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“What I believe is true”: Belief-confirming reasoning bias in social anxiety disorder

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ABSTRACT

Background and objectives: Research shows that people tend to consider believable conclusions as valid and unbelievable conclusions as invalid (*belief bias*). When applied to anxiogenic beliefs, this belief bias could well hinder the correction of dysfunctional convictions. Previous work has shown that high socially anxious students indeed display such fear-confirming, belief biased, reasoning. A critical next question is whether these findings translate to a clinical population of people with social anxiety disorder (SAD). We test whether (i) patients with SAD show belief bias with regard to SAD-relevant themes, (ii) this belief bias is specific for SAD patients or can also be found in panic disorder (PD) patients, (iii) differential belief bias effects in SAD are restricted to social anxiety concerns or are also evident in the context of reasoning with neutral themes.

Method: 45 SAD patients, 24 PD patients, and 45 non-symptomatic controls (NSCs) completed a syllogistic belief bias task with SAD-relevant and neutral content.

Results: SAD patients displayed belief bias for social anxiety related materials, while the PD group and the NSC group did not. Yet, the difference between SAD and PD was not significant. All groups showed similar belief bias effects for neutral content.

Limitations: Content of the belief bias task was not tailored to idiosyncratic beliefs. The study lacked power to detect medium or small differences.

Conclusions: SAD patients showed concern-congruent belief biased interference effects when judging the logical validity of social anxiety relevant syllogisms. Such concern-relevant belief bias may contribute to the persistence of anxiogenic beliefs.

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1. Introduction

Encounters with an intensely feared stimulus will activate pre-existing (danger) beliefs. Accordingly, in individuals with social anxiety disorder (SAD), entering a social situation will probably

elicit beliefs about being rejected. If one wants to correct such phobic beliefs, one needs to accurately deduce the logical implications of the empirical evidence for these beliefs, and actively search for falsifying information in order to critically evaluate the validity of these beliefs. Basic research on everyday reasoning however suggests that people in fact tend to search for belief-confirming information and that our habitual reasoning pattern is biased in a way to confirm rather than to falsify prior beliefs (Evans, Newstead & Byrne, 1993). In general, people not only tend to consider believable conclusions as valid and unbelievable conclusions as invalid (e.g., Evans, Newstead et al., 1993), but are also inclined to prove believable conclusions as valid, and/or disprove

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unbelievable conclusions as invalid (e.g., Evans, 2003). Clearly, such a distorted reasoning pattern (known as “belief bias”) will logically contribute to the further consolidation of prior beliefs. When applied to anxiogenic beliefs, this would be a particularly direct pathway contributing to the persistence of fearful convictions (e.g., de Jong, 2015).

Belief bias has since long been studied in the general population (e.g., Evans, Barston, & Pollard, 1983; Klauer, Musch, & Naumer, 2000; Trippas, Handley, & Verde, 2014), yet little research has focussed on belief bias in psychopathology. Recently, research seems to have picked up on reasoning in psychopathology, as is also evident from a recent edited volume about aberrant beliefs and reasoning (Galbraith, 2015). Although some work has been conducted on reasoning in delusions and obsessive-compulsive disorder (e.g., Aardema, O'Connor, Emmelkamp, Marchand, & Todorov, 2005; Foa et al., 2003; Galbraith & Manktelow, 2015), little is known about belief bias and anxiety disorders.

Belief bias represents a well-established phenomenon in the general population (e.g., Evans et al., 1983; Evans, Over, & Manktelow, 1993; Goel & Dolan, 2003) and has been typically investigated using syllogisms. Syllogisms consist of premises that one needs to accept as being true, and a conclusion that does or does not logically follow from the premises. Most research in this domain employed categorical syllogisms. An example of such syllogism would be: *No ducks have four legs/Some animals have four legs//Therefore, some animals are not ducks* (e.g., Blanchette, Richards, Melnyk, & Lavda, 2007; Eliades, Mansell, Stewart, & Blanchette, 2012). In a belief bias paradigm, the conclusion of the syllogisms are manipulated in terms of both logical validity (valid or invalid) and believability (believable or unbelievable). If a logically valid conclusion is consistent with prior beliefs (in the above-mentioned syllogism: *Some animals are not ducks*), then a logical response is more likely to be drawn. If, on the other hand, a logically valid conclusion is unbelievable (as the conclusion *Some children with leukaemia feel happy* in the syllogism *Some sick children have leukaemia/All sick children feel happy//Therefore, some children with leukaemia feel happy*), then individuals are more likely to erroneously judge it to be logically invalid. The opposite pattern typically emerges for invalid conclusions. This interaction between logical validity and believability reflects the belief bias effect.

