Fighting against fear

Novel approaches to understanding, modifying, and manipulating maladaptive memories

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Chapter 6.

Reality Cheque: Financial incentives for accuracy reveal the multidimensional nature of threat-related beliefs in irrational fears

This chapter is in preparation for publication. Several others have contributed to this work. The idea developed out of discussions with Merel Kindt about patients' fear-related beliefs. Marieke Effting helped formalize the experiment and supervise students for Experiments 1 and 2. Two student groups helped generate Dutch versions of the protocols and tested participants. For Experiments 1 and 2, these were Donna Knoop, Nella Schrijver, Lena van den Nieuwenhof, and Suraya Gangadien. For Experiment 3, these were Elias Geiser, Marta Jakschik, Esperanza Visbeek, and Casper Enkelaar.
Merel Kindt has additionally provided feedback on the manuscript.

Abstract

Influential models of extreme fears and phobias suggest that irrational beliefs about threats posed by feared stimuli underpin excessive fear of them. Yet, most phobic individuals apparently recognise their fear is not justified. How can these two positions be reconciled? Theories in several domains propose a multidimensional view of beliefs, distinguishing between what people feel vs. what they really endorse as accurate. Many experiments on fear-related beliefs have been limited by a unidimensional perspective, focusing on probabilities for hypothetical fear-related outcomes, or expectations of shock during fear conditioning. We aimed to assess evidence for a multidimensional perspective in three experiments (Experiment 1, N = 145; Experiment 2, N = 49, Experiment 3, N = 48), using a novel paradigm. Fearful and non-fearful individuals were asked not only to provide expectancy ratings for fear-related outcomes regarding a fear-relevant encounter, but also to place bets on what would happen. Experiment 1 used questionnaires regarding a mixture of hypothetical and real events, and Experiments 2 and 3 used a real exposure situation to a spider, assessing participants both distal from and proximal to threat. High Fear participants displayed much higher initial expectancies about negative fear-related events occurring than Low Fear participants. However, bets on these outcomes actually occurring revealed far less consistent differences between High and Low Fear participants, even when proximal to the feared stimulus. Among High Fear participants, expectancy ratings correlated with emotion ratings, but not with bets. Our findings suggest that fearful individuals' beliefs about threat may indeed be multidimensional, with different responses elicited according to how beliefs are probed. Our findings may have implications for therapies aimed at tackling maladaptive beliefs, and further inform a burgeoning multidisciplinary literature emphasising a nuanced understanding of beliefs.

Beliefs feature prominently in descriptions and explanations of multiple psychiatric disorders, from the paranoid delusions of patients in the midst of a psychotic episode, to the conviction of a panic patient that they may die during a panic attack. Despite the frequent occurrence of bizarre or irrational beliefs across mental health conditions, and their apparent importance for diagnosis and treatment, the nature of beliefs is often underspecified or relatively unexplored in clinical theory (Bentall, 2018). As exemplary cases of how powerful the mind can be in producing disturbance, extreme fears and phobias have proven a fertile ground for psychological theories of anxiety, and the underpinnings of irrational beliefs and emotions more generally.

Broadly cognitive or cognitive-behavioral approaches have risen to prominence in recent decades to become the dominant treatment models for specific phobias and other anxiety disorders (American Psychological Association, 2019; David, Cristea, & Hofmann, 2018; National Collaborating Centre for Mental Health, 2011). A fundamental tenet of cognitive-behavioral approaches is that faulty cognitions are a cause of maladaptive emotional responses. Consequently, correcting these offending cognitions should reduce anxious responding. The core foci of such models vary considerably, but a significant number suggest that irrational beliefs or expectations about threats posed by phobic stimuli are at the root of phobic anxiety (Hofmann, 2008; Smits, Julian, Rosenfield, & Powers, 2012). We refer to such models as 'threat-belief-based' models. For example, summarizing their interpretations of experiments on the beliefs of spider phobic participants, Thorpe and Salkovskis (1995, p.813) state: "Phobics have a range of negative beliefs about their phobic object", beliefs concerning harm appear "essential in the maintenance, and therefore the understanding, of the phobic anxiety state". As was more recently explained to patients undergoing a virtual reality cognitive treatment for fear of heights (Freeman et al., 2018, p. 627): "The reason we're afraid of heights is because we think something bad is going to happen. And that makes us feel anxious". Clinicians are encouraged to elicit and challenge patients' irrational beliefs through rational discussion/Socratic dialogue (Beck, Emery, & Greenberg, 2005). Beliefs may also be treated like scientific hypotheses that can be tested in behavioral experiments (Bennett-Levy et al., 2004). When exposing participants to their fears, the goal is thus also to change irrational cognitions and catastrophic beliefs by disproving them in explicit tests (Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014; Davis, Ollendick, & Öst, 2012; Hofmann, 2008).

Research indicates that phobic people indeed express a range of irrational beliefs regarding their feared objects or situations (Arntz, Lavy, & van Rijsoort, 1993; Jones & Menzies, 2000; Jones, Whitmont, & Menzies, 1996; Mavromoustakos, Clark, & Rock, 2016; Thorpe & Salkovskis, 1995). Some of the beliefs endorsed by phobic people in these studies may not be wholly irrational, such as: "when exposed to my phobic stimulus I would…*scream* or *feel trapped* or *make a fool of myself*" (Thorpe & Salkovskis, 1995). Still, patients may overestimate the likelihood of such occurrences, or their severity. Patients also apparently express some clearly irrational and catastrophic beliefs, such as that a spider might hide and return having grown 10 times as large (Arntz et al. 1993), or that one's plane will probably crash 5 minutes after takeoff (Mavromoustakos et al., 2016). Genuine endorsement of these beliefs would justify extreme fear, but corrective information should also be very easy to provide. Knowing – and rationally accepting – statistics regarding the likelihood of plane crashes, the impossibility of spiders mushrooming in size, or the general recognition that a common house spider is not really dangerous, is rarely consoling to truly fearful patients.

Many patients appear fully aware that there is no logical basis for their fears, and in our experience may even be frustrated at the suggestion that they believe such things. Indeed, until DSM-V, diagnostic criteria for phobias stipulated that the patient should recognize their fear as irrational (American Psychiatric Association, 1994). Removal of this criterion in DSM-V owed to clinicians noting that some patients were apparently convinced their fears were reasonable (American Psychiatric Association, 2013b), but estimates suggest only a small minority of phobic patients lack insight into the irrationality of their fears (Zimmerman, Dalrymple, Chelminski, Young, & Galione, 2010). How can the evidence for endorsement of irrational beliefs in people with fear and anxiety-related disorders be reconciled with them commonly having insight that there is no logical justification for their fear?

Some have suggested that fearful individuals' threat-related beliefs are most active only when proximal to threat, at which point they lose insight into the irrationality of their fears (Beck et al., 2005). This suggestion is challenged by findings indicating that irrational threat-related beliefs appear to be endorsed even when distal from threat (e.g., Mavromoustakos et al., 2016). An alternative perspective on beliefs is suggested by contemporary philosopher Tamar Gendler. Drawing upon findings from risk perception and behavioral economics (e.g., Kahneman & Egan, 2011; Slovic, Finucane, Peters, & MacGregor, 2004), Gendler (2019) distinguishes between what she refers to as 'aliefs' and 'beliefs'. In essence, 'aliefs' are recalcitrant and emotionally laden responses that may arise in response to a stimulus, even while more rational 'beliefs' may reflect endorsement of an entirely different perspective. For example, when a person balks at stepping onto a perfectly secure glass bridge, knowledge of safety is often rationally accepted and 'believed' in the common use of the term. Nevertheless, the person 'alieves' or feels *as if* they are in danger at the same time. We argue that this may match the experience of many people with phobias when confronted with their feared objects or situations.

