .97, with median $r = .85$). When correlations between a potential covariate and dependent measures are of this magnitude, the ANCOVA is typically the most powerful statistical procedure for assessing between-group effects of experimental manipulations in randomized designs (Fitzmaurice, Laird, & Ware, 2004; Maxwell, 1998; Maxwell & Delaney, 2004; Maxwell, O'Callaghan, & Delaney, 1993). To yield valid estimates of the main effect of Time, the covariate for all Condition × Time ANCOVAS was centered (Delaney & Maxwell, 1981). Across all measures, there were no significant between-group differences on the covariates.

A continuation ratio (CR) model (e.g., Allison, 1990; Fienberg, 1980; Hilbe, 2009) was employed to assess the effects of the safety behavior intervention on the number of steps that participants completed on the three BATs. This model is an ordinal regression model that is appropriate when the dependent measure is a series of steps such that individuals must pass through each lower step before they go onto higher steps. With the appropriate configuration of the data, the CR model can be specified using standard binary logistic regression software and assesses the effects of predictor variables on the conditional probability of advancing from one stage to the next (e.g., Allison, 1990). In the present context, data from the three BAT tasks were combined to assess the main and interactive effects of the intervention on the probability of advancement through the approach sequence. In addition, dummy-coded variables were created that assessed the main effect of Task and the Intervention × Task interaction. To model non-independence of observations across tasks, we originally specified random effects for subject and for BAT step nested within subjects. As only the latter random effect accounted for significant variability in the data, we omitted the former in the analyses reported below. Separate analyses were conducted for the first and second post-intervention time points to simplify the statistical model.

Results

Manipulation checks

General health status

An independent sample *t*-test revealed no significant differences between participants in the control ($M = 16.76$, $SD = 2.71$) and safety behavior ($M = 15.90$, $SD = 2.84$) condition at baseline in general health status, $t(58) = 1.20$, $p = .23$.

Compliance with safety behaviors

Scores on the SBC during the first baseline week for the full sample were significantly correlated ($ps < .05$) with scores on the SHAI ($r = .45$), WI ($r = .46$), number of steps completed on the BAT ($r = -.26$), PI ($r = .66$), and BAI ($r = .49$) suggesting that an increase in the number of safety behaviors endorsed on the SBC at baseline was associated with more health anxiety, hypochondriacal beliefs, avoidance of health hazards, contamination fear, and general anxiety. To confirm that participants in the safety behavior condition complied with instructions to increase their performance of health-related safety behaviors during the manipulation week, the number of self-reported safety behaviors per day (SBC) during the three study phases was assessed. To account for the intra-subject dependencies linked to repeated measures, a negative binomial

[1] The results are unchanged when the mean of pre-intervention times 1 and 2 is used as the covariate.

generalized estimating equation (GEE) analysis (e.g., Hilbe, 2007) specifying main effects for Intervention Condition and Week and Intervention × Week interaction terms was conducted.[2] The analysis yielded significant effects for Intervention $\chi^2_1 = 40.91$, $p < .0001$, Week $\chi^2_2 = 127.70$, $p < .0001$, and the Intervention × Week interaction, $\chi^2_2 = 182.63$, $p < .0001$. Step-down Bonferroni-protected comparisons (e.g., Holm, 1979) indicated that, during the pre-intervention phase, as expected, the safety behavior ($M = 33.57$, $SD = 15.41$) and control conditions ($M = 29.37$, $SD = 17.72$) failed to differ in safety behaviors, $\chi^2_1 = 0.87$, $p > .30$. In contrast, the safety behavior group engaged in significantly more safety behaviors during the intervention week, $\chi^2_1 = 133.93$, $p < .001$ (Intervention $M = 116.00$, $SD = 38.29$; Control $M = 26.27$, $SD = 16.14$), and between-group differences were sustained during the return to baseline week $\chi^2_1 = 25.25$, $p < .001$ (Intervention $M = 54.90$, $SD = 29.19$; Control $M = 25.03$, $SD = 16.01$).

