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Belief biased reasoning in anxiety disorders

Vroling, Maartje Sophie

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Threat-confirming belief bias and symptoms of anxiety disorders

M. S. Vroling & P. J. de Jong

Abstract

This study tested the hypothesis that a generally enhanced threat-confirming reasoning style would set people at risk for the development of anxiety disorders. Therefore, a non-clinical student sample (N = 146) was presented with a series of linear syllogisms referring to threatening and safety themes and with the anxiety subscale of the SCL-90 and trait anxiety in order to correlate reasoning with anxiety. Half of the syllogisms' conclusions were in line and half were in conflict with generally believable threat and safety related convictions (e.g., potassium cyanide is more toxic than Tylenol; The Netherlands are safer than Afghanistan). For each type of syllogism, half was logically valid and half invalid. Overall, participants showed a clear interference of believability on logical reasoning, which is known as the belief bias effect. Furthermore, in line with the idea that people are generally characterised by a better safe than sorry strategy, the pattern indicated that the participants took more time to solve invalid threat related syllogisms as well as valid safety related syllogisms. This threat-confirming belief bias was however not especially pronounced in participants reporting relatively intense anxiety symptoms. Thus, the present findings do not lend support to the idea that a generally enhanced threat-confirming belief bias is a diathesis for the development of anxious psychopathology.

Introduction

Dysfunctional beliefs are assumed to play an important role in the acquisition and persistence of anxiety disorders (e.g., Beck, 1976; McNally, 2001). A striking feature of these dysfunctional beliefs is that they are both stable and irrational (i.e. that they are unhealthy and mostly even untrue). Why do patients hold on to unhealthy beliefs that are not in accordance with the empirical world?

Recently it has been proposed that individual differences in common deductive reasoning patterns may be involved in the development and/or persistence of irrational fears (e.g., Smeets & de Jong, 2002, September). Modifying (irrational) beliefs in the face of disconfirming evidence requires that people deduce the logical implications of the evidence for the validity of their beliefs. It is well documented that, in general, people have a tendency to endorse conclusions that are in line with their prior beliefs as valid and those that are in conflict with their view as invalid ("belief bias"; e.g., Evans, Newstead, & Byrne, 1993). The stronger this tendency, the more people will be liable to not correcting their prior beliefs. In other words, a strong "belief bias" may act in a way to immunize against refutation of once acquired (e.g., anxiogenic) beliefs. To the extent that anxiogenic convictions are critically involved in anxiety disorders, individuals with an enhanced belief bias would be at risk for developing such disorder.

The interference of believability with logical reasoning (i.e. belief bias) is commonly measured using a syllogistic reasoning task (e.g., Evans, Newstead et al., 1993), in which participants are instructed to judge as quickly as possible the logical validity of syllogisms consisting of two statements (the premises) and a conclusion. Logical validity refers to the necessity of a conclusion, assuming that the premises are true. If it is true that 'A is faster than B' and that 'B is faster than C', it follows that 'A must be faster than C'. Logical validity would be violated when one concludes that 'C is faster than A' based on the given premises. When judging the validity, participants are instructed to ignore the believability of the conclusions. Believability refers to the meaning of the syllogism's conclusion. Thus, participants have to judge whether a syllogism is logically valid, while ignoring its meaning. An example of a generally believable conclusion would be: 'A tree is larger than a plant', whereas 'a plant is larger than a tree' represents an example of a generally unbelievable conclusion. A valid yet unbelievable syllogism would be as follows:

Premise 1	A plant is larger than a bush
Premise 2	A bush is larger than a tree
Conclusion	**A plant is larger than a tree**

People are typically faster in reaching a decision about the validity of a syllogism when there is a match than when there is a mismatch between the validity and believability of the conclusion. This is known as the belief bias effect (cf. e.g., Evans, Newstead et al., 1993). The syllogistic reasoning task measures how people evaluate the validity of prior beliefs in light of (new and possibly disconfirming) information. The belief is represented in the conclusion of the syllogisms, and the data/information on which the reasoning takes place are represented in the premises.