Some clinicians have attempted to incorporate similar ideas into clinical theory, such as Barnard and Teasdale's (1991; Teasdale, 1997) distinction between intellectual and emotional belief (also briefly acknowledged by Beck & Haigh, 2014), and Stott's (2007) concept of rational-emotional dissociation. Distinctions between 'hot' vs. 'cold' cognition have also been influential in theories of depression (Barnard & Teasdale, 1993; Roiser & Sahakian, 2013). However, we are not aware of these concepts having been clearly demonstrated in clinically relevant experiments on fear-related beliefs. Empirical treatment of beliefs in experimental psychopathology has often simply drawn a parallel between patients' fear-related beliefs and participants' expectations of shocks in fear conditioning experiments (Boddez et al., 2013). Though not without merit, these lines of research can feed into an impoverished conception of cognition among clinicians and researchers, reflecting a simplistic understanding of belief as merely a unidimensional verbal expectation (cf. Arntz, 2019). Some studies have demonstrated the insufficiency of more unidimensional conceptions of fear-related beliefs by showing dissociations between expressed expectations regarding shock and physiological responses believed to reflect threat responding during fear conditioning (Kindt et al., 2009; Sevenster, Beckers, & Kindt, 2012a; Soeter & Kindt, 2010). Beyond dissociations between verbal beliefs and physiological responses, concepts such as the alief-belief distinction suggest that even regarding more verbally accessible and deliberative fear-related expectations, some fearful individuals may be 'in two minds'.

To test this possibility, we conducted three experiments in which participants were required to assess the credibility of various threat/fear-related beliefs. Beyond providing likelihood estimates of threatening events happening with regards to a fearful encounter, we included a further assessment that placed consequences on the accuracy of participants' predictions. Specifically, participants were required to place financial wagers to endorse their expressed beliefs, thus motivating them to respond not merely with what 'felt' correct but what they really thought would happen.

Experiment 1 was a proof-of-concept investigation using questionnaires, in which we compared High and Low Fear participants in what they said they believed would happen to them in a hypothetical exposure situation regarding their fear, and whether they differed in predicting whether these events would *actually* happen to fearful individuals undergoing treatment. As these responses only related to a hypothetical event for participants, and a real event for other people about whom participants made predictions, we subsequently conducted two behavioral studies focusing on spider fearful women, and self-relevant events. In both these studies, participants were instructed that they would perform a brief exposure task involving a large spider, which they were to approach closely, barefooted, and touch with a brush. Participants first reported beliefs about likelihoods for several fear-related outcomes. They then had to place financial wagers on whether their most-believed outcome would happen or not when they performed the task. In Experiment 2, High and Low Fear women performed these tasks both Distally (with the spider in another room, after the task was explained) and Proximally (when standing right next to the spider, just before they believed they were going to perform the task). In Experiment 3, High Fear women were allocated to perform these tasks *either* Distally or Proximally. In all these experiments, financial incentives were tied to accurate predictions of fear-related outcomes that could be objectively assessed, but which were outside the control of the experimenter. Hence, to win the most money, participants would have to bet on what they truly thought would happen, not just what they felt like, or what they thought the experimenter might want them to say.

We predicted that, in accordance with several previous studies (Jones & Menzies, 2000; Jones et al., 1996; Mavromoustakos et al., 2016; Thorpe & Salkovskis, 1995), High Fear participants would express much higher probabilities regarding the likelihood of unpleasant or threatening fear-related events happening in a confrontation with their feared stimulus, relative to Low Fear participants. However, when required to bet on those events actually happening, we expected that the prospect of winning more money for accurate predictions would incentivize highly fearful participants to draw more upon an alternative and more accurate representation of the threat posed by the stimulus, resulting in no or smaller differences between High and Low Fear participants in their betting behavior than in their expressed beliefs. By assessing fear-related beliefs when participants were Distal from vs. Proximal to threat, it was also possible to assess whether fear-related beliefs are increased during a direct fearful confrontation, and whether this undermines a fearful individual's capacity to take a more rational perspective regarding the likelihood of the feared outcome (c.f. Beck et al., 2005). If this is the case, then there should be a large difference between High and Low Fear participants in both beliefs and bets when they are Proximal to the feared stimulus.

Methods – Experiment 1

Ethical Approval

All experiments were approved by the local ethics board under codes 2018-COP-9491, 2018-CP-9492, and 2019-COP-10169. All participants gave informed consent.

Materials

Baseline Questionnaires

Acrophobia Questionnaire (AQ: Cohen, 1977). The AQ is a 20-item, self-report scale designed to assess fear and avoidance of heights. Participants indicate how anxious they would feel (from 0: "not at all anxious", to 6: "extremely anxious") and how much they would avoid (from 0: "would not avoid situation" to 2 "would not do it under any circumstances") several situations involving heights. We defined High/Low Fear groups based upon participants' anxiety scores. Higher scores indicate greater fear of heights (range = 0-120). The anxiety scale shows good internal consistency (Cohen, 1977; Emmelkamp et al., 2002).

Fear of Spiders Questionnaire (FSQ: Szymanski & O'Donohue, 1995)**.** The FSQ is an 18-item, self-report scale designed to assess fear of spiders. Participants indicate the degree to which they agree with statements referring to spiders (from 1: "completely disagree", to 7 "completely agree"). Higher scores indicate greater fear of spiders (range = 18-126). The scale has shown excellent reliability and validity (Muris & Merckelbach, 1996; Szymanski & O'Donohue, 1995).

Injection Phobia Scale – Anxiety (IPS: Olatunji, Sawchuk, Moretz, Armstrong, & Ciesielski, 2010)**.** The IPS is an 18 item, self-report scale designed to assess fear/phobia of needles/injections/blood draws. Participants indicate how anxious they would be (from 0: "No anxiety", to 4 "Maximum anxiety") in different situations related to needles (e.g., undergoing venepuncture). Higher scores indicate greater fear of injections (range = 0-72). The scale has shown excellent reliability and validity (Olatunji et al., 2010).

Experimental Tasks

Belief Task. Participants were asked to imagine what would happen if they were exposed to a specific situation involving their fear. For spiders: a confrontation with a large (6-7cm) house spider. For heights: climbing three storeys high on a ladder. For needles: undergoing/receiving a blood draw/injection in the arm. For each fear, three general and three more specific feared outcomes were listed. For every fear, participants indicated the likelihood that they would be so afraid that they have a heart attack, that they would faint, and that they would be "so scared that it just feels absolutely terrible". Each fear also had three fear/situation-specific items, such as being jumped on by the spider, falling from the ladder, or losing control and being mistakenly stabbed by the needle (full stimulus details are available in Appendix 3). Items were chosen based upon past questionnaire items and studies of expressed belief, experience with expressed fears of patients undergoing treatment in our clinical trials, and through discussion with a registered health psychologist (Merel Kindt). Participants provided probability ratings for each item by moving a digital slider to any number from 0-100, with 0 = "Certainly not happen", 100 = "Certainly happen", and 50 = "Equally likely to happen or not". Item order was randomised.

Betting Task. Participants were told that over the following months, a university-based clinical facility would be investigating a treatment for their fear, and that 50 phobic patients would participate in a study involving a brief confrontation with their feared stimulus. The fear-related scenarios, and six possible consequences following them, were described very similarly to those presented in the *Belief Task*. Participants had to predict how many patients would experience each of the six consequences, using a sliding scale to indicate their estimates, from 0-50. Item order was randomized. We doubled estimates for analyses to generate a 0-100 probability estimate. Participants were informed that they could win €50, with the winner selected based upon who had the most accurate predictions. Ultimately, one winner of €50 was selected and informed that although the clinical facility does conduct very similar treatments/experiments, this precise 50-patient experiment did not take place; they had instead been selected to win the money by lottery.

Procedure

Participants completed all questionnaires on a PC running *Qualtrics* survey software, and completed the questionnaires in either Dutch or English. Participants were informed that we were interested in what factors people are afraid of in relation to different feared objects/situations. They would be asked to respond to some questions about what they were afraid of, and that part of the experiment would involve a monetary task that would be fully explained to them at the appropriate time. Participants were then asked to indicate whether they believed they had a higher than average fear of spiders, heights, or needles/injections, or if they did not have an above average fear of any of these. When participants selected a specific fear, questions related to that fear were presented. If they did not select a fear, they were randomly allocated to respond to spider-, height-, or needle-related questions, functioning as a neutral-to-low fear comparison group for that fear.

Participants first completed the *Belief Task*, then either the FSQ, AQ, or IPQ (according to their designated fear type), then the *Betting Task*. A final question asked participants the degree to which they had answered honestly and to the best of their ability, from 0 ("not at all") to 100 ("absolutely"). Several attention check questions were interspersed throughout the questionnaires to ensure participants were reading each question carefully.