Categorical syllogisms are, however, relatively difficult to solve: Error rates are often substantial in spite of the fact that most studies rely on university student participants (e.g., Evans, Newstead et al., 1993). Therefore, this type of reasoning task seems not suitable for the investigation of belief bias in clinical populations that also comprise of individuals with limited educational background. In addition, the structure of categorical syllogisms (e.g., *no A's are B/Some C's are B//Therefore some C's are not A*) seems quite distant from every day reasoning problems, and many people without training in formal reasoning are probably unaware of these problems and their logical implications. Therefore, we decided to use so-called linear syllogisms in most of our studies on anxiety-relevant belief bias. This type of syllogism is relatively simple to solve, and in the absence of a time limit, people generally make only few errors in judging their logical validity (e.g., Smeets & de Jong, 2005). Instead of using the percentage of logical errors to index individuals' reasoning performance, participants' latencies for solving the syllogisms are used. Supporting the validity of this approach, an initial series of studies using linear syllogisms concerning factual beliefs (e.g., *An elephant is larger than a cat/A cat is larger than a fly//Therefore an elephant is larger than a fly*) systematically showed that response latencies were higher when there was a mismatch between the logical validity and believability of the syllogisms' conclusions (e.g., de Jong, Weertman, Horselenberg, & van den Hout, 1997; Smeets & de Jong, 2005; Vroling & de Jong, 2010).

To test the potential role of belief bias in the context of phobic convictions, we presented a series of linear syllogisms concerning social anxiety relevant themes to a group of student participants, and tested the strength of belief bias as a function of their fear of negative evaluation (Vroling & de Jong, 2009). The syllogisms related to social anxiety relevant convictions varied in logical validity and social anxiety congruency (SA-congruency). A SA-congruent conclusion would be ‘*Others find me less competent than person A*’,² whereas a SA-incongruent conclusion would be ‘*Others find person A less competent than me*’. In support of the hypothesis that belief bias may be involved in social anxiety, the results showed that individuals high in fear of negative evaluation were relatively fast when there was a match and relatively slow when there was a mismatch between SA-congruency and logical validity. This belief bias effect was similarly evident for valid and invalid syllogisms. This pattern suggests that high socially anxious individuals took additional time to reconsider both a logically justified *refutation* of a SA-congruent (“threat”) conclusion (viz, with a [for socially anxious people] believable yet invalid conclusion, such as *Person A is less competent than person 1/Person 1 is less competent than me//Therefore I am less competent than person A*), and a logically justified *acceptance* of a SA-incongruent (“safe”) conclusion (viz, with a [for socially anxious people] unbelievable yet valid conclusion, such as *Person A is less competent than person 1/person 1 is less competent than me//Therefore Person A is less competent than I am*). Such concern-congruent belief biased reasoning pattern likely counteracts the correction of dysfunctional convictions, and may therefore contribute to the maintenance of social anxiety.

Even though the results from Vroling and de Jong (2009) are promising and suggest that belief biased reasoning might indeed be involved in psychopathology, this earlier study relied on an analogue student sample. For evaluating the clinical relevance of these findings, a crucial next step would be to test whether these initial findings also translate to a clinical population of people with a formal diagnosis of SAD. In addition, it would be informative to establish whether belief bias concerning social anxiety relevant themes is specific for people with SAD or can be found in other anxiety disorders as well. This is a crucial way to test for the specificity of a disorder-specific belief bias. If indeed a social anxiety related belief bias can also be found in patients with other anxiety disorders, this would indicate that maybe an anxious state rather than SA-specific concerns elicits these belief bias effects. Finally, we want to examine whether differential belief bias effects in clinical groups would be restricted to the domain of concerns, or would also be evident with regard to disorder-irrelevant contents. Perhaps, people with anxiety disorders, more generally, show an enhanced tendency to rely on their prior beliefs when judging the validity of particular pieces of information. Prior studies on the relationship between generally enhanced belief bias and psychopathology have been conducted in analogue or healthy student samples, and have so far been inconclusive: Whereas correlational studies failed to show evidence for a relationship between symptoms of psychopathology and a generally enhanced belief bias (Smeets & de Jong, 2005; Vroling & de Jong, 2009, 2010), a study using an experimental fear induction paradigm showed that a generally enhanced belief bias was related to delayed extinction of conditioned fear (Vroling & de Jong, 2013).