The beliefs for which belief bias has been found generally concern beliefs that are in accordance with the empirical world or with prejudice (e.g., elephants are larger than mice, de Jong, Weertman, Horselenberg, & van den Hout [1997]; some Muslims are terrorists, Blanchette, Richards, Melnyk, & Lavda, [2007]), whereas beliefs of anxiety disorder patients concern untrue beliefs. This could well be an indication that patients suffering from anxiety disorder indeed have more difficulty separating logical truth from believable truth. In line with the hypothesis that a generally enhanced belief bias is a diathesis for the development of irrational fears, there is tentative evidence that spider phobic individuals show a stronger belief bias regarding universal convictions (e.g., elephants are larger than mice) than non-phobic controls (de Jong, Weertman et al., 1997). Yet, a subsequent study in a non-clinical sample failed to find a correlation between the strength of belief bias regarding universal convictions and symptoms of anxiety and depression (Smeets & de Jong, 2005). It should be noted that this study focused on universal beliefs regarding emotionally neutral themes. Conceptually similar work on other cognitive biases (such as attentional bias) has shown that the mood (or valence) of the materials that are used can be an important moderator. For instance, the relationship between attentional bias and psychopathology is particularly evident in negatively valenced materials (e.g., MacLeod & Hagan, 1992; van den Hout, Tenney, Huygens, & Merckelbach, 1995). In a similar vein, it might well be that enhanced belief bias regarding emotionally relevant rather than neutral themes might be especially relevant for the development of psychopathological symptoms. Therefore, in the present study we added syllogisms concerning emotionally valenced materials. More specifically, given the overly threatening content of the convictions of anxiety patients, this study focused on syllogisms regarding generally threatening themes and tested the relationship between the strength of a generally enhanced belief bias regarding threatening themes and symptoms of anxiety disorders in a non-clinical sample. If indeed generally enhanced belief bias regarding threatening themes sets people at risk for developing anxiety disorders, the relationship between belief bias and anxiety symptoms should also be evident in the preclinical range.

Method

Participants

Participants (N = 146, 48 male and 98 female) were undergraduate students of various faculties (e.g., psychology, n = 84, medicine, n = 17, pedagogy, n = 10). The mean age was 20.7 years (SD = 2.89). The participating psychology students received course credits, the other students received a small financial reward.

Materials and apparatus

Belief bias task

Belief bias was measured using a computerized syllogistic reasoning task. Participants were asked to judge as quickly as possible the logical validity of syllogisms. The presented syllogisms varied in logical validity and in believability of the conclusions. A belief bias effect is found when participants find it relatively easy to judge valid-believable and invalid-unbelievable syllogisms (i.e., when there is a match between validity and believability) and relatively difficult to judge the logical validity of valid-unbelievable and invalid-believable syllogisms (i.e., when there is a mismatch). An example of a syllogism varying in validity and believability is presented in Table 2.1.

Table 2.1
Example of a linear syllogisms varying in believability and logical status.

	Believable conclusion	Unbelievable conclusion
valid	An elephant is bigger than a dog A dog is bigger than a mouse **An elephant is bigger than a mouse**	A mouse is bigger than a dog A dog is bigger than an elephant **A mouse is bigger than an elephant**
invalid	A mouse is bigger than a dog A dog is bigger than an elephant **An elephant is bigger than a mouse**	An elephant is bigger than a dog A dog is bigger than a mouse **A mouse is bigger than an elephant**

The syllogistic reasoning task used in the current experiment involves the evaluation of a given conclusion. This was done to mimic the way information is processed in daily life: The premises contain the data (viz. the experiences that provide the information that is either in line or in contrast with a given belief), and the conclusions represent beliefs the participants hold (or do not hold, in the case of unbelievable conclusions). Through the use of top down processing, participants need to evaluate whether the conclusion (viz. their belief) holds (viz. logically follows from) in face of the presented data/information.

We used both generally believable neutral and generally believable emotionally valent syllogisms. Threat and safety themes were used as generally

emotional stimuli: It seems reasonable to assume that people who are liable to reason in a confirmatory style in light of threat-related information are at risk for the consolidation of anxiogenic beliefs. The same holds for discarding safety information as a result of a diminished safety-confirming belief bias. Both a surplus of threat-confirming reasoning and/or a lack of safety-confirming reasoning may strengthen the predisposition for the development of symptoms of anxiety disorders.