Health anxiety and hypochondriacal beliefs

Preliminary Intervention Condition × Pre-Intervention Phase (Pre1/Pre2) ANOVAS indicated that the two conditions failed to differ across both pre-intervention assessments on either health anxiety, as assessed by the SHAI, or hypochondriacal beliefs, as assessed by the WIQ, during the pre-intervention phase, SHAI Condition main effect, $F(1,58) = 1.18$, $p > .25$; and WIQ Condition main effect, $F(1,58) < 1$, $p > .45$. Similarly between-group comparisons on scores from Pre-intervention Week 2 alone indicated no significant differences, SHAI $t(58) = 1.09$, $p > .25$, WIQ $t(58) < 1$, $p > .50$.

An Intervention Condition × Post-Intervention Phase (Post1/Post2) ANCOVA on the SHAI with Pre2 scores as the covariate indicated a highly significant main effect for Condition, $F(1,57) = 13.67$, $p < .0005$, and a significant Condition × Phase interaction, $F(1,57) = 4.68$, $p < .05$ (see Fig. 1). As shown by the covariate-adjusted means displayed in Table 2, safety behavior participants reported more health anxiety than control participants during the post-intervention phase. Although the significant interaction indicated that group differences were larger immediately after the safety behavior intervention, group differences were significant at both time points, Week 3 $t(57) = 4.17$ step-down Bonferroni $p < .001$, Week 4 $t(57) = 2.06$, step-down Bonferroni $p < .05$.

The Intervention Condition × Phase ANCOVA on the WIQ yielded a highly significant main effect for Condition, $F(1,57) = 9.00$, $p < .005$. As indicated by the covariate-adjusted means shown in Table 2, the safety behavior intervention produced an increase in hypochondriacal beliefs across both post-intervention assessment points. Consistent with the finding of a significant main effect of Intervention Condition across both the SHAI and WIQ but only a significant Condition × Phase interaction on the former, the two variables were highly correlated at the Post1 and Post2 time points ($rs = .82$ and $.73$, $ps < .001$), but much more weakly correlated on Time 4 – Time 3 difference scores ($r = .35$, $p < .01$).[3]

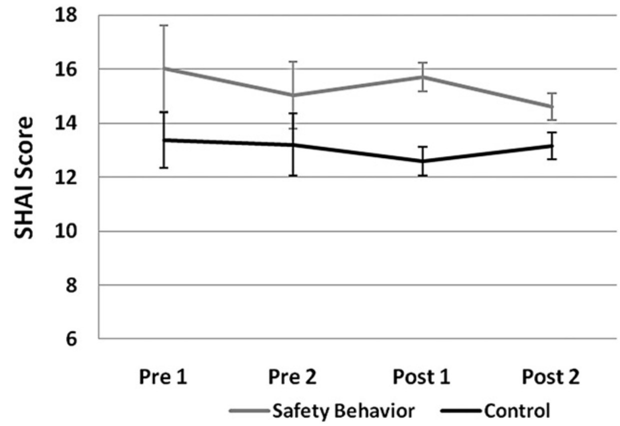

Fig. 1. Changes in health anxiety scores over time in the Safety Behavior and Control conditions. Observed means and standard errors are shown for the Pre1 and Pre2 time points while covariate-adjusted means and standard errors with Pre2 as covariate are shown for the Post1 and Post2 time points.

