

Two reasoning strategies in patients with psychological illnesses

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Conceived and designed experiment: AG, FM. Data collection: AG, KT. Data Analysis: AG, FM. Wrote the paper: AM, FM, KT.

Keywords

Hyper Emotion Theory, Emotions, reasoning, Anxiety Disorders, Obsessive-compulsive disorders, corroboratory strategy, Refutatory strategy

Abstract

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The hyper-emotion theory states that psychological disorders are conditions in which individuals experience emotions that are appropriate to the situation but inappropriate in their intensity. When these individuals experience such an emotion, they inevitably are compelled to reason about its cause. They therefore develop characteristic strategies of reasoning depending on the particular hyper-emotion they experience. In anxiety disorders (e.g., panic attack, social phobia), the perception of a threat leads to hyper anxiety, and the reasoning is corroboratory, adducing evidence that confirms the risk (corroboratory strategy). In obsessive-compulsive disorders, the perception of the threat of having acted in an irresponsible way leads to both hyper anxiety and guilt, and the reasoning is refutatory, adducing only evidence disconfirming the risk of being guilty (refutatory strategy). We report three empirical studies corroborating these hypotheses. They demonstrate that patients themselves recognize the two strategies and spontaneously use them in therapeutic sessions and in evaluating scenarios in an experiment.

Contribution to the field

So far psychological disorders represent one of the deepest mystery that confront clinicians. What are the immediate causes of psychological disorders and what maintains them? No consensus exists amongst professionals about these matters. Psychoanalysts attribute the cause of mental illnesses to unconscious conflicts in childhood. Cognitive therapists attribute it to false beliefs and faulty reasoning. And psychiatrists attribute it to defects in brain chemistry. An answer to the preceding question comes from the hyper-emotion theory: emotions cause psychological illnesses; they are appropriate to the situation but inappropriate in their intensity. The theory yields testable predictions including an account of the different reasoning strategies in psychopathology. In the present paper we demonstrated that patients actually develop characteristic strategies of reasoning that depend on the (hyper)emotion elicited by the threat: anxious patients make corroboratory inferences, while obsessive patients make refutatory inferences. Both strategies lead to the systematic confirmation of dysfunctional beliefs inherent in these illnesses. With these results we contribute some progress in solving the mystery of the maintenance of psychological disorders.

Ethics statements

Studies involving animal subjects

Generated Statement: No animal studies are presented in this manuscript.

Studies involving human subjects

Generated Statement: The studies involving human participants were reviewed and approved by Associazione di Psicoterapia Cognitiva, Rome, Italy. The patients/participants provided their written informed consent to participate in this study.

Inclusion of identifiable human data

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Data availability statement

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Abstract

Hyper-emotion theory states that psychological disorders are conditions in which individuals experience emotions that are appropriate to the situation but inappropriate in their intensity. When these individuals experience such an emotion, they inevitably are compelled to reason about its cause. They therefore develop characteristic strategies of reasoning depending on the particular hyper-emotion they experience. In anxiety disorders (e.g., panic attack, social phobia), the perception of a disorder-related threat leads to hyper-anxiety; here, individuals' reasoning is corroboratory, adducing evidence that confirms the risk (*corroboratory strategy*). In obsessive-compulsive disorders, the threat of having acted in an irresponsible way leads to both hyper-anxiety and guilt; here, individuals' reasoning is refutatory, adducing only evidence disconfirming the risk of being guilty (*refutatory strategy*). We report three empirical studies corroborating these hypotheses. They demonstrate that patients themselves recognise the two strategies and spontaneously use them in therapeutic sessions and in evaluating scenarios in an experiment.