The computerized syllogistic reasoning task was adapted from Smeets and de Jong (2005) and extended with themes from the domain of threat (e.g., 'potassium cyanide is more toxic than Tylenol) and safety (e.g., 'The Netherlands are safer than Afghanistan'), see the Appendix for a complete list of the syllogisms used. The neutral themes were adjusted to correct for length of sentences. There were 4 different topics within each domain, resulting in 12 topics. Each topic was presented in a valid-believable, an invalid-unbelievable, a valid-unbelievable and an invalid-believable type. Every syllogism was presented in two orders (a > b, b > c, therefore a > c and b > c, a > b, therefore a > c) to counter possible reading-strategies (cf. Smeets & de Jong, 2005).

In total, 96 syllogisms were presented in two blocks of 48. The blocks were separated by a 30-second break. The stimuli were presented in a fixed random order with some restrictions: topic should differ with every stimulus presentation, type of syllogism should differ after a maximum of two stimulus presentations, and order should differ after a maximum of three stimulus presentations. The outcome measures were reaction time (RT) and amount of errors.

Believability check

To confirm that the syllogisms that were defined as 'believable' were indeed believable, the participants were asked to rate the alleged believable conclusions of all the syllogisms used in the syllogistic reasoning task[3]. These conclusions were presented as statements on the computer screen. Four statements were presented per screen, and each statement had to be rated on a visual analogue scale (VAS) ranging from 'unbelievable' to 'believable'. Each VAS was presented directly under the statement. Using the mouse, participants could click on a position on the line for their answer, and could change the position of their answer if desired. The VASs were 17 cm in length, but the responses of the participants were rescaled into a 0-100 range.

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[3] Due to miscommunication, a last minute change in one of the syllogisms was not carried through in the believability check. Therefore, the syllogism 'a scrape is more innocent than a heart attack' from the safety domain was not rated on believability.

Anxiety symptoms

We used the Anxiety (ANX) subscale of the Dutch version of the Symptom Checklist, an index for anxiety symptoms (SCL-90, Arrindell & Ettema, 2003). Internal consistency was satisfactory ($\alpha = .76$).

Trait anxiety

Trait anxiety was measured with a Dutch version of the STAI-T (Spielberger, Gorsuch, & Lushene, 1970) (i.e., ZBV, van der Ploeg, Defares, & Spielberger, 1980), consisting of 20 self-statements which can be rated on a scale of 1 (almost never) to 4 (almost always). High scores indicate high trait anxiety. Test-retest reliability shows that the ZBV is a stable measure of trait anxiety ($r = .75$ for both male and female students over a period of 4 months). Internal consistency in the current sample was good ($\alpha = .90$).

Depression questionnaire

To test the alleged *specificity* of enhanced belief bias for threatening information as a diathesis for the development of *anxiety symptoms* we also included the Center for Epidemiological Studies Depression scale (CES-D). The CES-D is a self-report questionnaire designed to measure depressive symptoms in community-samples. It consists of 20 items concerning feelings and behaviours over the past week which can be rated on a scale from 0 (seldom or never) to 3 (mostly or always), resulting in a range of 0 – 60 with 60 indicating extreme depressive symptoms (Bouma, Ranchor, Sandermans, & Van Sonderen, 1995). Internal consistency proved to be good in the current sample ($\alpha = .88$).

Rigidity

As a subsidiary issue, we tested whether belief bias is related to rigidity. It seems plausible to argue that an information-processing style that neglects available disconfirming information is a representation of the more general personality characteristic rigidity. We therefore included a subscale of the NPV (Nederlandse Persoonlijkheids Vragenlijst [Dutch Personality Questionnaire], Luteijn, Starren, & Van Dijk, 2000) as a measure of trait rigidity in our study. The rigidity-scale (RG) of the NPV consists of 25 self-statements (e.g., 'once I have made a decision, I stick to it') that can be scored as 'correct', 'incorrect' or '?'. High scores (frequent use of 'correct') indicate a need to have things going as planned, fixed habits and principles, and sometimes intellectual rigidity. Internal consistency was fair in the current sample ($\alpha = .73$).