BAT responses

Approach behavior

A preliminary random effects continuation ratio (CR) model indicated no significant effects involving the two experimental conditions on the BATs during the Pre2 assessment point, all $ps > .10$ (see Table 2). A CR analysis of the Post1 BAT data included the following fixed effect predictors: dummy codes indicating step, the main and interactive effects of Intervention Condition and Task, and a dummy-coded step-dependent covariate indicating participants' Pre2 responses (advance/do not advance) at the given step. The analysis yielded significant effects for the Pre2 covariate, $\chi^2_1 = 86.12$, $p < .001$, Step, $\chi^2_4 = 14.46$, $p < .05$, and, most importantly, Intervention Condition, $\chi^2_1 = 4.45$, $p < .05$. All other main effects and interactions were non-significant ($ps > .10$). The first two effects indicated that pre-intervention responses were a strong predictor of post-intervention responses and that the conditional probabilities of success differed across the BAT steps. The main effect for Intervention Condition indicated that, conditional upon the other predictors and the random effects, the Safety Behavior manipulation lowered the odds of advancing at a given step. More specifically, conversion of the logistic regression coefficients to odds ratios (ORs) indicated that, holding all other variables constant, the Safety Behavior manipulation decreased the odds of successfully completing a given BAT step by a factor of .37 (estimated OR = .37, 95% confidence interval for the OR = .15–.93).[4]

The results of CR analyses conducted on Post2 BAT performance mirrored those of the first post-intervention session. The analysis yielded significant effects for the Pre2 covariate, $\chi^2_1 = 51.70$, $p < .001$, Step, $\chi^2_4 = 18.06$, $p < .005$, and Intervention Condition, $\chi^2_1 = 7.67$, $p < .01$. Consistent with the Post1 results, the significant effect for Intervention was due to the fact that the Safety Behavior condition lowered the probability of advancing at a given step. Specifically, holding all other variables constant, the Safety Behavior manipulation decreased the odds of successfully

[2] Six participants (3 per experimental condition) were missing at least one day of diary data on one of the three weeks. Their data for the two weeks with complete data were included in the analysis. GEE provides valid estimates of effects when data are missing completely at random (MCAR), as may well be the case here given the very high rates of compliance across all participants. Although some bias can be introduced when data are missing at random (MAR), the results and conclusions were completely consistent when multiple imputation estimation and analysis procedures was used to estimate missing values. Given the relatively small amount of missing data here, we present the more standard GEE analyses for the sake of brevity.

[3] Because the SHAI and WIQ were highly correlated, we also conducted a multivariate analysis of covariance (MANCOVA) across the two measures. The MANCOVA yielded a highly significant main effect of Intervention Condition, $F(2,55) = 7.72$, $p < .005$, and a marginally significant Condition × Phase interaction, $F(2.55) = 2.67$, $p = .078$.

[4] In order to test the proportionality assumption that the effects of the intervention were not conditional upon the specific step in the approach sequence, a subsequent analysis including Step × Intervention Condition interaction terms was conducted. Both the Post1 and Post2 analyses yielded non-significant Condition × Step interactions, $ps > .20$, indicated that the proportionality assumption was met.

Table 2
Observed and adjusted means across measures and time points.

Variable	Pre 1		Pre 2		Post1		Post2	
	Means		Means		Means		Means	
	Control	SB	Control	SB	Control	SB	Control	SB
SHAI								
Observed								
M	13.37	16.03	13.20	15.03	11.80	16.50	12.40	15.37
(SD)	(6.35)	(5.69)	(6.76)	(6.30)	(6.00)	(6.30)	(5.83)	(6.18)
Adjusted								
M					12.59	15.71	13.15	14.61
(SD)					(2.76)	(3.02)	(2.67)	(2.83)
WI								
Observed								
M	3.50	4.13	3.20	3.60	3.03	4.53	3.03	4.50
(SD)	(2.47)	(3.03)	(2.99)	(2.67)	(2.93)	(3.05)	(3.06)	(3.04)
Adjusted								
M					3.21	4.36	3.21	4.34
(SD)					(1.71)	(1.78)	(1.79)	(1.78)
BAT # steps								
Observed *M*	8.90	7.90	8.93	7.60	9.13	7.43	9.27	7.20
Observed (SD)	(3.55)	(3.00)	(3.54)	(3.06)	(3.59)	(3.02)	(3.35)	(3.12)
BAT likelihood								
Observed								
M	2.62	2.00	1.93	1.90	1.83	2.76	1.62	1.84
(SD)	(3.05)	(2.12)	(2.02)	(2.68)	(2.19)	(3.33)	(1.84)	(2.60)
Adjusted								
M					1.81	2.77	1.61	2.21
(SD)					(1.52)	(2.32)	(1.15)	(1.63)
PI								
Observed								
M	9.70	10.07	9.10	10.37	9.27	12.70	9.30	12.10
(SD)	(7.36)	(7.02)	(6.16)	(6.82)	(6.48)	(7.24)	(7.62)	(8.09)
Adjusted								
M					9.88	12.09	10.01	11.39
(SD)					(2.74)	(3.05)	(2.87)	(3.05)
BAI								
Observed								
M	9.07	12.80	7.60	10.60	7.37	12.87	6.60	11.20
(SD)	(5.23)	(8.64)	(5.63)	(7.37)	(5.95)	(10.90)	(6.79)	(8.43)
Adjusted								
M					8.95	11.27	7.93	9.87
(SD)					(3.71)	(6.80)	(4.48)	(5.56)