In review

1. INTRODUCTION

The psychological illnesses' maintenance and their resistance to change show a paradoxical nature: people who worry about a certain catastrophe continue to experience fear despite the evidence of their survival. Cognitive models of psychopathology focus their attention on the dysfunctional beliefs implicated into the genesis and maintenance of these illnesses (e.g., Beck, 1976; Harvey, Watkins, Mansell and Shafran, 2004; Johnson-Laird, Mancini and Gangemi, 2006). The hyper-emotion theory of psychopathology is in line with these cognitive models (Johnson-Laird et al., 2006; Mancini, Gangemi and Johnson-Laird, 2007). Such model states that psychological disorders are conditions in which individuals experience emotions that are appropriate to the situation but inappropriate in their intensity. The hyper-emotion model is based on a cognitive view, where the emotions are related to conscious or unconscious evaluations. These evaluations predispose individuals to certain thought and action (Oatley and Johnson-Laird, 1987). Hence, when individuals are experiencing a hyper-emotion, they inevitably are compelled to reason about its cause, and over the long term, their ability to reason in this way increases (cf. Gangemi, Mancini and Johnson-Laird, 2013). As a consequence, patients acquire specific reasoning strategies depending on the hyper-emotion elicited by the disorder-related threat. The paradoxical effect is that these strategies serve to support the psychological disorders, leading as they do to the continued confirmation of the dysfunctional beliefs central to them. In anxiety disorders, such as hypochondria, panic attack, and social phobia, the perception of a disorder-related threat leads to hyper-anxiety. Prudent cognitive processes are thus oriented towards corroborating the danger in order to avoid it or to prevent it, because it is 'better to be safe than sorry' (e.g. de Jong et al., 1998; de Jong, Mayer and van den Hout, 1997; Smeets, de Jong and Mayer, 2000). For example, de Jong and colleagues (1998) showed that hypochondriac individuals were more likely to select confirming information when judging a danger about a conditional hypothesis on physical health (e.g. *If a person suffers from a headache, then that person must have a brain tumour*), and disconfirming information of the safety conditional hypothesis. The reasoning of anxiety disorder patients should therefore be corroboratory, adducing only evidence that prudentially confirms the risk. We refer to this as the "corroboratory" strategy.

In certain cases such threats may be associated to guilt emotion and responsibility, which have been proven to have a key role in the onset and maintenance of Obsessive Compulsive Disorder (OCD; e.g.: Shapiro and Stuart, 2011, Mancini and Gangemi, 2015). In fact Shapiro and Stewart (2011) showed that: (1) in nonclinical samples, guilt determines obsessive-compulsive-like symptoms, together with an increased perception of threat (see Gangemi, Mancini and van den Hout, 2007), over-responsibility, and intrusive thoughts/impulses (Niler and Beck, 1989); and, (2) in neuro-imaging studies of non-clinical samples, the state of guilt activates brain regions in proximity to OCD-affected ones (Shin et al., 2000; Takahashi et al., 2004). In obsessive patients, cognitive processes should therefore aim to exclude the possibility of guilt for having done something wrong from leading to, for example, risk of contamination. If one wants to falsify a risk with certainty, s/he can only try to imagine all the situations in which the condition could be true and falsify them one by one. Accordingly, obsessive patients should focus on all the possibilities that could put them at risk, and then try to refute them beyond a reasonable doubt. This strategy is chosen because it is not possible to act on the facts themselves, for example by changing them (I cannot go back and avoid touching a contaminating photo). In this case, not only the results obtained but also one's own efforts are evaluated against very high standards. The ultimate goal of this strategy is to avoid the self-accusation of having not been up to fulfilling one's duties. This goal has a paradoxical effect: it suggests possible mechanisms by which the risk could be real (see Johnson-Laird et al., 2006). The reasoning of obsessive-compulsive patients should therefore be refutatory, searching for evidence to refute the risk. We accordingly refer to this reasoning strategy as "refutatory". Unlike the corroboratory strategies in anxiety disorders, so far no studies have investigated the refutatory form

of reasoning in obsessive patients. Only the obsessive-like step-by-step reasoning from a neutral situation towards an unlikely catastrophic consequence, examined by Giele and colleagues (Giele, van den Hout, Engelhard, Dek, and Klein Hofmeijer, 2011) is comparable to the hypothesized refutatory pattern of reasoning. The obsessive-like step-by-step reasoning form would induce uncertainty and increase the perceived probability of a negative outcome. But, in their study, the authors did not evaluate whether participants, when are engaging in this step-by-step reasoning, try to find counterexamples of the obsessive-like consequence, although it would be plausible that the experiment too induced some form of refutatory reasoning.

Here are two vignettes illustrating the contrasting sorts of reasoning strategies, but using contents suggestive of hypochondria (in Johnson-Laird, et al., 2006).

The first vignette is of corroboratory reasoning:

I'm afraid of the slight pain I feel in my abdomen on the same side as my liver. It could be a symptom of cancer, a liver cancer. I remember an uncle of mine who died from liver cancer after a lot of suffering. In the beginning, his symptoms were the same as mine: he had a similar stomach ache. He didn't take any notice, and the doctors told him that he wasn't ill. But, meanwhile the cancer was spreading. Now, in the same way the cancer may be spreading in my abdomen. Moreover, it seems to me that I look unhealthy; my tongue is pasty; sometimes I have a bitter taste in my mouth. I look pale, and I could be anemic.