Procedure

Participants were tested in small groups of between 1 and 7 individuals. After filling out an informed consent form, they were asked to start the syllogistic reasoning task. Participants were instructed to judge the validity of the syllogisms ('is this conclusion valid?') as quickly as possible by pressing a red

'NO' key on the left side or a green 'YES' key on the right side of the keyboard. Participants were given four practice items with feedback on the correctness of their response. Further explanation on the validity of the conclusion was given for the first and second practice items. Instructions were repeated at the start of the second block.

Each stimulus was preceded by a blank screen (500 ms) and a screen reading 'pay attention!' (1500 ms). Each stimulus disappeared as soon as a response was given with a maximum of a 20-second delay before the response was coded 'incorrect'. No feedback was given during the test-phase.

After having completed the reasoning task, the participants completed a second reasoning task (for pilot purposes; these will not be discussed in this paper) and the believability check, after which the participants filled out the questionnaires in a fixed order: SCL-90, CES-D, STAI-T and NPV.

Data analysis
Participants, distribution of anxiety symptoms
The distribution of anxiety symptoms was explored by calculating the means and standard deviations of the various scales of the current sample. These were compared with the Dutch normal population norm groups of the various questionnaires by means of independent sample t-tests.
Believability check
The believability ratings were averaged for each domain. The ratings for the three domains were compared by means of a repeated measures ANOVA with domain as within subject factor. Also, correlations between the believability ratings and the anxiety and depression measures were calculated.
Belief bias and anxiety symptoms
Per cell of the design, a single reaction time score was calculated by averaging the median scores of the two blocks of the belief bias task. Only correct responses were included in the calculation of the RT scores. The RT scores were normalized using a square root transformation. The normalized mean median reaction times scores will from here on be referred to as RTs. For the errors, the sum of errors over the two blocks was computed, again per cell of the design.

In line with previous research we computed belief bias summary scores (BB scores). For each domain a separate BB score was computed by subtracting RTs for the matched syllogisms from the RTs for mismatched syllogisms (viz. BB = [valid-unbelievable + invalid-believable] – [valid-believable + invalid-unbelievable]). The BB scores for errors were calculated in a similar vein.

Prior to exploring the relationship between belief bias and psychopathology, we checked whether belief bias was indeed present by means of two repeated measures ANOVA's with domain (neutral, threat, safety) as within subject

factor and BB score for RTs and errors as dependent variables. We looked for a significant deviation from zero for the intercept. In addition, we explored the differences between the domains. When present, we further explored these differences by interpreting the observed scores.

Because we compared BB scores comprised of within subject interactions (validity*believability), there was no need to correct for length of sentences within the analyses (the syllogisms within each interaction were of equal length due to the design of the task).

The six BB scores (3 domains * 2 outcome measures) were correlated with the measures of anxiety, depression and rigidity. If correlations between the believability ratings and the psychopathology measures are present, we will repeat the belief bias – psychopathology correlational analyses while correcting for the potential influences of these believability ratings.

For all analyses α = .05 was adopted.

Results

Participants, distribution of psychopathological symptoms

Observed means, standard deviations and range as well as norm group statistics are displayed in Table 2.2. No differences occurred between man and woman for ANX, STAI, CES-D or RG (multivariate $F(4,139)$ = 1.14, p = .34, all univariate tests were also non-significant, with high p-values). The observed means did not differ from the Dutch normal subjects (norm group II) for ANX ($t(2234)$ = -0.0010, p >.10; Arrindell & Ettema, 2003). For ANX, four participants (2.8%) scored in the category 'very high' of the normal population norm group as well as the 'average' category of the out-patient psychiatric norm group.

The observed mean for the STAI-T did not differ from the Dutch normal subjects, $t(549)$ = -.0500, p > .10 (norm group 'all students'; van der Ploeg et al., 1980). Also, there were no differences between our sample and the selected norm groups for the CES-D (student norm group 3b $t(418)$ = 0.06, p > .10; general sample norm group 2a $t(2705)$ = 0.01, p >.10).