Inclusion/exclusion criteria

Beyond self-identifying as High/Low Fear, participants in the High Fear group were required to score in the top 75% of scores from a student sample collected in previous years (percentiles based on N = 325 for AQ; N = 316 for IPQ; N = 315 for FSQ), or in the bottom 50% of scores for the low fear group, on their respective questionnaires. Qualifying scores were ≤ 26 or ≥ 46 on the FSQ, ≤ 15 or ≥ 30 on the AQ anxiety section, and ≤ 15 or ≥ 27 on the IPS. Participants were excluded if they failed an attention check (n = 19), indicated that they had not answered sufficiently honestly (1.5 SD below the mean or lower on a question asking if they had answered honestly, n = 18), or if they fell outside of the questionnaire cutoff scores (n = 46).

Participants

Participants in Experiment 1 were recruited through yearly testing rounds in which psychology undergraduates completed several questionnaires for course credit. The final sample comprised 145 participants (99 women), with an average age of 21.33 years (SD = 2.72, Range = 18.84-40.28). No evidence was found for differences in sex distributions between High vs. Low Fear groups for heights or needles, but women were significantly overrepresented in the High Fear spider group (Appendix 3, Table S1). Given the selection of participants based upon scores, there was overwhelming evidence that High Fear groups scored more highly than Low Fear groups on their respective questionnaires (Appendix 3, Table S1). Questionnaire scores for the High Fear groups were similar to scores of diagnosed phobic groups in previous studies (Krijn et al., 2004; Muris & Merckelbach, 1996; Olatunji et al., 2010).

Analytic approach

A more detailed explanation of the analytic approach, particularly useful for those unfamiliar with Bayesian analytic approaches, is provided in Appendix 3. Assessments of differences between groups in baseline questionnaire responses in all experiments were performed in *JASP* (JASP team, 2019), using 2-tailed Bayesian *t*- and Mann-Whitney *U*-tests to ensure inferences were robust against normality violations (we also provide *p* values for these analyses).

Mann-Whitney *U*-tests were used to compare Low and High Fear participants' responses to each fear-related item. These analyses were performed 1-tailed and uncorrected, favoring the detection of higher ratings among High vs. Low Fear participants that would be expected according to standard threat-belief-based models. Analyses used JASP's default priors, described Wagenmakers et al. (2018).

Results – Experiment 1

Tables 1a, 1b, and 1c depict comparisons of the probability ratings given by High and Low Fear groups when performing the *Belief Task* and *Betting Task*. Across all fear types, the findings strongly support the hypothesis that High Fear participants report higher probabilities of experiencing the expected negative outcomes than Low Fear participants ('Belief' ratings). However, when asked to predict what will occur in a future experiment, in which a group of phobic individuals actually undergoes the proposed fear-related scenario, High and Low Fear participants appear to expect quite similar outcomes to occur: Bayes factors and *p*-values typically show equivocal evidence for or against the alternative hypothesis, or even favor the null of no differences between groups ('Bet' ratings). This was shown most clearly in participants who were afraid of needles and spiders, and to a slightly lesser degree in those who feared heights. This pattern can be explained both by some reductions in probability ratings in High Fear participants when asked to predict what will actually happen in reality – e.g., recognizing that the spider will probably *not* jump on people in the experiment, or that people will *not* be genuinely harmed by the needle – as well as Low Fear participants acknowledging that highly fearful individuals will likely find the situation to be extremely unpleasant, or that needle phobic participants may well faint upon exposure to a needle.

Table 1a. Beliefs vs. bets for spider participants

		Median		*Mean Rank*		*Mann-Whitney Test*		
		High	Low	High	Low	*Stat*	BF_{+0}	*p*
Have a	Belief	0.5	0	31.26	21.1	468	18.44	0.004
heart attack	Bet	0	0	29.69	23.77	414.5	1.58	0.059
Faint/	Belief	4	0	33.22	17.77	534.5	509.18	< .001
pass out	Bet	12	7	29.51	24.07	408.5	1.14	0.111
Be absolutely	Belief	70.5	0	36.91	11.5	660	353645.55	< .001
terrible	Bet	87	93	26.03	30	290	0.21	0.819
Spider	Belief	40.5	6	24.54	15.53	579.5	1607.36	< .001
jumps	Bet	6	2	29.21	24.6	398	0.96	0.145
Spider	Belief	9.5	0	32.81	18.48	520.5	79.95	< .001
bites	Bet	0	0	29.29	24.45	401	0.70	0.103
Can't get	Belief	32	1	34.44	15.7	576	1618.75	< .001
spider off	Bet	5	3	28.53	25.75	375	0.49	0.263

Table 1b. Beliefs vs. bets for heights participants

		Median		*Mean Rank*		*Mann-Whitney Test*		
		High	Low	High	Low	*Stat*	BF_{+0}	*p*
Have a	Belief	4.5	0	23.96	12.08	272	68.44	< .001
heart attack	Bet	2	0	22.31	15.38	229	4.09	0.025
Faint/	Belief	7.5	0	23.85	12.31	269	52.61	0.001
pass out	Bet	6	6	21.1	17.81	197.5	0.82	0.201
Be absolutely	Belief	60	2	25.83	8.35	320.5	13890.65	< .001
terrible	Bet	88	82	21.65	16.69	212	1.46	0.1
Fall/jump	Belief	20	2	23.75	12.5	266.5	30.02	0.002
from ladder	Bet	10	6	22.06	15.88	222.5	1.95	0.055
Freeze and	Belief	30	0	25.71	8.58	317.5	5419.56	< .001
need rescue	Bet	48	30	21.69	16.62	213	1.33	0.097
Ladder	Belief	16	2	23.85	12.31	269	25.62	0.001
breakage	Bet	4	0	23	14	247	15.30	0.005

Table 1c. Beliefs vs. bets for needle participants

		Median		*Mean Rank*		*Mann-Whitney Test*		
		High	Low	High	Low	*Stat*	BF_{+0}	*p*
Have a	Belief	1.5	0	30.67	17.12	438	120.63	< .001
heart attack	Bet	0	0	25.42	28.94	249	0.18	0.812
Faint/	Belief	64.5	1	34.22	9.12	566	36853.30	< .001
pass out	Bet	34	27	29.08	20.69	381	2.36	0.033
Be absolutely	Belief	80	1	34.08	9.44	561	24586.76	< .001
terrible	Bet	74	80	26.46	26.59	286.5	0.35	0.516
Unbearable	Belief	47	3	32.54	12.91	505.5	2723.23	< .001
pain	Bet	27	27	26.32	26.91	281.5	0.29	0.555
Physical	Belief	40	3	31.36	15.56	463	114.98	< .001
harm	Bet	2	2	26.15	27.28	275.5	0.26	0.606
Lose control	Belief	20	0	32.74	12.47	512.5	4929.88	< .001
& be stabbed	Bet	10	20	24.49	31.03	215.5	0.15	0.927

Stat = Mann-Whitney U statistic from JASP, BF_{+0} = Bayes factor for the high fear group scoring higher than the low fear group, p = 1-sided p-value

These results provide a preliminary indication that highly fearful individuals do not fully endorse irrational beliefs about the threats posed by their feared stimuli. However, because participants were initially asked to imagine *themselves* in the situation, and then to predict what would happen in reality with *other* fearful people, the findings may reflect a distinction between expectations for the self vs. others, rather than a recognition that one's beliefs do not match reality. In the following experiments, participants therefore made assessments regarding their own experience of a task that they would perform.

Methods – Experiments 2 and 3

Materials

Baseline Questionnaires

FSQ (Szymanski & O'Donohue, 1995). Participants completed the FSQ, described above.

Patient Health Questionnaire-9 (PHQ: Kroenke et al., 2001). The PHQ is a 9-item self-report scale measuring symptoms of depression, and was included to determine whether groups differed in depressive symptomatology. Respondents indicate the degree to which they have been bothered by 9 depression symptoms over the past two weeks, on a 4 point Likert scale (from 0 = "not at all", to 3 = "nearly every day"). Higher scores indicate greater depression (range = 0-27). The scale is deemed a valid measure of depression severity and accords with diagnoses and other measures of depression (Martin, Rief, Klaiberg, & Braehler, 2006).

Spielberger State Trait Anxiety Inventory - Trait (STAI-T: Spielberger, Gorsuch, & Lusthene, 1970). The STAI-T is a 20 item, self-report scale designed to measure a respondent's tendency to experience negative/anxious states of mind. It was included to assess whether differences between groups might be caused by general anxious tendencies, rather than specific fears. Participants indicate how frequently they experience several anxiety-related phenomena on a 4 point Likert scale (from 1 = "almost never", to 4 = "almost always"). Higher scores indicate greater trait anxiety (range = 20-80). The scale has good reliability and validity (van der Ploeg, 1980).