In short, the present study was designed to test whether (i)

² Instead of actual names, ‘person A’ and ‘person 1’ are used as comparison categories. This was done because we cannot control the comparative value of actual names. Participants may or may not know a ‘John’ or a ‘Jane’, or they may know more than one ‘John’.

treatment-seeking individuals with SAD display a domain-specific belief bias (i.e., a belief bias concerning social anxiety relevant concerns), when compared to non-symptomatic controls; (ii) this domain-specific belief bias is specific for SAD patients or can also be found in other clinical groups such as patients with panic disorder (PD³); (iii) differential belief bias effects in SAD are restricted to social anxiety concerns or are also evident in the context of reasoning with neutral themes.

2. Method

2.1. Participants

Patients with SAD as primary diagnosis ($n = 45$; 17 women) and patients with PD as primary diagnosis and no comorbid SAD ($n = 24$; 11 women) were recruited among individuals seeking treatment in various outpatient community health care centres in The Netherlands (Overwaal, Centre for Anxiety Disorders: $n = 33$; Hendriks & Roosenboom: $n = 19$; GGZ Friesland: $n = 15$; University Medical Centre Groningen: $n = 2$). The mean age in the SAD group was 31.47 years ($SD = 10.57$) and in the PD group was 37.46 years ($SD = 14.03$). Mean (and median) educational level was intermediate vocational education for both the SAD group and the PD group. All patients met DSM-IV criteria for SAD or PD respectively, as diagnosed by a clinical psychologist or psychiatrist and additionally established with the Mini-International Neuropsychiatric Interview-Plus (M.I.N.I.-Plus; van Vliet, Leroy, & van Megen, 2000). In the SAD group 33 patients (73%) had one or more comorbid disorder(s), among which were depression/dysthymia (40%), generalized anxiety disorder (31%) and panic disorder (20%). In the PD group 11 patients (46%) had one or more comorbid disorders, among which were depression or dysthymia (38%) and generalized anxiety disorder (17%).

Non-symptomatic control (NSC) participants ($n = 45$; 17 women) were recruited through local advertisements and through indirect acquaintances of the staff members and students of the Department of Clinical Psychology of the University of Groningen and Radboud University Nijmegen. They were asked to serve as control participants in a study about anxiety. These NSC participants were matched with the SAD patients on gender, age and level of education and were included after verifying the absence of DSM-IV axis-I disorders as measured by the M.I.N.I.-Plus. One NSC participant did have a diagnosis of alcohol dependence. Mean age was 31.16 years ($SD = 11.60$) and mean (and median) educational level was intermediate vocational education.

All participants included in the study had good comprehension of the Dutch language. The present report was part of a larger study with a longitudinal design in which we followed the SAD and NSC groups (but not the PD group) over time. In order to estimate the strength of the effect, on which we could build our power-analysis, we reviewed the belief bias literature. In general, belief bias generates strong effects (see e.g., Macpherson & Stanovich, 2007; Sá, West, & Stanovich, 1999, where Cohen's d scores of 1.3 and 1.5 were found). We therefore anticipated a strong belief bias effect for the SAD group (for SA-relevant themes), and anticipated no effects for the NSC and the PD group. Power-analysis showed that, to be able to detect large effects and group comparison by means of F -tests with $\alpha = 0.05$ and power = 0.8, at least $n = 21$ per group is

needed (based on Cohen, 1988, Table 8.3.13). Power analysis showed that, to be able to detect large correlations at follow-up (for a different part of the overall study, not relevant to the present cross-sectional study) with correlational analyses per group with $\alpha = 0.05$ and power = 0.8, at least $n = 23$ per group is needed (Cohen, 1988, Table 3.3.2). Since we expected a drop-out percentage of 50% at most, we decided to double the numbers for the SAD and NSC groups (but not the PD group, as this group was measured only once). Ethical approval for the study has been given by an accredited medical research ethics committee (METIGG). This study was part of a larger study: Part of this study has been reported in a separate manuscript (Glashouwer, Vroling, de Jong, Lange, & de Keijser, 2013).⁴

2.2. Materials

2.2.1. Reasoning task

Belief bias measurement was based on the linear syllogistic reasoning task used by Vroling and de Jong (2009) in which the believability of the conclusions and the logical validity of the syllogisms were systematically varied. An example of the four possible variations is given in Table 1 for the neutral syllogisms, and in Table 2 for the social anxiety related syllogisms.