Notes: SB = safety behavior manipulation condition; SHAI = Short Health Anxiety Inventory; WI = Whiteley Index; BAT = Behavioral Approach Test; PI = Padua Inventory contamination fear subscale; BAI = Beck Anxiety Inventory. Adjusted means are predicted values from ANCOVAs with Pre 2 values as the covariate. Only observed means are presented for the BAT because continuation ratio analyses rather than ANCOVAs were performed. For the number of steps and likelihood measures, means are sums across the three BAT tasks.

completing a given BAT step by a factor of .14 (estimated OR = .14, 95% confidence interval for the OR = .05–.56).

Likelihood ratings

To assess effects on participants' ratings of the likelihood of contracting an illness during the BAT, we specified an analysis of covariance that combined the data from the three BAT tasks and tested for main effects and interactions involving Intervention Condition, BAT Task, and Post-Intervention Session (Post1/Post2). As a between-subject covariate to adjust the effects of Condition, we used each subject's average likelihood ratings across the three BAT tasks during Session 2 (centered across the whole sample). As a within-subjects covariate to assess effects involving the Task factor, deviation scores were computed for each participant as the difference between the score on a given task and the overall mean score across tasks during Pre2. In order to model non-independence due to the dual within-subjects factors of Task and Session, a Kronecker product parameterization (e.g., Galecki, 1994) was employed that is appropriate for doubly multivariate repeated measures contexts. The mixed model analysis yielded significant effects for both covariates ($ps < .001$) and a significant main effect for Intervention Condition, $F(1,55) = 4.05$, $p < .05$. No other effects were statistically significant (all $ps > .05$). The main effect reflected the fact that, across tasks and sessions, the Intervention Condition elicited higher ratings of the likelihood of contamination (see Table 2).

Individual differences in contamination fear and anxiety

There were no differences between the intervention conditions on PI scores assessed during the pre-intervention sessions ($ps > .40$). An Intervention Condition × Session mixed effects ANCOVA was run on post-intervention PI scores using the Pre2 PI score as a covariate. The analysis yielded a significant effect for Intervention Condition, $F(1,57) = 7.79$, $p < .01$. As shown by the covariate-adjusted means in Table 2, after the intervention, Safety Behavior participants demonstrated increased contamination fear relative to those in the Control condition.

The two Intervention Conditions failed to differ on BAI scores during session 2, $F(1,58) = 3.14$, $p = .09$. A Condition × Session ANCOVA on post-intervention BAI scores failed to yield a significant effect for Intervention Condition. A trend was, however, evident indicating higher post-intervention scores in the safety behavior condition, $F(1,57) = 3.38$, $p = .07$ (see Table 2).