Spider Probability Scale (SPS) (cf. Öst & Csatlos, 2000). The SPS was based upon Öst and Csatlos's (2000) Claustrophobia Scale. The scale has been used previously to show that individuals with specific fears differ markedly from non-fearful individuals in their perception of probabilities related to their feared object, but not with regards to generally positive or negative outcomes. In the original scale, respondents gave probability ratings for the occurrence of several generally positive, negative, or claustrophobia-related events. Other authors have adapted the claustrophobia items to instead reflect aeroplane-relevant incidents (Mavromoustakos et al., 2016). We changed claustrophobia items to spider-related items (e.g., *"You kill a spider in your living room, but you find that this has only attracted another even bigger spider."*). These new spider items are presented in Appendix 3. Some minor modifications were made to other scale items due to strange wording or one positive event not being strictly positive but merely unlikely. The 20-item scale contains 8 spider-related, 5 generally positive, and 7 generally negative events that participants respond to. Internal consistency was generally good, although the positive items did not form a highly consistent scale (α Spiders = .87, α Positive = .63, α Negative = .82).

Risk Orientation Questionnaire (ROQ: Rohrmann, 2005). The ROQ is a 12 item self-report scale designed to measure tolerance/seeking of risk. This was included to assess the possibility of general risk-taking tendencies in each group affecting betting behavior. The scale shows good convergent validity with other risk-related measures (Rohrmann, 2005). Respondents indicate the degree to which risk-related statements are true for them (from 1 = "not at all", to 7 = "yes, very much so").

Experimental Tasks

Belief Task. A task involving exposure to a live spider was explained to participants (see Procedure section below). Participants were then presented with a list of 5 fear-related events, reflecting objective outcomes that might occur during the task (e.g., *"The spider will run onto my bare feet"*). Items were again chosen based upon previous arachnophobia questionnaire items and studies of fear-related beliefs, experience with fear-related beliefs of patients undergoing treatment for fear of spiders, and through discussion with a registered health psychologist (the supervising author). The possible outcomes were additionally required to be objectively assessable and out of the control of both the participants and experimenters. For each possible outcome, participants gave a probability rating, from 0-100, where 0 = "Certainly will not happen", 100 = "Certainly will happen", and 50 = "Equally likely to happen or not". Items are presented in Appendix 3. Ratings from the *Belief Task* are often simply referred to as 'Beliefs' in the Results.

Betting Task. The outcome rated as most likely by the participant (specifically when distal from threat, in Experiment 2) was used for the *Betting Task*. We prompted participants to select one outcome if they rated two as equally likely. Participants were presented with the outcome and asked to allocate €100 between whether the event would or would not occur. They were informed that the amount of money that they could win would depend on a) the amount of money they place on each outcome, and b) what actually happens in reality when the exposure task is performed. Hence, if the participant spread the money 25:75 between the spider *not* jumping on them vs. jumping on them, then they would win €75 if the spider did jump on them, and €25 if it did not. Participants were informed that one person from each experiment would be randomly selected to win the money from their bet. Ratings from the *Betting Task* are often simply referred to as 'Bets' in the Results.

Emotion Rating Task. Participants were required to indicate how tense, anxious, and scared they currently felt from 0-100, with 0 labelled "Not at all [tense/anxious/scared]", 50 labelled "Moderately [tense/anxious/scared]", and 100 labelled as "Extremely [tense/anxious/scared]". These three items were averaged and used as a measure of negative emotion. The three items that formed the emotion rating scale mean showed very high internal consistency when assessed both distant from and proximal to threat (α = .96 & .98 respectively). Ratings from the *Emotion Rating Task* are often simply referred to as 'Emotions' and 'Emotion ratings' in the Results.

Spider Size Estimation. The spider size estimation task served as a further distraction/filler task in between participants' performance of the Belief and Betting tasks. Participants were asked to think of the spider they had just seen in the pictures (Distal condition) or in real life (in the Proximal condition, they turned their back on the spider in the enclosure). Participants were required to draw a line on a piece of paper indicating the spider's size, from the tips of its front legs to the tips of its hind legs.

Procedure

A schematic summary of the protocol for Experiment 2 is presented in Figure 1. Participants read an information brochure and gave informed consent. Experimenters then checked whether participants reported taking any psychoactive medication or having a psychiatric diagnosis. Participants then completed the battery of baseline questionnaires.

For the 'Distal' tasks, visual aids (Figure 2) were used to explain that in about 10 minutes, participants would perform an exposure task. An enclosure (220cm*220cm) was set up in another room. On the enclosure's floor was a grid (30cm*30cm squares). A spider sat in the center of this 7x7 grid, under a transparent cover. The participant would enter the enclosure in their bare feet, stand in a designated square adjacent to the spider, and answer some questions. Then, once the cover was removed, they would use a brush to gently touch the spider. A mark close to the end of the brush indicated where the participant must hold it, ensuring close proximity to the spider.

After this explanation, participants performed the *Belief Task*, *Emotion Rating*, and *Spider Size Estimation* tasks. The experimenter selected the betting sheet corresponding to the participants' strongest belief. An example of how the betting payoffs would work was provided, focusing on predicting the weather. After confirming they understood the task, participants completed the *Betting Task*.

We then informed participants that they would perform the exposure task. They were taken to a separate room and removed their shoes and socks before entering. The 'Proximal' tasks were then performed. Upon entering the room, the exposure task was again explained and participants stepped into the enclosure. The experimenter remained outside the enclosure and handed them the *Belief Task*, *Emotion Rating Task*, *Spider Size Estimation Task*, and *Betting Task* in turn. To ensure participants were motivated to provide a true bet, it was explained that their current bets would be used to determine their payout if they were selected.

Once these Proximal tasks were performed, participants were informed that they need not undergo the full exposure and could exit the enclosure. Participants completed the experiment by watching a video of what happened when someone really performed the exposure task (the spider simply runs away), and it was explained that this outcome would be used to determine their bet winnings. Participants were debriefed and asked to sign a form indicating that they would not discuss the research or bets/outcomes with other possible participants. Once all participants had completed the study, we randomly selected and paid the winning participant.

Experiment 3 procedure

A schematic summary of the protocol for Experiment 3 is presented in Figure 1. Materials and procedures for Experiment 3 were identical to Experiment 2, with two exceptions. Firstly, we only ran High Fear participants. Secondly, we wondered whether the repeated measures design in Experiment 2 might corrupt participants' ratings in the Proximal condition (e.g., changing their approach after becoming aware of discrepancies between their ratings). Therefore, the Distal and Proximal conditions were run as independent groups in Experiment 3. Participants in the Distal condition proceeded as in Experiment 2, but then did not perform the Proximal task. After completing baseline questionnaires, participants in the Proximal condition had the exposure task explained to them and were immediately asked if they were willing to go to the room to perform it. Once inside the exposure room they completed the *Belief Task* and *Emotion Rating Task*. They then briefly left the room to perform the *Spider Size Estimation* and had the *Betting Task* explained to them. This was done away from the spider to ensure complete attention to the instructions. They then returned to the square adjacent to the spider and were informed that straight after their bet, the cover would be removed and the exposure task would commence. They were then handed the betting sheet and performed the *Betting Task*. A winning participant was again randomly determined and paid once the study was completed.