For the social anxiety related syllogisms, we used seven of the eight themes used by Vroling and de Jong (2009): being competent, being less socially skilled, being spontaneous, being ridiculed, being rejected, being found more interesting, and being taken seriously.⁵ We further only used the syllogisms that reflected evaluation by others, e.g.: 'Others find me less competent than person A/Others find person A less competent than person 1//Therefore, others find me less competent than person 1'. The neutral, or generally believable, syllogisms were identical to those used by Vroling and de Jong (2009; in Vroling & de Jong, 2009, these were referred to as 'common knowledge domain' syllogisms).

In total, $7 * 4$ SA-congruency syllogisms and $8 * 4$ neutral syllogisms were presented. Both categories of syllogisms were presented intermixed in two blocks of 30 trials, separated by a fixed 30 s break. For information regarding order of the premises and randomization of the syllogisms, see Vroling & de Jong, 2009. Participants were instructed to judge the syllogisms' validity ("is this conclusion valid?") as accurately and quickly as possible.

2.2.2. Manipulation check

To confirm that the SA-congruency syllogisms were indeed congruent with social anxiety concerns, participants were asked to rate the believability of these particular conclusions in a separate task following the main task. Conclusions of the syllogism were presented on screen, and participants were asked to rate (on a 17 cm visual analogue scale, ranging from 'unbelievable' to 'believable') how believable they considered each statement. See the belief check section of Vroling and de Jong (2009) for more details.

2.2.3. M.I.N.I

The Mini-International Neuropsychiatric Interview (M.I.N.I.;

³ PD was chosen as clinical comparison group, because PD is a relatively prevalent anxiety disorder, because we expect PD-concerns to be different in content than SAD concerns, and because PD is relatively comparable to SAD (when one can choose from PD, specific phobia, generalized anxiety disorder, obsessive-compulsive disorder, and posttraumatic stress disorder).

⁴ Coincidentally, three researchers (M.V., W-G.L. and K.G.) discovered that they had need of a similar patient group, using a similar research design. For sparsity reasons, we decided to combine our data-collection. The studies had independent goals and questions: the study by M.V. targets belief bias, the study by W-G.L. targets approach-avoidance behavior, and the study by K.G. targets implicit associations. All measures that were relevant to the study of M.V. have been reported on in the present paper.

⁵ Data from follow-up studies have shown that the eighth theme ('being looked at') can be interpreted in different ways. Therefore, this theme was excluded.

Table 1

Example of the four possible believability* logical validity variations of a neutral syllogism.

	Believable conclusion	Unbelievable conclusion
Logically 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
Logically 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

Table 2

Example of the four possible social anxiety congruency* logical validity variations of a social anxiety related syllogism.

	SA congruent conclusion	SA non-congruent conclusion
Logically valid	Others find me less competent than person A Others find person A less competent than person 1 Others find me less competent than person 1	Others find person 1 less competent than person A Others find person A less competent than me Others find person 1 less competent than me
Logically invalid	Others find person 1 less competent than person A Others find person A less competent than me Others find me less competent than person 1	Others find me less competent than person A Others find person A less competent than person 1 Others find person 1 less competent than me

Sheehan et al., 1998) is a brief structured interview used to diagnose axis-I psychopathology according to the DSM (American Psychiatric Association, 2000). In the present study, a Dutch translation of the M.I.N.I.-Plus was used, adapted for the DSM-IV criteria (van Vliet et al., 2000). The M.I.N.I.-Plus was administered by either the first or second author (MV and KG, both psychologists) who were successfully trained by Dr. Van Vliet, psychiatrist at Leiden University Medical Centre.

2.2.4. Social phobia and anxiety inventory

To measure the level of social anxiety, a Dutch translation of the Social Phobia and Anxiety Inventory was used (SPAI; Scholing, Bögels, & van Velzen, 1995; Turner, Beidel, Dancu, & Stanley, 1989). The SPAI consists of 45 self-statements on experienced tension/anxiety in various social and non-social situations, which can be scored on a scale of 0 (never) to 7 (always). A total score was computed by subtracting the sub-score for agoraphobia from the sub-score for social anxiety. Psychometric properties for the Dutch SPAI are good (Bögels & Reith, 1999).