Believability check

On average, all domains were considered highly believable. The mean believability rating for the neutral conclusions was 95.32 (SD = 8.43), for the safety conclusions was 94.51 (SD = 6.54) and for the threat conclusions was 95.12 (SD = 6.79). The repeated measures ANOVA with domain as within subject factor and believability rating as outcome measure showed that these believability scores do not significantly differ, $F(2,143)$ = 0.90, p = .41. On average, all domains were considered equally believable by the participants.

Believability for the safety domain was negatively correlated with trait anxiety as measured by the STAI-T (r = -.21, p = .01), and marginally significantly correlated with generalized anxiety as measured by the ANX subscale (r = -.15, p = .07). The higher trait anxiety or generalized anxiety (respectively), the less believable the safety related conclusions were perceived. Also, believability for the threat domain were marginally significantly and negatively correlated with trait anxiety (STAI-T, r = -.16, p = .07). The higher trait anxiety, the less believable the threat related conclusions were perceived. Other correlations proved to be non-significant.

Table 2.2
Means, standard deviations, range and N for ANX, STAI-T, CES-D, and RG for the current sample as well as for the various norm groups.

	ANX	STAI-T	CES-D	NPV-RG
Current sample				
M	12.78	33.40	8.76	27.97
SD	3.14	8.35	7.29	7.00
range	10 - 29	20 - 64	0 – 37	34 - 73
N	144	144	144	144
Norm group sample				
M	12.83	36.9	8.3	*
SD	4.39	6.13	8.5	*
N	2092	407	276	*

* No norm group available comparable to current sample.
Note. For norm group data see Arrindell & Ettema (2003) for ANX, see van der Ploeg et al. (1980) for STAI-T, and see Bouma et al. (1995) for CES-D.

Belief bias and anxiety symptoms

The repeated measures ANOVA for RT BB scores with domain as within subject factor revealed a significant deviation from zero of the intercept, $F(1,139)$ = 44.22, p < .01, η^2 = .24. In addition, a significant effect of domain was present ($F[2,138]$ = 6.93, p < .01, η^2 = .05). Post hoc analyses showed that neutral BB scores were significantly higher than threat and safety BB scores (repeated measures ANOVA with neutral and threat as domains: $F[1,139]$ = 11.57, p < .01, η^2 = .08; repeated measures ANOVA with neutral and safety as domains: $F[1,139]$ = 8.62, p < .01, η^2 = .06) and that the BB scores for threat and safety did not differ significantly from each other (repeated measures ANOVA with threat and safety as domains: $F(1,139)$ = 0.24, p =.63). The observed (square rooted mean median) RTs for the various cells of the design are displayed in Figure 2.1. When looking at the observed RTs (Figure 2.1), it can be seen that the belief bias effect is most pronounced for neutral materials. Furthermore, the influence of believability on reasoning performance is markedly stronger for

invalid syllogisms when it comes to threat related materials and stronger for valid syllogisms when it comes to safety related materials.

Figure 2.1. Square root normalized mean median RT (ms) on neutral, threat and safety syllogisms, varying over validity and believability.
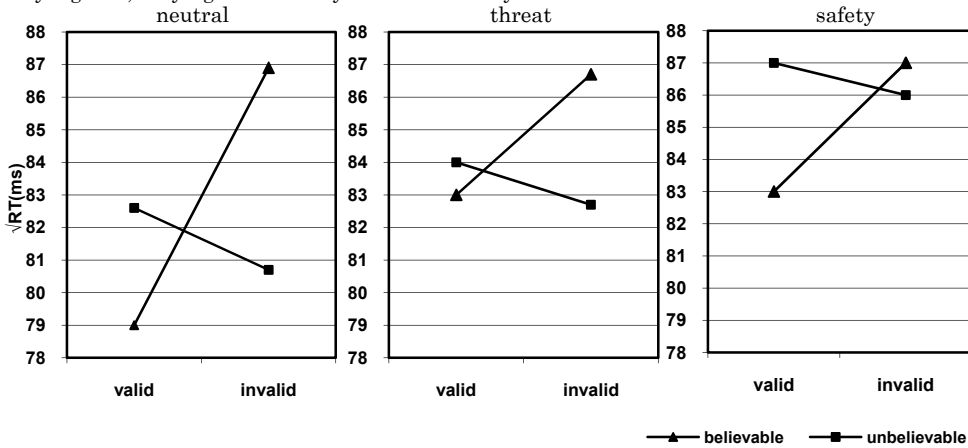
Note: Post hoc analyses showed that the domain*believability interaction is significant (F[2,138] = 10.88, p < .01, η^2 = .14) but is due to the believability ratings of the syllogisms (domain*believability interaction with believability rating as covariate, (F[2,134] = 0.71, p = .49) instead of a true difference of how believability is treated over the various domains.