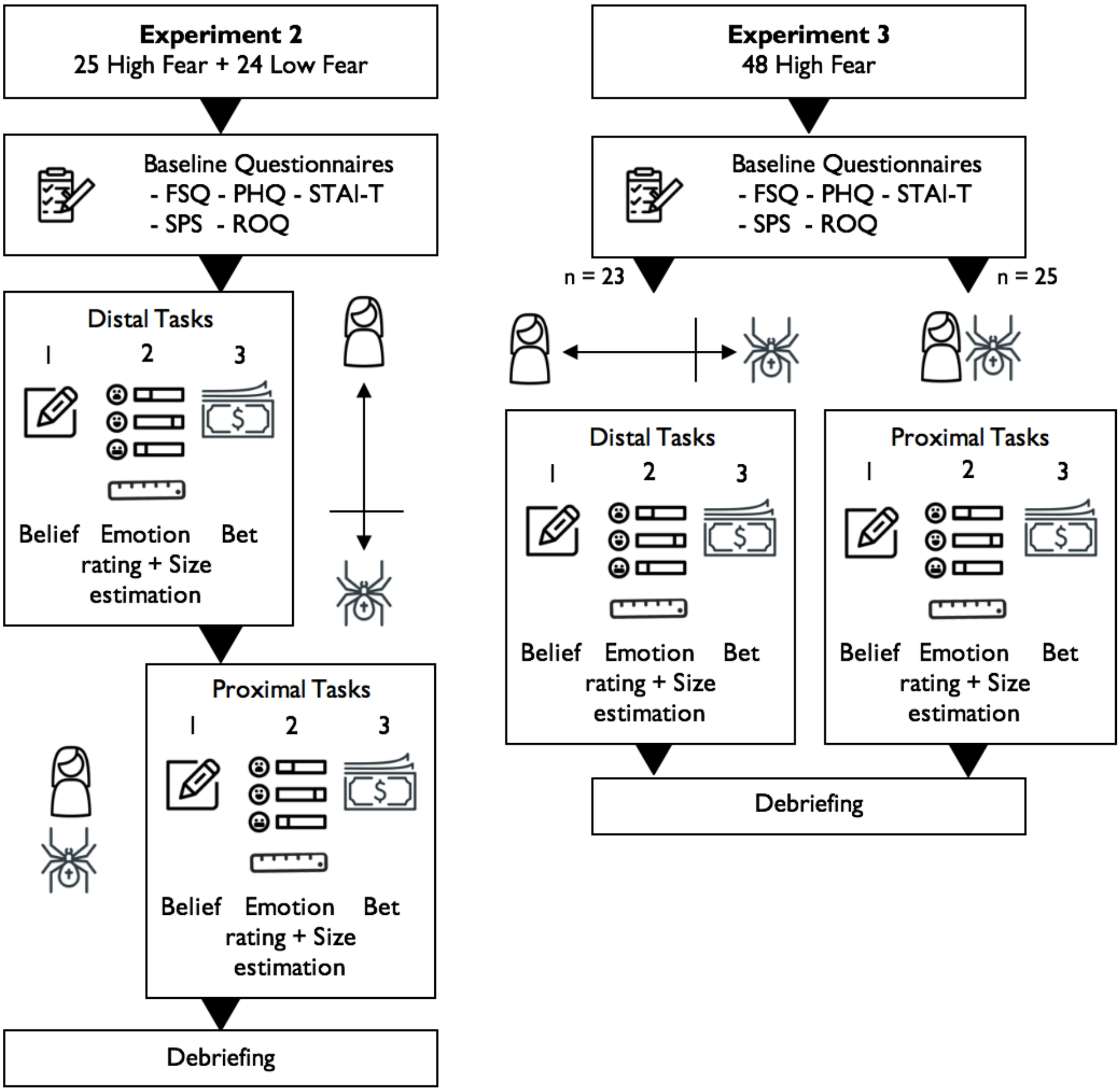

Figure 1. Summary of the procedure for Experiments 2 and 3.

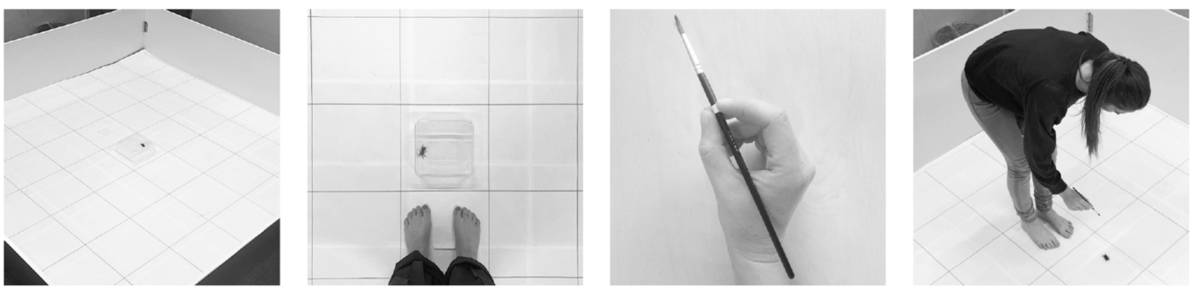

Figure 2. Picture of the experiment setup shown to participants when Distal, depicting (from left to right) the enclosure, where the participant must stand by the spider, how they should hold the brush, and the act of reaching to touch the spider with the brush.

Inclusion/exclusion criteria

Given the disparity between men and women expressing high and low fear of spiders, we only recruited women. Because we were able to recruit participants based upon their fear ratings, our High Fear groups were required to have FSQ scores in the top 12.5% of participants from a previous year (≥ 67). The Low Fear group again matched the bottom 50% (≤ 26). Participants were also required to be aged 18-35, score <15 on the PHQ (the cutoff for moderately severe depression), to report an absence of diagnosed psychological disorders (besides possibly a specific phobia), and not be using psychoactive medication.

Exclusions were as follows: Other mental health problems or psychoactive medication (Experiment 2: n = 3), FSQ scores outside the designated ranges on the day of the experiment (Experiment 2: n = 8; Experiment 3: n = 5), PHQ scores too high (Experiment 2: n = 5; Experiment 3: n = 3). One participant dropped out in Experiment 2 due to not wishing to perform the behavioral task. In Experiment 3, one High Fear participant, who had extensive research experience, informed us that she did not believe she would actually perform the exposure task, and was therefore excluded.

Participants

Participants were recruited via the university lab system and posters placed around the campus. They took part in exchange for research credit or €10, and also knew that one participant in each experiment would be chosen to win up to €100.

The final sample in Experiment 2 comprised 49 women (25 High Fear). Experiment 3 comprised 48 High Fear women (23 Distal, 25 Proximal). Both experiments were entered into a combined analysis. Table 2 shows the pooled age and questionnaire scores for participants. Comparisons between subgroups from each experiment are presented in Appendix 3, Table S3.

Analytic approach

Data from Experiments 2 and 3 were analyzed in combination. Emotion ratings, Beliefs, and Bets were all analyzed using Bayesian hierarchical 'beta regression' models in *R* v3.5.3 (R Core Team, 2013), using *RStudio* v1.2.1335 (RStudio Team, 2015), and the *R* package *brms* (Bürkner, 2017), with repeated observations of any variable nested within subjects. Following Smithson and Verkuilen (2006), responses were divided by 100 to produce a 0-1 range, and transformed as follows to avoid actual zeroes or ones:

$y^n = [y'(N - 1) + ½] / N$

The means (*mu* of the beta distribution) were predicted by Group (Low Fear, High Fear$_{Exp1}$, and High Fear$_{Exp2}$), Proximity (Distal vs. Proximal from threat), and their interaction. STAI and Age were also included to control for possible confounds between conditions. Precision (*phi* of the beta distribution) was predicted by Group (Low vs. High Fear – comprising all High fear participants). Possible effects of ROQ scores on outcomes were assessed and determined to be negligible in a separate regression analysis presented in Appendix 3. For comparisons involving Low Fear Distal vs. High Fear Distal, posterior distributions for the two Distal High Fear groups were averaged together (weighted according to sample size), as these groups are procedurally equivalent and almost exactly replicated one another. Parameter estimates in this approach are based upon a posterior distribution of plausible values. Hence, a point estimate (the mean of the posterior distribution) is accompanied by a 95% Highest Density Interval (HDI), reflecting the 95% most plausible values in the posterior, indicating uncertainty around the estimate.

Alongside comparisons between conditions, we assessed the degree to which participants' Beliefs, Emotion ratings, and Bets correlated with one another. High Fear participants' responses from Experiments 2 and 3 were pooled for these analyses. Given non-normal distributions of the correlated variables, we used a non-parametric Bayesian Kendall's *tau* correlation in *JASP*. Pairwise correlations were run to determine evidence for positive associations between Beliefs and Bets, Beliefs and Emotions, and Emotions and Bets, separately for High and Low Fear participants, under Distal and Proximal conditions.

All analyses used the default priors from the analysis package, outlined in Wagenmakers et al. (2018) and Bürkner (2017) for *JASP* and *brms* respectively.

Table 2. Baseline comparisons between High and Low Fear participants.