Frequency of health-related thoughts

The effect of the safety behavior manipulation on weekly responses to the question "how often did thoughts about your health enter your mind today" was then examined. Participants' responses to this item across the 0–4 scales completed each day were average to generate a weekly index.[5] There were no differences between the safety behavior and control condition during the pre-intervention week, $t(54) < 1$, $p > .50$. The Intervention Condition × Session ANCOVA with centered Pre2 scores as covariate indicated a significant main effect for Condition, $F(1,53) = 13.54$, $p < .005$, and a significant Condition × Session interaction, $F(1,53) = 9.35$, $p < .005$. Subsequent step-down Bonferroni-corrected simple effects analyses indicated that participants in the safety behavior condition reported significantly more health-related thoughts than control participants during the intervention week (Post1), $F(1,53) = 20.26$, $p < .001$ (safety behavior adjusted $M = 1.99$, control adjusted $M = 1.24$) but not during the follow-up week (Post2), $F(1,53) = 3.74$, $p = .058$ (safety behavior adjusted $M = 1.56$, control adjusted $M = 1.26$).

Mediational assessment

Given the significant effects of the safety behavior intervention on frequency of health-related thoughts, increases in health-related thoughts (SBC item response to the question "how often did thoughts about your health enter your mind today") was examined as a mediator of the effects of the safety behavior intervention on changes in health anxiety. Three variables were formed to address this: (1) a dummy-coded variable (safety behavior condition = 1, control condition = 0) comparing the two experimental conditions; (2) a Post1 − Pre2 difference score assessing change in health anxiety as assessed by the SHAI across the intervention week; and, (3) a Post1 − Pre2 difference score assessing changes in health-related thoughts during the intervention week relative to the previous week.

As depicted in Fig. 2, the experimental manipulation was specified as a distal cause influencing both changes in health-related thoughts and in health anxiety. In addition, the meditational model specified that changes in health-related thoughts had a direct influence on changes in health anxiety. As shown in Figure 2, the two coefficients linked to the meditational paths were both statistically significant. Interpreted in light of the specified model, these effects indicate that the intervention significantly increased health-related thoughts and such increases in turn were related to increased health anxiety. The direct effect of the experimental manipulation on changes in health anxiety was no longer statistically significant ($p > .05$), despite the fact that the total effect of the manipulation on health anxiety (as assessed by the regression of health-related anxiety on the dummy variable) was statistically significant, $B = 2.91$, $t(55) = 3.62$, $p < .001$. To formally test for mediation, two procedures that have been shown to provide adequate protection of Type 1 errors and optimal power relative to competing methods (e.g., MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002) were employed. The first tested the joint significance of the *a* and *b* coefficients. The

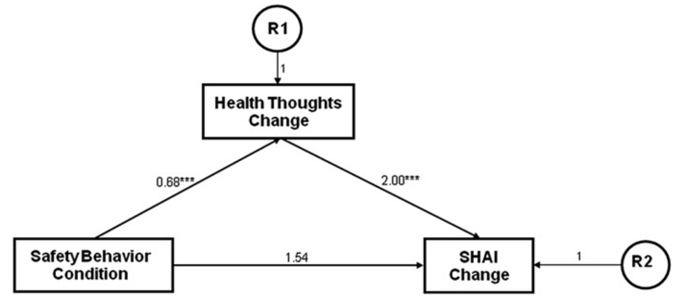

Fig. 2. Mediational model of the direct and indirect effects of the safety behavior manipulation on changes in health anxiety. (***$p < .001$). Health Thoughts = SBC thoughts item; SHAI = Short Health Anxiety Inventory.

second method tested whether the indirect effect, computed as the product of the *a* and *b* coefficients, was significantly greater than 0 (MacKinnon, Fritz, Williams, & Lockwood, 2007). Both the test of the joint significance of the *a* and *b* coefficients (step-down Bonferroni-corrected $ps < .001$) and the test of the a^*b product (95% confidence interval = .50–2.49) indicated significant mediation.