2.3. Procedure

Patients were asked to participate in the study after their diagnostic intake at the treatment facility. After having indicated interest in the study, patients and NSCs were contacted by telephone and were screened for the presence of axis I disorders by means of the MINI-Plus. When found eligible, participants were invited either to the mental health institution where they sought treatment or to the labs of Radboud University Nijmegen. First, participants were informed about the study, and were asked to give informed consent. Following this, they completed several computer tasks and questionnaires (among which the SPAI, the reasoning task, and the manipulation check). For details about the computerized syllogistic reasoning task, see Vroling and de Jong (2009). The participants continued with the computerized manipulation check, after which they completed the paper-and-pencil version of the SPAI. They were then debriefed and were compensated with a €15,- coupon.

2.4. Data reduction and analysis

Data from the manipulation check were used to compare believability of the syllogisms between groups. The SA-incongruent

believability ratings were averaged and subtracted from the averaged SA-congruent believability ratings to create a single believability score per participant. These scores were compared between groups (SAD/PD/NSC) with an ANOVA. Scores on the SPAI were also compared between groups with an ANOVA.

For the syllogistic reasoning task, reaction times (RTs) were calculated by averaging the RTs of the correct responses, per type of syllogisms within each domain. For both domains, a separate belief bias score (BB-score) was computed by subtracting the mean RT for the matched syllogisms from the mean RT for the mismatched syllogisms (cf. Vroling & de Jong, 2009, 2010). Five participants (4 SAD, 1 PD) had to be excluded from the analysis for the SA-relevant themes, because they probably failed to understand the task and systematically responded with an erroneous response on trials with particular types of syllogisms, which rendered it impossible to compute a BB-score. For the same reason, five participants (3 SAD, 2 PD) had to be excluded from the analysis of the neutral theme belief bias effects.

To test whether the SA-relevant belief bias effect was indeed stronger in the SAD group compared to both the NSC and the PD group, we used Dunnett's method for multiple comparisons within the context of a one-way ANOVA with the SAD group as the reference group. Reliability intervals were inspected to evaluate for each of the groups whether the BB-score was significantly larger than zero. To examine if the SAD group would show a generally enhanced belief bias (i.e. larger BB-score for neutral themes than NSC), and to explore whether perhaps also the clinical comparison group would show a generally enhanced belief bias, we used a similar (but non-directional) approach with regard to the neutral theme BB-scores with the NSC group as the reference group.

A level of $\alpha = 0.05$ was adopted for all tests. Consistent with previous research using this belief bias task (Vroling & de Jong, 2009), analyses were restricted to reaction time data.⁶

⁶ Because linear syllogisms are relatively easy to solve, participants make few or no mistakes in some conditions. With little or no variance in some conditions, error data cannot be reliably analyzed.

3. Results

3.1. Participants

The participant groups were compared with regard to level of social anxiety by means of an ANOVA with Group (SAD/PD/NSC) as between subject factor and SPAI as outcome measures, with repeated contrasts to compare the SAD versus the PD group and versus the NSC group. The social anxiety levels are highest for the SAD group ($M = 97.24$, $SD = 26.56$), lower for the PD group ($M = 43.93$, $SD = 34.18$) and lowest for the NSC group ($M = 35.81$, $SD = 21.02$). As expected, there was a significant difference between the groups on the level of social anxiety, $F(2,109) = 66.25$, $p < 0.01$, $\eta^2 = 0.55$. The contrasts show that the SAD and the NSC group differed in social anxiety ($p < 0.01$) as well as the SAD and the PD group ($p < 0.01$).

3.2. Manipulation check

In order to test the differences of explicit (subjective) believability of syllogistic conclusions per group, believability ratings were compared by means of an ANOVA with Group (SAD/PD/NSC) as between subject factor and believability ratings as dependent variable, with simple contrasts to compare the SAD versus the PD group and the SAD versus the NSC group. As expected, the groups differed on their believability ratings, $F(2,108) = 32.67$, $p < 0.01$, $\eta^2 = 0.38$. The contrasts indicate that the SAD group scored higher than the PD group ($p < 0.01$) and higher than the NSC group ($p < 0.01$): The SAD group showed, on average, a positive believability rating ($M = 23.02$, $SD = 30.79$), whereas the PD group and the NSC group showed, on average, a negative believability rating ($M = -13.98$, $SD = 23.01$ and $M = -20.66$, $SD = 23.31$, respectively). In sum, this means that at the explicit level SAD patients found SA-congruent conclusions more believable than SA-incongruent conclusions whereas the opposite was true for the PD and the NSC groups.