	Fear	*Mean [SD]*	*Med*	Test	Stat	*p*	BF_{10}
Age	High	20.77 [2.32]	20.00	*t(95)*	1.75	0.083	0.90
	Low	19.88 [1.57]	20.00	*M-W*	1077.00	0.088	0.76
FSQ	High	91.69 [12.72]	91.00	*t(95)*	26.45	< .001	6.554e +41
	Low	22.13 [3.06]	22.00	*M-W*	1752.00	< .001	429516.70
SPSs	High	43.99 [18.70]	43.75	*t(91)*	5.88	< .001	158217.87
	Low	19.33 [14.32]	16.63	*M-W*	1399.50	< .001	4142.59
SPS+	High	14.49 [11.62]	12.40	*t(91)*	0.88	0.383	0.34
	Low	12.18 [9.40]	10.60	*M-W*	902.00	0.519	0.31
SPS-	High	16.93 [13.35]	13.43	*t(91)*	1.16	0.248	0.44
	Low	13.21 [14.05]	8.14	*M-W*	1017.00	0.098	0.64
ROQ	High	4.28 [0.70]	4.25	*t(95)*	-2.89	0.005	8.18
	Low	4.77 [0.80]	4.92	*M-W*	552.50	0.007	6.29
PHQ	High	5.60 [3.02]	5.00	*t(95)*	-0.94	0.352	0.35
	Low	6.29 [3.56]	5.00	*M-W*	780.50	0.424	0.38
STAI-T	High	40.70 [9.39]	39.00	*t(95)*	0.48	0.635	0.27
	Low	39.58 [11.59]	38.00	*M-W*	974.50	0.412	0.27

SPSs = SPS spider items; SPS+ = SPS positive items; SPS- = SPS negative items; Med = median; BF_{10} = Bayes factor for alternative hypothesis of a difference between groups; Stat = value of statistic for respective test; SD = standard deviation; M-W = Mann-Whitney U test; *t* = independent groups *t*-test.

Results – Experiments 2 and 3

Figure 3 displays posterior parameter estimates for the means of the beta distributions underpinning the observed data in each group/condition. Figure 4 depicts posterior distributions for several comparisons of interest between these groups. It can be clearly seen from plots of both means and comparisons that Emotion ratings and Beliefs are highly different in Low Fear vs. High Fear participants (HD - LD, HP_2 - LP, HP_3 - LP). The 95% HDIs for comparisons between High and Low Fear groups in Beliefs and Emotions are all far from 0, suggesting we can be confident that High Fear participants score more highly than Low Fear participants on these variables. For Bets, differences between High and Low Fear participants are less clear-cut. For Distal comparisons (HD - LD), the HDI excludes 0 by a small margin. Proximal comparisons between High and Low Fear participants in Experiment 2 (HP_2 - LP) indicate a tendency towards higher scores in the High Fear group, but do not exclude 0. Comparisons in the Proximal condition for Low Fear participants from Experiment 2 vs. High Fear participants of Experiment 3 (HP_3 - LP) suggest that an absence of differences between groups is well within the plausible values of the posterior.

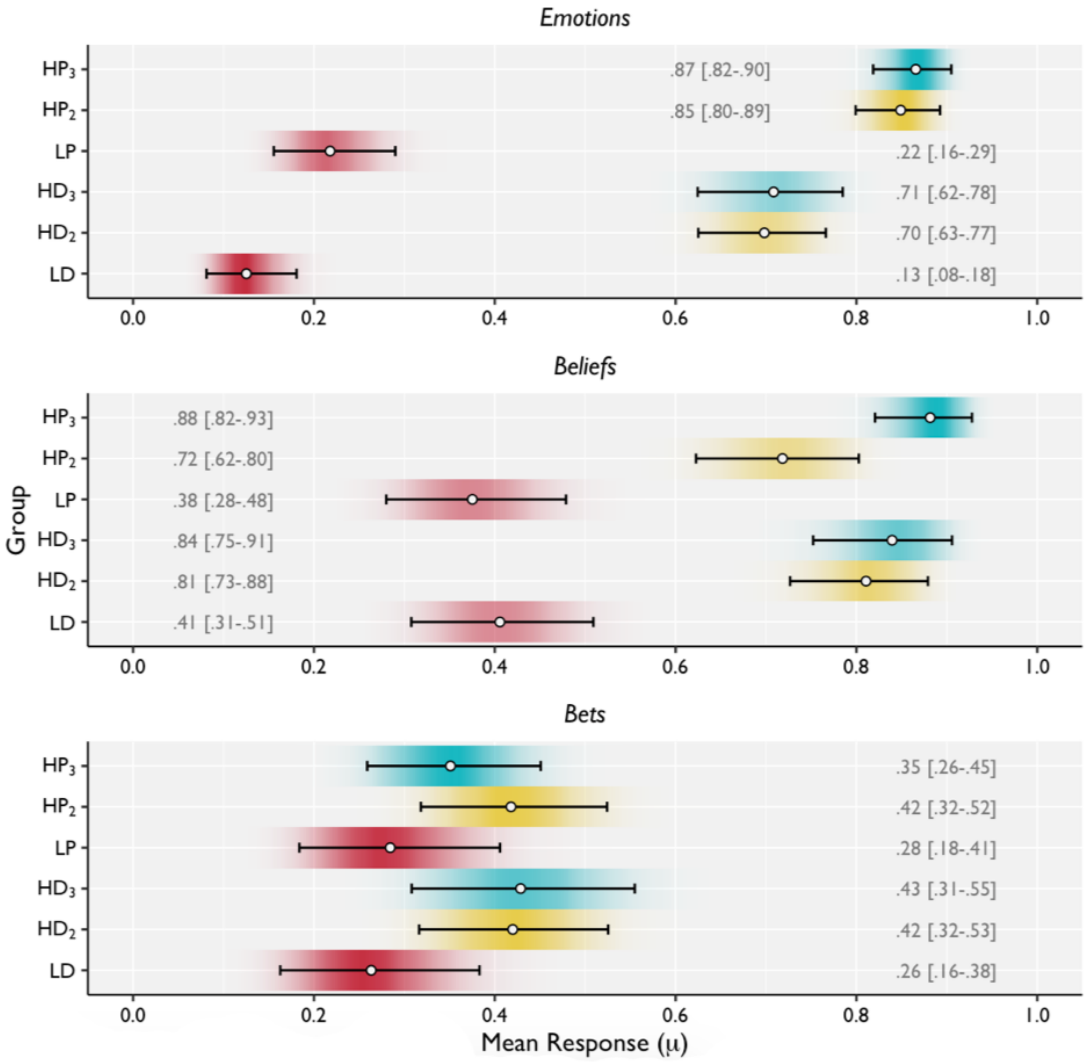

Figure 3. Posterior parameter estimates for mean [with 95% HDI] Emotions, Beliefs, and Bets, in each condition of Experiments 2 and 3. H = High Fear; L = Low Fear; D = Distal condition; P = Proximal condition; subscript 2 and 3 = Experiment 2 and 3, respectively. Circles reflect point estimate for Mean response, whiskers reflect 95% HDI, and shading is mapped directly to the posterior distribution, with darker shades reflecting higher probabilities.