The error data showed considerable variability. Overall, participants differed substantially in how many errors they made. Also, the amount of errors differed over the various cells of the design. The BB scores as well as the scores of which they are comprised can be seen in Table 2.3. There seems to be a belief bias effect for errors on all three domains. Indeed, the repeated measures ANOVA for error BB scores with domain as within subject factor revealed a significant deviation from zero of the intercept, F(1,143) = 17.95, p < .01, η^2 = .11. No significant differences over domains occurred, F(1,143) = 1.82, p =.17. The belief bias as measured on errors was equally strong for all domains.

All the above-mentioned analyses were repeated with gender as between subject variable. There were no differences in BB scores between the genders.

Table 2.3

Mean (and SD) belief bias scores (BB scores) for the amount of errors per domain, and the mean amount of errors (and SD) per syllogism type, of which the BB scores are comprised.

	Neutral		Threat		Safety	
BB score	0.83 (2.74)		0.66 (2.60)		0.99 (2.56)	
	believable	unbelievable	believable	unbelievable	believable	unbelievable
valid	0.47 (0.74)	1.02 (1.55)	0.62 (1.10)	0.99 (1.54)	0.67 (0.87)	1.26 (1.62)
	range 0-3	range 0-8	range 0-6	range 0-8	range 0-4	range 0-8
invalid	1.17 (1.57)	0.89 (1.07)	0.86 (1.42)	0.58 (1.08)	1.13 (1.43)	0.72 (1.20)
	range 0-8	range 0-6	range 0-8	range 0-8	range 0-8	range 0-8

The BB scores for the neutral, threat and safety domain were correlated with ANX, STAI-T, CES-D and RG scores. The correlations are shown in Table 2.4. None of the correlations reached significance at $a = .05$[4]. We repeated the correlational analysis, partialing out the potential influence of the believability ratings of the specific domains. The correlations for threat related belief bias and measures of anxiety and depression, when corrected for the threat believability ratings, proved to be non-significant. The results were similar for safety belief bias when correcting for the safety believability ratings, and for neutral belief bias when correcting for the neutral believability ratings.

Table 2.4

Correlations between neutral, threat- and safety-related belief bias (BB), ANX, STAI-T, CES-D and RG.

	RT			errors		
	BB_neutral	BB_threat	BB_safety	BB_neutral	BB_threat	BB_safety
ANX	.05	-.09	-.13	-.04	.00	.00
STAI-T	-.09	-.06	-.08	-.01	-.08	-.04
CES-D	.00	.00	-.15	.00	-.05	-.03
RG	.03	-.03	.06	-.10	-.08	-.06

Note. None of the correlations reached significance at $a = .05$.

Discussion

This study was designed to investigate the potential predisposing role of threat-confirming reasoning for the development of anxiety disorders. We used a non-clinical sample that was comparable to other non-clinical samples on all measures of psychopathology. Firstly, as expected, there was a clear belief bias

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[4] The BB scores were computed in a different way than Smeets and de Jong (2005) did. We used difference-scores whereas Smeets and de Jong used ratios. We repeated our analysis using BB ratios. Results were similar to those reported above.

effect for neutral materials. The slower responses of participants on trials for which the believability is in contrast with the logical validity are in line with the idea of a dual-process theory for belief bias: Initially, the syllogism is processed by the implicit, automatic, associative system (System 1). When a conflict in believability and logical validity is detected, the explicit, rational system (System 2) overrides the initial processing and engages in deliberate reasoning (cf. Evans, 2003): The primary response initiated by System 1 is located in the ventral medial prefrontal cortex, associated with intuitive affective processing. When the conflict within the stimulus is detected, the right lateral prefrontal cortex, associated with logical reasoning, is involved in the inhibition of this primary response and will create a logically correct response (Goel & Dolan, 2003). This route of processing takes more time, and thus results in slower responses.