3.3. Domain-specific belief bias

Mean RTs for the social anxiety related syllogisms are displayed for each group in Table 3 as a function of SA-congruency and logical validity. For the SAD group ($n = 41$) mean BB-score was 0.70 (95% confidence interval: 0.23–1.17); for NSC group ($n = 45$) mean BB-score was -0.07 (95% confidence interval: -0.52 to 0.38); and for the PD group ($n = 23$) mean BB-score was 0.22 (95% confidence interval: -0.64 to 1.07). Thus only the SAD group showed a significant SA-relevant belief bias effect (0 not in confidence interval). Dunnett's multiple comparison tests with SAD as the reference group showed that the BB-score of the NSC group was significantly lower than that of the SAD group with a mean difference of -0.77 ($SE = 0.35$) and the upperbound of the 95% confidence interval being -0.09 ($p = 0.027$). The BB-score of the PD group was not significantly lower than that of the SAD group with a mean difference of -0.48 ($SE = 0.42$) and the upperbound of the 95% confidence interval being 0.33 ($p = 0.21$).

3.4. General belief bias

For all groups, mean BB-scores as well as RTs (and SD's) for the neutral syllogisms are displayed in Table 4 as a function of believability and logical validity. For the SAD group ($n = 42$) mean BB-score was 1.27 (95% confidence interval: 0.71–1.84); for NSC group ($n = 45$) mean BB-score was 0.93 (95% confidence interval: 0.35–1.51); and for the PD group ($n = 22$) mean BB-score was 0.60 (95% confidence interval: -0.31 to 1.51). Thus both the SAD and NSC group showed a significant belief bias effect. Although the pattern was very similar for the PD group, it was not statistically significant ($p = 0.09$). Dunnett's multiple comparison tests with NSC as the reference group showed that the BB-score of the SAD group was not significantly different from that of the NSC group with a mean difference of 0.34 ($SE = 0.41$) (95% confidence interval: -0.58 to 1.27) ($p = 0.62$). Also the BB-score of the PD group was not significantly different from that of the NSC group with a mean difference of -0.33 ($SE = 0.50$) (95% confidence interval: -1.46 to 0.79) ($p = 0.74$).

4. Discussion

This study investigated social anxiety related belief bias in SAD patients when compared to NSCs and PD patients. It was also tested whether SAD patients displayed a generally enhanced belief bias. The main results can be summarized as follows: (i) specifically the SAD group displayed a significant belief bias for social anxiety relevant syllogisms; (ii) although this belief bias effect in SAD patients differed significantly from the NSCs, the difference with the clinical comparison (PD) group was not significant; (iii) SAD patients showed no stronger belief bias effect for the neutral themes than NSCs.

The first goal of the present study was to examine whether disorder-relevant belief bias could be traced in a clinical group of SAD patients. Supporting the view that belief bias is involved in psychopathology, we found that SAD patients displayed a social anxiety related belief bias whereas the NSCs did not. Thus the general finding that strong universal beliefs interfere with people's reasoning performance also applies to disorder-specific convictions. This finding confirms and extends the earlier findings of a social anxiety related belief bias in an analogue sample (Vroling & de Jong, 2009). In the current study belief bias was indexed in terms of fastened responding when logical conclusions matched and slowed responding when logical conclusions did not match SAD-congruent beliefs. Although participants in the current context eventually succeeded in giving logical correct responses, belief bias can be expected to translate in reasoning errors in daily-life, as real-life events typically demand quick responses instead of providing extended time periods to elaborate on the validity of a conclusion. Such domain-specific belief bias will therefore hamper the disconfirmation of anxiogenic beliefs in the context of everyday reasoning, thereby contributing to the maintenance of SAD patients' fearful convictions. It would be important for future research to test the causal influence of belief bias on the persistence of SAD. In addition, it would be interesting to examine how the influence of

Table 3

BB-score, mean RT (in seconds) and SD for the social anxiety related syllogisms as a function of SA-congruency and logical validity for the SAD, the NSC, and the PD group.

BB-score	SAD ($n = 41$)		NSC ($n = 45$)		PD ($n = 23$)	
	0.70 (1.50)		-0.07 (1.50)		0.22 (1.98)	
	SA-congruent	SA-incongruent	SA-congruent	SA-incongruent	SA-congruent	SA-incongruent
Valid	9.13 (2.64)	9.83 (2.85)	10.54 (3.30)	9.97 (3.15)	10.34 (2.36)	10.00 (3.23)
Invalid	10.71 (3.32)	9.99 (3.38)	11.14 (3.18)	10.81 (3.08)	10.74 (2.92)	10.69 (2.66)

Table 4

BB-score, mean RT (in seconds) and SD for the neutral syllogisms as a function of believability and logical validity for the SAD, the NSC, and the PD group.