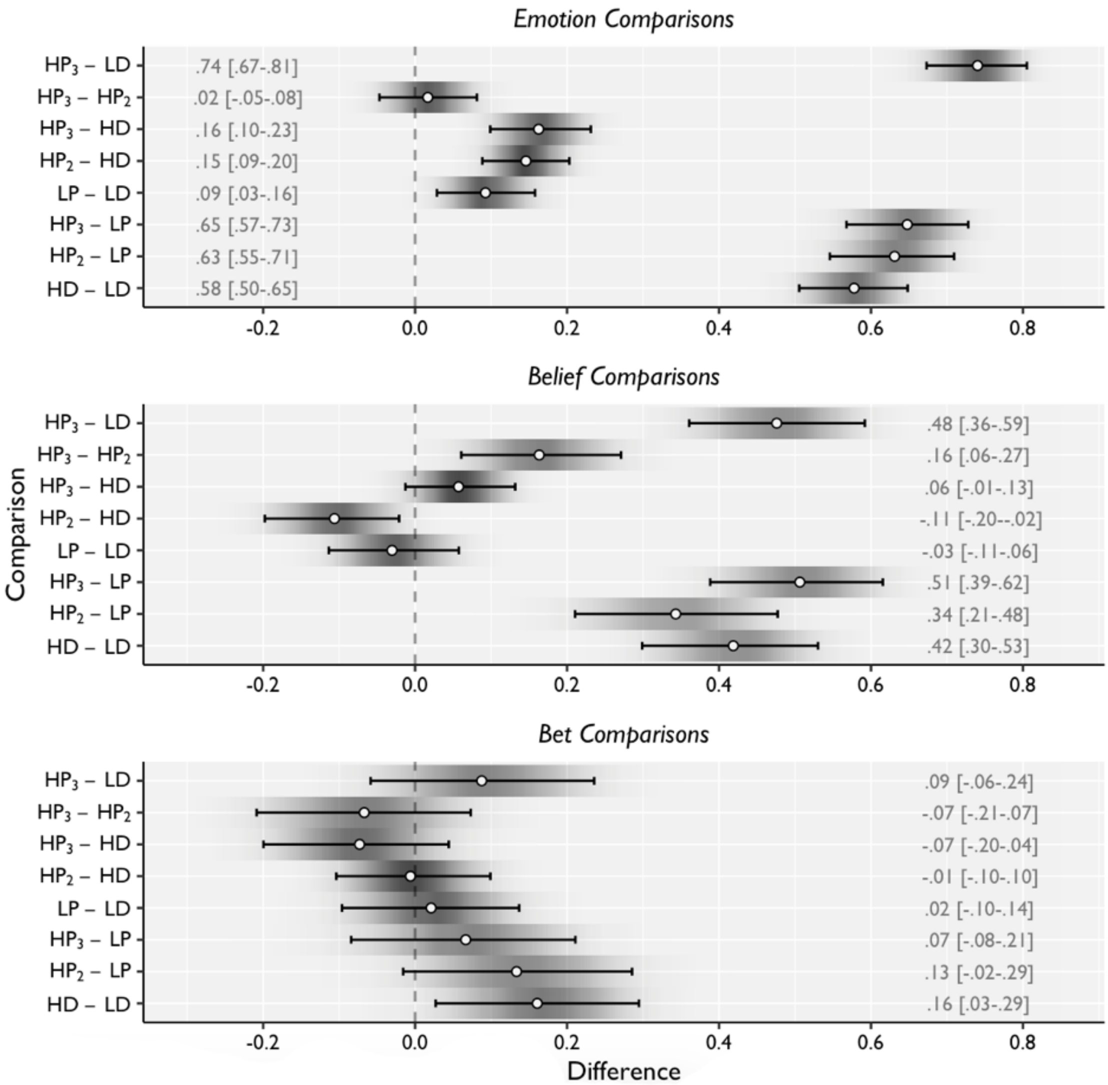

Figure 4. Posterior parameter estimates for mean [with 95% HDIs] values of differences between groups/conditions for Emotions, Beliefs, and Bets, in Experiments 2 and 3. H = High Fear; L = Low Fear; D = Distal condition; P = Proximal condition; subscript 2 and 3 = Experiment 2 and 3, respectively. Circles reflect point estimate for mean difference, whiskers reflect 95% HDI, and shading is mapped directly to the posterior distribution, with darker shades reflecting higher probabilities.

An instructive comparison can be made where we might expect to see the greatest differences between groups. *A priori*, it might be expected that the most rational responses would be given by Distal, Low Fear participants, and the most irrational responses by High Fear participants who were put directly into the Proximal situation. This comparison (HP_3 - LD) shows obvious and very large differences between High and Low Fear participants in their Emotion ratings and Beliefs, yet for the Bets, zero difference between groups is again well within the 95% HDI, and the mean of the posterior estimate indicates a small difference relative to the same comparison made for Beliefs or Emotions.

Some further comparisons provide additional insight into participants' responses. Comparisons between Distal and Proximal ratings of Emotion indicate that both groups tended to see an increase in their negative emotions when in the enclosure with the spider vs. in another room (LP - LD, HP_2 - HD, HP_3 - HD) - though Low Fear participants' responses remain low. In general, responses of High Fear participants in Experiments 2 and 3 closely parallel one another, with the exception of proximal Belief ratings. It can be seen that under repeated measures in Experiment 2, Proximal Beliefs tended to be lower than Distal Beliefs (HP_2 - HD), whereas when participants were immediately put into the Proximal situation in Experiment 3 (HP_3 - HD), their Beliefs tended to be somewhat higher than those of Distal participants (though no difference is not completely excluded from the posterior). Consequently, High Fear participants' Proximal Beliefs are higher in Experiment 3 than 2 (HP_3 – HP_2). This suggests that the Proximal measures in Experiment 2 may have been affected by the repeated measures design. It is possible, for example, that High Fear participants in particular in Experiment 2 recognized some disparities in their thinking when first asked to give Beliefs and Bets distally, and reduced their Proximal Beliefs accordingly.

Our analytic approach also allowed the *phi* parameter (aka. 'precision' or 'size') of the beta distribution to vary according to fear group. For Bets, the 95% HDI comparing High (11.72, HDI = 5.44-18.56) and Low Fear groups (3.26, HDI = 1.88-4.75) indicated a reliable difference between them, with higher precision in the High Fear group (8.46, HDI = 2.12-15.20). This indicates that Low Fear participants' responses spanned a greater range around the mean estimate than those of High Fear participants. Estimates of *phi* for Emotions and Beliefs suggested generally greater precision for High (15.60, HDI = 8.66-22.93) vs. Low Fear participants (9.14, HDI =

4.66-14.18) in Emotions, and lower precision in High (7.88, HDI = 4.87-11.13) vs. Low Fear participants (11.45, HDI = 5.12-18.07) for Beliefs, though comparisons between groups did not exclude an absence of differences (Emotion difference = 6.47, HDI = -1.26-14.84; Belief Difference = -3.57, HDI = -10.88-3.19).

Posterior parameter estimates for the two control variables, STAI and Age, spanned across zero for Emotions, Beliefs, and Bets. Regressions tables depicting all estimated parameters for each variable are available in Appendix 3, Table S4.

Finally, we explored relationships among Emotions, Beliefs, and Bets in High and Low Fear participants, when Distal or Proximal, by means of Bayesian non-parametric Kendall's *tau* correlations. If participants truly believed what they said they believed with regards to the behavior of the spider, we would expect a tight coupling between Bets and Beliefs, as betting in accordance with what one truly believes would result in the highest monetary gains. As shown in Table 3, among High Fear participants, 1-sided Bayes factors indicate considerable evidence favoring a positive association between Emotions and Beliefs, whether Distal or Proximal. In contrast, there is only equivocal evidence for an alignment between Beliefs and Bets. Among Low Fear participants, when Distal, Bayes factors greatly favor such a positive association between Beliefs and Bets. When Proximal, a positive relationship between Beliefs and Bets is still favored over the null of no association at a ratio of approximately 5:1. Bayes factors also favor a positive relationship between Emotions and Beliefs among Low Fear participants, when assessed Proximal to the spider, though no relation between Bets and Emotions.

Table 3. Relationships among Beliefs, Bets, and Emotions in High and Low Fear participants

Low Fear		BF_{+0}	95% CCI
Distal	Bet-Belief	287.60	0.53 [0.21 - 0.72]
	Emotion-Belief	0.54	0.11 [-0.16 - 0.36]
	Emotion-Bet	0.29	0.02 [-0.24 - 0.28]
Proximal	Bet-Belief	5.17	0.32 [0.02 - 0.54]
	Emotion-Belief	4.44	0.31 [0.01 - 0.53]
	Emotion-Bet	0.22	-0.04 [-0.3 - 0.23]

High Fear		BF_{+0}	95% CCI
Distal	Bet-Belief	2.10	0.19 [-0.01 - 0.36]
	Emotion-Belief	73.50	0.33 [0.12 - 0.49]
	Emotion-Bet	2.28	0.19 [-0.01 - 0.37]
Proximal	Bet-Belief	1.14	0.15 [-0.04 - 0.33]
	Emotion-Belief	14048.81	0.45 [0.24 - 0.61]
	Emotion-Bet	0.37	0.07 [-0.12 - 0.25]

BF_{+0} = Bayes factor favoring a positive correlation vs. no correlation; CCI = 'central credible interval': 95% of the posterior distribution between the 2.5 and 97.5 percentiles.