Discussion

Research in anxiety disorders has shown that safety behaviors maintain pathological anxiety by preventing the disconfirmation of inaccurate threat beliefs (Salkovskis, Clark, Hackmann, Wells, & Gelder, 1999). Conceptualizations of hypochondriasis as an extreme form of health anxiety (Noyes, 1999; Olatunji, Deacon, et al., 2009; Olatunji et al., 2009) have also identified safety behaviors as an important maintenance factor (Abramowitz & Moore, 2007). However, a causal role for safety behaviors in health anxiety remains unclear. Therefore, the present study investigated the extent to which safety behaviors contribute to the development and exacerbation of health anxiety symptoms. Consistent with predictions, participants who actively engaged in a clinically representative array of health-related safety behaviors demonstrated a significant increase in health anxiety and hypochondriacal beliefs compared to the control group. Given that the safety behavior manipulation occurred outside of the laboratory, there is admittedly no objective way of knowing to what extent the safety behavior group actually engaged in the safety behaviors. However, participants in the safety behavior condition also demonstrated more behavioral avoidance of potential health hazards that may have led to acquisition of the common cold, the flu, and mononucleosis. Unlike those in the control condition, participants in the safety behavior condition also reported increased appraisals of the likelihood of acquiring an illness during exposure to the BATs, after the safety behavior manipulation. These findings suggest that safety behaviors may be associated with the development of health anxiety, hypochondriacal beliefs, and behavioral avoidance of health hazards.

The finding that engaging in health-related safety behaviors increases symptoms of hypochondriasis appears to be rather robust. In fact, participants in the safety behavior condition continued to report higher levels of health anxiety, hypochondriacal beliefs, and avoidant responses to the health-related BAT's than those in the control condition even after the final baseline week where participants in both groups were instructed to monitor only their normal use of health-related safety behaviors. Given that those in the safety behavior condition also reported a higher frequency of health-related thoughts than those in the control condition during the return to baseline phase, it is possible that those in the safety behavior condition came to view safety behaviors as necessary to cope with a perceived threat and prevent a catastrophic health

[5] Four participants (one per condition) were removed from the analysis that had more than one missing data point per week on the health thought index. Forty-three participants had no missing data during the 21 days while 13 participants were missing one day's rating in at least one of the three weeks.

outcome. This finding may have important treatment implications given that participants in the safety behavior condition were explicitly instructed to return to their normal use of safety behaviors. Skafety behaviors lead to a misattribution of perceived safety ("it is because I am engaging in this behavior that nothing bad has happen") and control (Salkovskis, 1991) and simply instructing individuals to stop engaging in safety behaviors during treatment may not be sufficient.

The present findings also suggest that the effects of engagement in health-related safety behaviors are specific to changes in health-related outcomes, as general anxiety symptoms remained significantly unchanged as a function of the safety behavior manipulation. However, participants in the safety behavior condition reported a significant increase in contamination fear compared to those in the control condition after the safety behavior manipulation. Prior research has shown that washing distress is best predicted by health anxiety (Thorpe, Patel, & Simonds, 2003). A recent study also found that contamination fear predicted various components of health anxiety, including overestimations of the likelihood of acquiring an illness, the perceived severity of acquiring an illness, and body vigilance, even after controlling for disgust levels and negative affect (Olatunji, 2009). Contamination fear may be implicated in health anxiety as an additional mechanism to facilitate avoidance of infection and disease. Furthermore, health-related safety behaviors are often geared toward avoiding sources of contamination (i.e., carrying anti-bacterial hand sanitizer with you throughout the day). Given such a synergistic relationship, engagement in health-related safety behaviors may be expected to also increase symptoms of contamination fear. However, the effects of engagement in health-related safety behaviors on contamination fear may also reflect the composition of the SBC employed in the present study. Several of the items on the SBC are related to concerns of contagion and this may partially account for the increase in contamination fear among those that actively engaged in safety behaviors.