BB-score	SAD (n = 42)		NSC (n = 45)		PD (n = 22)	
	1.27 (1.82)		0.93 (1.94)		0.60 (2.05)	
	Believable	Unbelievable	Believable	Unbelievable	Believable	Unbelievable
Valid	6.77 (2.28)	7.98 (2.42)	6.69 (2.36)	8.09 (3.09)	7.48 (2.80)	8.48 (2.95)
Invalid	8.57 (2.91)	7.14 (2.35)	8.04 (3.03)	7.23 (2.43)	8.70 (2.44)	8.08 (2.43)

belief bias relates to other known cognitive biases in SAD such as negative interpretative biases (Huppert, Pasupuleti, Foa, & Mathews, 2007), biased attention to negative social information (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzen-doorn, 2007), and post-event rumination (Hofmann, 2007).

Our second goal was to determine whether the SAD-relevant belief bias is specifically related to SAD patients, or would also be evident in other clinical groups. Although the analyses showed that social anxiety related belief bias was only evident in the SAD group and not in the PD group, the difference between the SAD and the PD group was not statistically significant. The present pattern of findings therefore provided only partial support for the view that the SAD-relevant belief bias is restricted to SAD patients. With respect to other information processing biases (more specifically, attentional bias), it has been found that the bias is especially pronounced when participants are in a state of fear (e.g., Chen, Lewin, & Craske, 1996; Juth, Lundqvist, Karlsson, & Öhman, 2005; Mansell, Clark, Ehlers, & Chen, 1999). In line with this, it could be that social anxiety related belief bias displays itself more prominently in SAD patients during activation of social fear. One way to test this assumption would be to enhance state anxiety prior to the presentation of the reasoning task (e.g., by having participants undergo a Trier Social Stress Test [Kirschbaum, Pirke, & Hellhammer, 1993]). In addition, it could be that the lack of support for the disorder specificity of the belief bias effect stems from a lack of power. Sample size was calculated based on the assumption of large effects, whereas in fact the belief bias effects for the SA-relevant syllogisms were small to moderate for the SAD group. This substantially limited the power of the current study to detect a difference between the SAD and the PD group. It may thus well be that a significant difference between both clinical groups would have been evident, when we would have used a larger sample size. The finding that, in contrast to the SAD group, the PD group did not show a social anxiety related belief bias corroborates this interpretation.

The third goal of the present study was to test whether the differential belief bias effects in SAD would be restricted to SAD-relevant themes or would also be evident in the context of reasoning with neutral themes. In the present study, SAD patients did not show a heightened belief bias when reasoning with disorder-irrelevant themes. Thus SAD patients did not show evidence for a generally deviant reasoning style. Also the PD group showed a similar belief bias effect for neutral themes as the non-clinical comparison group. Together these findings do not support the view that people with anxiety disorders show a generally enhanced tendency to rely on their prior beliefs. Considering all evidence on the relationship between general belief bias effects and psychopathology, we conclude that no such relationship has been found in observational studies using either healthy, analogue, or patient samples (Smeets & de Jong, 2005; Vroling & de Jong, 2009, 2010). Yet, when using a fear conditioning paradigm as a means of modeling the development of an anxiety disorder, higher levels of generally enhanced belief bias were found to be related to slowed extinction of fear (Vroling & de Jong, 2013). Bringing these results together, it seems that a generally heightened belief bias itself does

not contribute to the development of anxiety disorders, but that heightened belief bias combined with anxiety-inducing learning experiences can. If so, it is likely only one of many factors that contributes to the development of anxiety disorders. It seems that a generally heightened belief bias is by no means a major factor in the development of anxiety disorders.