Secondly, as predicted, participants also showed a threat-confirming belief bias. Participants were slower and made more errors when there was a mismatch between validity and believability. Interestingly, the validity*believability interaction patterns for the threat and the safety themes are consistent with the adaptive conservatism bias (Hendersen, 1985): In line with the idea that it is adaptive to be especially reluctant to falsify danger signals (cf. de Jong, Mayer, & van den Hout, 1997), participants had greater difficulty distinguishing believability from logical validity only on invalid trials when the content was threat related. The confirmation of danger seems to have priority over the confirmation of beliefs: Only when it was not dangerous to make a mistake in logical reasoning performance (viz. when one is not about to erroneously deny danger) the influence of beliefs on reasoning became apparent. Thus participants' responding as a function of validity and believability of the threat-related syllogisms (see Figure 1) matches the notion of belief bias and confirmation bias: Participants are generally quick in solving the syllogism when being valid or being unbelievable and invalid (a match between believability and validity). They are only slow when having to disconfirm danger (invalid) when the conclusion is believable (believable-invalid syllogisms). The opposite is true for safety themes: Here, the participants had great difficulty distinguishing believability from validity only on valid trials. Only when one is not about to erroneously accept safety information will beliefs influence reasoning performance. At first sight, it seems unexpected that participants are generally slower in solving invalid syllogisms (one would expect both the invalid and the believable-valid syllogisms to be solved more rapidly). This is however probably caused by the validity main effect: it is well known that participants generally find it more difficult to solve invalid than valid syllogisms (Evans, Newstead et al., 1993).

Thirdly, although the participants generally displayed belief bias over all domains, there was considerable variation in the strength of these effects, which suggests that the present findings cover a sufficient range to be meaningfully related to the psychopathology variables. Contrary to expectations, the threat-related belief bias effects were not only independent of depression, but also unrelated to the level of participants' anxiety symptoms. Furthermore, belief bias was unrelated to the personality trait rigidity, indicating that the belief bias effect reflects something different than 'just being rigid'.

Cognitive models of anxiety disorders underline the importance of dysfunctional beliefs in the aetiology of anxiety symptoms. In line with this there is ample evidence that anxiety disordered individuals indeed are characterized by inflated levels of believability for disorder-specific convictions. Treatment studies confirm the importance of anxiogenic beliefs in the generation of irrational fears by demonstrating that symptoms disappear by taking the edge off underlying beliefs (Arntz, 2003). Correcting (irrational) beliefs requires that people deduce the logical implications of disconfirming experiences (or information) for their beliefs. Building on this, we hypothesized that especially people who tend not to correct their somehow acquired convictions in the face of incompatible data/information would be at risk for developing persistent irrational beliefs. And since fear related beliefs are central to the development of anxiety disorders, it is people who generally tend to mistake believability for logical validity in the face of *threat* related concerns that are at risk for the development of these disorders. If threat-related belief bias is indeed a diathesis for the development of symptoms, a relationship between enhanced belief bias and symptoms of psychopathology should also be evident in the pre-clinical range. In a similar line of reasoning, we assumed that a reasoning style that ignores the validation of safety-information would also serve as a threat-confirming reasoning bias. In apparent contrast, there was no relationship between fear-confirming reasoning and anxiety symptoms. Consistent with the findings by Smeets and de Jong (2005), there was neither a relationship between generally enhanced (neutral) belief bias and psychopathological symptoms. Thus, the present findings lend no support to the idea that a generally enhanced threat-confirming belief bias sets people at risk for developing persistent anxiety symptoms.

It should be acknowledged however that there were some limitations to our study. A first remark concerns the use of an analogue sample. Although the current sample had a considerable range in both the anxiety symptom scores and the belief bias scores, it cannot be ruled out that we had an insufficient number of participants high on anxiety and/or extreme on belief bias to be able to show the alleged relationship.

Second, the use of a student sample may have hampered the sensitivity of the belief bias task: Belief bias scores decrease with intelligence and with training in analytical reasoning (MacPherson & Stanovich, 2007 and Evans, Newstead, Allan, & Pollard, 1994, respectively), both of which are likely to be present in highly educated groups. We did however find strong interference effects of believability on logical reasoning in the current sample, which indicates that belief bias was present.