Discussion

Our findings paint a picture of the irrational beliefs held by fearful people that confirms certain assumptions of cognitive theory, while also indicating that beliefs may be considerably more complex than is often conveyed in discussion of fear-related beliefs, or experiments involving them. Consistent with threat-belief-based models, fearful individuals in our study did express a range of beliefs regarding their feared stimuli that were not held (or not held as strongly) by those without high fear. There was a slight tendency for High Fear participants' probability estimates to increase when placed right in front of their feared stimulus vs. when in another room, somewhat in line with the suggestions of Beck et al. (2005). However, differences between High and Low Fear participants in their expressed beliefs were already apparent when they anticipated but remained distal from the upcoming fearful encounter (Experiments 2 and 3), and also when merely contemplating hypothetical events (Experiment 1), which accords with previous findings regarding threat beliefs among fearful individuals (Jones & Menzies, 2000; Jones et al., 1996; Mavromoustakos et al., 2016; Thorpe & Salkovskis, 1995).

Despite large differences between High and Low Fear groups in their probability estimates regarding fear-related events, differences between groups were less evident when they were required to place bets and thereby fully endorse what they said they thought would happen during a fearful encounter. Additionally, correlations among Beliefs, Bets, and Emotion ratings suggested that Beliefs and Emotions were tightly coupled with one another among High Fear participants, but that there was little evidence for a relationship between Beliefs and Bets. Among Low Fear participants, particularly when Distal from the spider, there was strong alignment between what participants said they believed would happen and what they were willing to financially endorse as likely to actually occur. These findings might suggest that the initially expressed probability estimates of High Fear participants are an emotionally laden form of belief that does not correspond to what they recognize will really happen upon reflection. Such an interpretation aligns with more multidimensional perspectives on threat-related beliefs, such as the 'alief-belief' distinction (Gendler, 2019), rational-emotional dissociation (Stott, 2007), or intellectual and emotional belief (Barnard & Teasdale, 1991).

One perspective which may help understand the presence of seemingly contradictory representations of threat is that of memory competition, proposed by Brewin (2006). Brewin suggests that patients may harbor both adaptive and maladaptive representations of stimuli, which compete for control over behavior. Most animal phobias are already acquired by age 10 (Becker et a. 2007), meaning that for fearful adults, an emotionally laden and fearful representation of the phobic object has likely had many years to be reinforced through fearful encounters and avoidance. Such a strong and well-worn representation may be so easily retrievable as to appear almost automatically upon exposure to the feared stimulus, arriving not as a logical consideration of the threat posed by the stimulus, but as a strongly felt sense of impending danger. Participants thus report what they *feel* to be the case on the basis of this rapid threat signal. When motivated to reflect upon what will truly happen when exposed to their feared stimulus, participants may engage in a more effortful retrieval process and be better able to draw upon experiences and knowledge that do not align with their immediate felt sense, but which they may accept as more accurate. A key question is whether this mere logical recognition is sufficient to reduce anxious responding.

These theories and findings could provide a partial explanation for the purported inefficacy of some highly logical approaches pursued in cognitive therapy (Longmore & Worrell, 2007): such approaches may simply be telling participants what they already know at a deliberative level. Numerous pioneering cognitive theorists/therapists recognize and highlight that experience – not analysis – is the best teacher (J Bennett-Levy et al., 2004). This possibility has been explained by some as reflecting that personal experience may be most convincing for logical or propositional reasons (Lovibond, 2011). However, it could also be that the more emotionally intense experience of a behavioral experiment or exposure session, and the mixed feelings of fear and accomplishment they can engender, may render the lessons learned from them more easily retrievable owing to the mechanics of memory formation, whereby emotional experiences are often more readily remembered (McGaugh, 2003). Such a memory might more easily compete for retrieval with an emotionally laden maladaptive memory.

In addition to providing a multidimensional perspective on threat-belief-based models, our approach of eliciting bets from participants may itself provide a novel tool in the cognitive therapist's arsenal. Having patients contemplate giving themselves a 'reality cheque' – imagining what they would do if required to risk money on predicting what will really happen during a fearful confrontation – could be a strong rhetorical or mnemonic device to aid patients in retrieving a more adaptive representation of their feared stimuli. Additionally, discovering what beliefs patients would really bet on might serve as a means of highlighting targets for therapy. Some patients may still strongly endorse clearly irrational beliefs about threats posed by their feared stimulus. Understanding the level of conflict regarding such beliefs could further help a clinician to know what approaches might be most fruitful. For example, a more informational route might provide an initial 'in' for a patient who genuinely but mistakenly thinks that they are likely to encounter a shark when swimming in European waters: swimming really would be unwise if one truly believes the waters are shark-infested. Behavioral experiments and direct experience might be indicated if a participant rationally acknowledges the low likelihood of danger, but cannot shake the feeling.

Some limitations to our experiments, and conclusions we can draw from them, must be acknowledged. Firstly, our fearful participants did not undergo a diagnostic screening for the presence of clinically significant phobias, and our behavioral experiments involved only young women, with a focus on fear of spiders. Though it is possible that certifiably phobic individuals may respond differently, participants' questionnaire scores were well within the ranges of phobic participants assessed in previous studies (e.g., Muris & Merckelbach, 1996). Our proof of concept study at least intimates that such discrepancies between beliefs may also occur in situational and other object-related phobias besides arachnophobia. Furthermore, research from other domains of psychology, such as in relation to superstitious belief (Risen, 2016), highlights that beliefs across a range of domains in which thoughts and feelings interact may be similarly multidimensional. It would therefore be surprising if such discrepancies only occurred in relation to a very specific fear in very specific circumstances.

It is also worth considering that we presented participants with a selection of possible outcomes, rather than asking them to provide their own beliefs. This was done so that we could ensure an objectively verifiable outcome, and also to focus primarily on threat-related beliefs regarding the behavior of the spider, rather than subjective responses of the participants. Hence, our main findings do not speak to questions about beliefs participants may have regarding their capabilities of dealing with the situation, or how terrible they will find it (we would expect participants might well bet in line with their negative beliefs regarding such factors, and this will be interesting to investigate directly). Nevertheless, participants appeared to find the beliefs we presented them with highly plausible, and even if not representing an ultimate or core fear of participants, we believe discrepancies between the strong belief expression vs. weaker bets remains instructive. Our findings also speak primarily to estimates of likelihood, rather than magnitude of aversive events, which is another dimension along which fearful people may diverge from their less fearful counterparts. Participants in general did not choose a completely catastrophic outcome as most probable (e.g., "I will have a heart attack"), and it would be interesting to directly present participants with such an outcome and find out how much they would endorse it with a bet.

Finally, researchers with more or less 'cognitive' vs. 'emotional' leanings may interpret our findings quite differently. Those who strongly feel that emotions are the primary determinants of beliefs and actions may find it most plausible that participants' initially expressed beliefs are not really beliefs in any common sense of the word, but rather a *post-hoc* rationalization for their fears (cf. Arntz, Rauner, &

Van den Hout, 1995; Haidt, 2001). On the other hand, those emphasizing more unidimensional, propositional accounts of human reasoning might stress that, *even when they can make money by betting against them*, a number of fearful individuals still endorse irrational beliefs. Neither of these perspectives seem to fully account for the multidimensional nature of belief among fearful individuals, but further studies such as the present one, in which it is really possible to observe the conflicts respondents experience, will be necessary to further elucidate these issues.

Our findings and conclusions bring together insights from a range of disciplines to inform our understanding of beliefs. We agree with many cognitive models of psychopathology in that fearful individuals evidently express a range of maladaptive or irrational threat beliefs. However, our findings stress that how such beliefs are elicited can yield quite different results, conflicting with a unidimensional perspective on the nature of belief. Many fearful individuals appear to hold both a highly irrational and more rational representation of their feared stimulus. This idea accords with multi-representational as well as retrieval competition accounts of psychopathology (Barnard & Teasdale, 1991; Brewin, 2006; Gendler, 2019; Stott, 2007), but does not sit well with models explicitly or implicitly suggesting that pathological beliefs can be largely understood as coherent (albeit irrational) descriptions or propositions that fearful individuals hold with regards to their feared objects. It would be interesting to know the extent to which such an approach might extend to other disorders or cognitive distortions. At a more extreme end of the spectrum of irrational beliefs in psychopathology, can individuals with schizophrenic symptoms recognize reality when given certain incentives to aid more accurate appraisal? We hope that our findings can spark a more nuanced consideration of the nature of irrational beliefs in psychopathology.