Although the present findings suggest that engagement in health-related safety behaviors increases health-related outcomes, the causal mechanism remains unclear. One explanation is that merely asking participants to engage in health-related safety behaviors increases threat perception, which in turn elevates health-related thoughts and anxiety. Indeed, participants in the safety behavior condition did report a significant increase in the frequency of health-related thoughts compared to those in the control condition after the safety behavior manipulation. Dysfunctional medical and illness-related thoughts are central to cognitive-behavioral models of hypochondriasis (see Marcus, Gurley, Marchi, & Bauer, 2007 for review). Indeed, the present study found that changes in the frequency of health-related thoughts mediated the differences between the safety behavior and control conditions in the changes in health anxiety symptoms. This suggests that the safety behavior manipulation may have led to significant increases in catastrophic thoughts about the perceived likelihood and severity of acquiring a disease, which may partially account for the significant increase in health anxiety.

The safety behavior manipulation may have also led to significant increases in attentional vigilance for potential health hazards in the environment. By increasing selective attention toward potential health hazards, the safety behavior phase may be viewed as a manipulation of both overt behavior and the attentional allocation necessary for the application of such behavior. Prior research has shown that attentional vigilance is uniquely associated with health-related safety-seeking behaviors (Olatunji et al., 2007). However, increased attention for potential health hazards in the environment is also expected to increase their perception. This increased perception, in turn, might have lead to beliefs of heightened risk for acquiring a disease (Abramowitz et al., 2007). Future research should examine predictions derived from this view of hypochondriasis, such as (a) health-related safety behaviors increase selective attention toward health hazards in the environment, and that (b) this selective attention increases the perceived likelihood and severity of acquiring a disease via enhancing the awareness of health hazards in the environment. However, recent research suggests that the use of safety behaviors in the context of treatment may not always be detrimental (Rachman, Shafran, Radomsky, & Zysk, 2011). Thus, a comprehensive understanding the role of safety behaviors in hypochondriasis will need to consider the manner in which such behaviors are utilized. There is evidence showing that safety behaviors do not necessarily prevent disconfirmatory experiences and in some cases actually facilitate fear reduction (Rachman et al., 2008). A parsimonious view of safety behaviors is that their *judicious* use may not necessarily result in an increase in health anxiety. However, *excessive* use of safety behaviors will likely exacerbate symptoms of hypochondriasis and also interfere with the progress of therapy.

The present study has important implications for the conceptualization of hypochondriasis. The finding that safety behaviors serve a similar function in hypochondriasis further supports contemporary cognitive-behavioral models that view hypochondriasis as an anxiety disorder (Abramowitz, Deacon, et al., 2007; Abramowitz, Olatunji, et al., 2007; Abramowitz et al., 2002; Warwick & Salkovskis, 1990). Indeed, hypochondriacs, in their obsessions about illness, compulsions to check with others, and failure to be reassured, share many features in common with those with OCD (Deacon & Abramowitz, 2008; Fallon et al., 1992). Based largely on such similarities, hypochondriasis has been conceptualized as part of an obsessive-compulsive spectrum that may include disorders such as OCD, body dysmorphic disorder, bulimia nervosa, anorexia nervosa, and trichotillomania (Hollander, 1993). However, this conceptualization will likely be more valuable as a diagnostic framework if the basis for membership of the spectrum be extended beyond artificial symptom similarities. A more informative approach may be to consider functional similarities between OCD and the proposed spectrum disorders. In addition to 'obsessions' marked by excessive fears about disease, illness, and injury being commonly observed in both OCD and hypochondriasis, excessive use of safety behaviors also appear to exacerbate symptoms of both disorders. Although this observation further supports the diagnostic parallel between the two disorders, the origins of the excessive use of health-related safety behaviors require elaboration in future research. Prior research has shown that parental reinforcement of sick-role behavior as a child is associated with health-focused anxiety in adulthood (Watt & Stewart, 2000). A more recent study also found that the development of illness sensitivity, an aspect of hypochondriasis, is linked to parental modeling and reinforcement of sick-role behavior related to aches and pains more specifically (Watt, O'Connor, Stewart, Moon, & Terry, 2008). Childhood learning experiences that give rise to maladaptive threat beliefs may then contribute to the development of health-related safety behaviors. As a result, the development of hypochondriasis may be attributable, in part, to the acquisition of habitual health-related safety behaviors from an early age that subsequently exacerbate health anxiety symptoms.