Finally and perhaps most important, it should be acknowledged that there was no experimental control over participants' prior anxiogenic learning experiences in the current study. Obviously, belief bias can only promote the generation of psychopathological symptoms if there are experiences that could lead to irrational anxiogenic beliefs. Therefore, it might be helpful in future research to model the experience of aversive learning in a laboratory setting. One possibility would be to test for differential acquisition and extinction in high and low fear-confirming individuals in the context of an aversive conditioning paradigm. If enhanced fear-confirming belief bias is causally related to psychopathology, this should facilitate the acquisition of conditioned fear and/or delay of extinction effects.

The absence of a relationship between generally enhanced belief bias and symptoms of anxiety in the present study seems in apparent contrast with the finding by de Jong, Weertman et al. (1997). They found a generally enhanced belief bias effect in women with spider phobia irrespective of the domain of their concerns. In light of the present results these findings can therefore perhaps best be interpreted as representing a consequence rather than a cause of the disorder. This could potentially be caused by an anxiety-induced general sense of insecurity and stress. Scanning patterns may therefore become chaotic and individuals may leap into unjustified conclusions (e.g., Kienan, 1987). There is also evidence that working memory capacity is reduced in anxious individuals, which affects attention and the temporary storage and manipulation of information (e.g., Eysenck, 1985; MacLeod & Donnellan, 1993; Tohill & Holyoak, 2000). Following this, enhanced belief bias in highly anxious individuals may be the result of a restriction in the available working memory capacity.

Belief bias effects have been found in patients when reasoning with *disorder-specific* syllogisms (see de Jong, Weertman et al., 1997). Since belief bias is commonly found for strongly held beliefs, it is not surprising that patients display belief bias when it comes to their strongly held psychopathological convictions. The present finding of the absence of a relationship between a neutral and/or threat related extreme belief bias and psychopathology symptoms provide no evidence for the notion that enhanced belief bias sets people at risk for the development of psychopathological symptoms. This does

not imply that belief bias is irrelevant in psychopathology. Although probably not causal in the development of psychopathology, (disorder-specific) belief bias may still serve to maintain dysfunctional convictions once they are acquired. Through the maintenance of convictions, belief bias may logically help maintain psychopathological symptoms (cf. de Jong, Weertman et al., 1997) and may hamper treatment interventions through the non-integration of corrective experiences. To test these issues we are currently examining the malleability of belief bias following treatment and explore the role of residual belief bias in the return of fear at follow up.

Appendix: List of the syllogisms, in believable-valid form (translated from Dutch)

Neutral syllogisms
An oak tree is larger than a rhododendron
A rhododendron is larger than a dandelion
An oak tree is larger than a dandelion

An airplane is faster than a car
A car is faster than a bicycle
An airplane is faster than a bicycle

A caravan is smaller than a mansion
A mansion is smaller than a castle
A caravan is smaller than a castle

A shrew-mouse is smaller than a dog
A dog is smaller than an African elephant
A shrew-mouse is smaller than an African elephant

Threat related syllogisms
Lung cancer is more dangerous than a pneumonia
Pneumonia is more dangerous than the flue
Lung cancer is more dangerous than the flue

A boa constrictor is more threatening than a rat
A rat is more threatening than a mouse
A boa constrictor is more threatening than a mouse

A burn is more painful than a scrape
A scrape is more painful than a mosquito sting
A burn is more painful than a mosquito sting

Potassium cyanide is more toxic than tar
Tar is more toxic than Tylenol
Potassium cyanide is more toxic than Tylenol

Safety related syllogisms
The Netherlands are safer than Russia
Russia is safer than Afghanistan
The Netherlands are safer than Afghanistan

A crash helmet is safer than a cap
A cap is safer than a bare head
A crash helmet is safer than a bare head

Chapter 2

A scrape is more innocent than a fracture
A fracture is more innocent than a heart attack
A scrape is more innocent than a heart attack

Travelling by train is safer than by car
Travelling by car is safer than by motorcycle
Travelling by train is safer than by motorcycle