The absence of a generally enhanced belief bias suggests that the domain-specific belief bias that we observed for the SAD group does not reflect a deviant reasoning pattern: The fact that we found this belief bias for the SAD group and not for the other groups can likely be fully explained by the presence or absence of strong SA-relevant convictions. Belief biased reasoning is generally found to be activated when reasoning with highly believable materials (e.g., Evans, Newstead et al., 1993). The current findings thus suggest that the beliefs of the SAD group are of sufficient strength to elicit belief biased interference effects when intentionally judging the logical validity of social anxiety relevant statements. An obvious starting point to reduce the impact of belief bias in SAD would be to modify SAD patients' dysfunctional beliefs. Another way to reduce the impact of prior beliefs would be to promote an analytical instead of heuristic approach in everyday reasoning about disorder relevant themes. Accordingly, we are currently testing whether a multi-session training, in which high fear individuals have to solve an extensive series of linear syllogisms of which the believable conclusions are mostly logically invalid, and the unbelievable conclusions most often valid, is helpful to promote an "advocate of the devil's perspective" and to reduce the strength of phobic convictions. If this would work out, this would not only provide direct evidence for the causal influence of belief bias on the persistence of dysfunctional beliefs but may also provide a fresh starting point for an efficient theory-derived clinical intervention.

Some remarks concerning the study's limitations are in order. First, the belief bias effect for the SA-relevant syllogisms for the SAD group was less strong than we had anticipated. Thus to obtain a 0.80 power to detect relevant between group differences, more participants should have been included, especially in the PD group. At present, the study is likely underpowered with regard to the SAD-PD contrast, meaning that we cannot decide with sufficient certainty whether or not the SAD-relevant belief bias effects are restricted to SAD. Also, the smaller-than-expected effect size may point to the relative relevance of the presently found domain-specific belief bias effects: The domain-specific belief bias effects were less strong than the generally found belief bias effects. Alternatively, it could be that this less strong effect was a result of our effort to create easier syllogisms: Indeed, the effect of belief bias has been found to decrease with easier syllogisms (Brisson, de Chantal, Forgues, & Markovits, 2014).

Second, the manipulation check indicated that there is still room for improving the believability of the syllogisms. Indeed, a believability rating of 23 (with a range of –100 to 100) is still low for what were assumed to be strongly held beliefs. One explanation for the relatively low scores could be that the themes within the social anxiety related syllogisms covered a wide range of social anxiety related convictions, in order to create a maximum response from our SAD patients. It might well be that only a few of these

convictions were central to each SAD patient's fearful pre-occupations, which might have limited the sensitivity of the current reasoning task. Future research may consider using an ideographic approach, by selecting those syllogisms that best match each patient's central convictions. An alternative explanation for the relatively low believability ratings might be that these ratings were obtained without activation of the fear network (e.g., Clark & Wells, 1995; Foa & Kozak, 1986; Juth et al., 2005; Mansell et al., 1999). Meanwhile, it should be noted that (low) explicit believability ratings may not necessarily be critical in the present context. Both explicit and implicit "beliefs" may be involved in SAD (e.g., de Hullu, de Jong, Sportel, & Nauta, 2011; Glashouwer et al., 2013), and both may play a role in belief biased reasoning (see Evans, 2003). For the future, it would therefore be worthwhile to also include implicit measures for dysfunctional convictions when checking the believability of the syllogisms, for example, by using the implicit association task.

Third, the use of the abstract comparison categories 'person A' and 'person 1' made the syllogisms relatively abstract. Although this abstract form was chosen deliberately, as concrete names can bring about associations with personality characteristics (e.g., the name 'Charlene' may bring about different associations than the name 'Elizabeth'), it could have influenced both the believability of the conclusions, and the comprehension of the syllogisms as a whole.

Fourth, the present task does not allow to disentangle the effect of beliefs and reasoning per se on the belief bias effects; yet the most parsimonious explanation for the concern specific belief bias effect that we found in SAD patients is that it reflects a common bias applied to dysfunctional beliefs.

5. Conclusion

The present study showed that SAD patients display belief bias with regard to social anxiety related materials. This type of concern-congruent belief bias may well counteract the correction of dysfunctional convictions, and as such contribute to the maintenance of SAD. It would be important for future research to test the proposed reciprocal relationship between such concern-related belief bias and individuals' anxiety symptoms. Accordingly, a next step would be to test the influence of treatment on concern-specific belief bias effects and to test whether residual beliefs and residual belief bias effects might have prognostic value for the return of fear following initially successful treatment (cf. Vasey, Harbaugh, Buffington, Jones, & Fazio, 2012). In addition, it would be worthwhile to experimentally manipulate social anxiety related belief bias (for instance by making use of cognitive bias modification; e.g., Beard, Weisberg, & Amir, 2011), to test whether reducing belief bias may enhance the susceptibility of patients for corrective learning experiences offered in therapy.

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