The present findings also highlight the potential importance of addressing safety behaviors in the treatment of hypochondriasis. Although in its early stages, research on the treatment of hypochondriasis based on a cognitive-behavioral model has produced very encouraging results (Clark et al., 1998; Greeven et al., 2007; Warwick, Clark, Cobb, & Salkovskis, 1996). Helping patients recognize and modify faulty beliefs about illness (i.e., "all bodily sensations are signs of serious illness") may be one mechanism by which cognitive-behavioral therapy (CBT) alleviates symptoms of hypochondriasis. However, the present findings suggest that elimination of safety behaviors that prevent the self-correction of such faulty beliefs may help to maximize treatment outcome during CBT. By systematically eliminating safety behaviors during CBT, health anxious individuals will have the opportunity to disconfirm the threat believes that maintain clinical symptoms.

The present study suggests that safety behaviors may play a role in the development and maintenance of excessive health anxiety that is commonly observed in hypochondriasis. Although this interpretation is supported by strengths of the present study, including an ecologically valid safety behavior manipulation, multi-trait, multi-method assessment of health concerns, and an experimental design that maximizes internal validity, we should note several limitations. For example, the use of undergraduate students that are primarily Caucasian limits the generalizability of the findings to the experience of more diverse patients with hypochondriasis. Indeed, scores on the SHAI (and other measures) for the present sample are well below norms reported for patients with hypochondriasis and generally anxious participants (Salkovskis et al., 2002), even after the safety behavior manipulation. The potentially harmful effects of safety behaviors may be most salient in individuals with clinical levels of health anxiety. However, if they are causal, they should be present prior to the development of clinical symptoms. Thus studies with nonclinical samples are relevant to understanding the development of health anxiety symptoms in clinical populations. Furthermore, research has shown that health anxiety is a dimensional construct (Ferguson, 2009), present to a greater or lesser extent in all individuals and have their origin in largely normal human processes (i.e., safety behaviors). The dimensionality of health anxiety has prompted recommendations that research attempting to delineate underlying causal mechanisms employ unselected samples rather than extreme groups (Longely et al., 2010).

The absence of a third condition where participants are not asked to monitor safety behaviors is another limitation of the present study. The observation of the effects of the safety behavior manipulation focuses on domain-specific concerns but not on general anxiety and the predicted health anxiety-related changes in self-report and behavioral outcomes makes it unlikely that the findings can be fully explained by demand characteristics. However, the inclusion of a no monitoring condition would allow for more definitive inferences to be made. To the extent that safety behaviors potentially increase threat perception, those asked to simply monitor safety behaviors may experience an increase in symptoms of health anxiety compared to those not asked to monitor such behaviors. Another limitation is the nature of the BAT used in the present study. Although they appeared to be effective at evoking appraisals of the likelihood of acquiring an illness, participants were free to refuse any of the BAT steps. It is likely that participants attempted only those steps that elicited a manageable degree of distress. A more distressing (and perhaps more believable) BAT that permits fewer opportunities for avoidance may yield even more robust effects. Furthermore, future research that directly assesses the specific context in which safety behaviors increase health anxiety is needed. Indeed, research has shown that not all safety behaviors are necessarily maladaptive (Schmidt, Richey, Maner, & Woolaway-Bickel, 2006). Although demonstrating that safety behaviors increase health anxiety is an important first step, future research aimed at clarifying the specific context in which this effect occurs may more directly inform the treatment of hypochondriasis.

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