This second vignette is of refutatory reasoning:

I'm afraid of the slight pain I feel in my abdomen on the same side as my liver. It could be a symptom of cancer, a liver cancer. I remember an uncle of mine who died from liver cancer after a lot of suffering. But he was in his eighties and a liver cancer at my age is not common. On the other hand, it's not impossible. Moreover, it seems to me that I look unhealthy; my tongue is pasty; sometimes I have a bitter taste in my mouth. I look pale, and I could be anemic. Of course these are common symptoms. But they are there, and they are not incompatible with cancer. Moreover, they don't exclude it.

In an earlier study (Johnson-Laird et al., 2006), we showed that psychiatrists distinguish the two strategies as the hyper-emotion theory predicts: corroboratory reasoning as the hallmark of patients suffering from various sorts of anxiety disorders, and refutatory reasoning as the hallmark of obsessive patients. Moreover they do so even when the contents of vignettes, as in the examples above, provide no clue to the disorder. The aim of the present studies, however, was to test whether patients themselves recognize the two strategies (Experiment 1), and spontaneously use them in therapeutic sessions (Experiment 2). As there are still no studies that have investigated the origin of refutatory reasoning strategies in obsessive patients, in a third study (Experiment 3) we wanted to examine whether this form of reasoning actually stems from the (hyper-) guilt emotion.

2. Experiment 1

The aim of this study was to verify whether patients themselves recognise their own reasoning strategy. It therefore used the same six matched pairs of vignettes used in the experiment with psychiatrists, including the pair in the Introduction, with the same contents. Hyper-emotion theory (e.g. Johnson-Laird et al. 2006) predicts that those suffering from anxiety will tend to see the corroboratory style of reasoning as being more similar to their own, whereas those suffering from obsessive-compulsive disorder will tend to see the refutatory style of reasoning as being more similar to their own.

2.1 Method

2.1.1 Participants

The experiment tested two groups of patients: 18 patients with obsessive compulsive disorder (male: 8; age: $M=32.7$, $SD=7.5$), and 20 patients with anxiety disorders (general anxiety disorder: 4, panic attack: 4, social phobia: 4, specific phobia: 4; hypochondria: 4; male: 14; age: $M=35.8$, $SD=5.9$). The two groups were similar in age (Mann-Whitney $U = 167$, ns) and educational level (obsessive patients: $M=14.4$ years, $SD=1.7$, anxiety patients: $M=14.2$ years, $SD=1.7$, Mann-

Whitney $U= 718$, ns). Both groups were undergoing treatment at the Centre for Cognitive Psychotherapy in Rome but were not taking any medication. They were at the beginning of treatment and had been diagnosed through the Structured Clinical Interview and diagnosis for OCD and anxiety disorders in DSM-IV-TR (SCID; First et al., 1996).

2.1.2 Design, Materials and Procedure

All participants, read the same six matching pairs of vignettes as those employed in the earlier study of psychiatrists (see the two examples above; Johnson-Laird et al., 2006). Each pair illustrated the contrasting sorts of reasoning strategies (corroboratory vs refutatory). The vignettes were been created on the typical content of six psychological illnesses: Obsessive Compulsive Disorder (of two types, one concerning contamination and the other concerning the checking compulsion), hypochondria, generalized anxiety, specific phobia, and paranoia. (For translations of the vignettes from the original Italian language into English see the Appendix).

Patients were asked whether they wanted to take part in a study of the way people who ask for psychological help reason about certain crucial topics. They were told that there were no right or wrong answers, and that it was their opinions that were of interest to the study. Before reading each vignette, the key question in the instructions they were given was this: *How similar is this vignette to how you reason when you think of what you are worried about because of your disorder?* The participants rated similarity on a 7-point Likert scale (from 0 = not similar at all, to 7 = absolutely similar). After having read each vignette, they were asked to describe the cues, if any, they used in evaluating the similarity. The vignettes were presented to each patients in one single random order.

2.2 Data Analysis

A research assistant, blind to the aim of the study, coded all paper data. Since our data were not normally distributed across groups, as assessed by Shapiro–Wilk’s test (all $P_s < 0.05$), we employed non-parametric statistics.

2.3 Results

In line with our hypotheses, we detected a critical interaction: the difference in selection between the refutatory and the corroboratory version was greater in obsessive patients than in anxious patients (Mann-Whitney $U= 406$, $p < .001$, $\eta^2 = 1.1$).

As shown in Table 1, almost all the patients affected by OCD identified the refutatory vignettes as being more similar to the way they reasoned when worried. Moreover, their performance was at the ceiling of what was possible (98% of trials). However, they were unable to describe the indicators that they had used and their judgments were quite rapid and intuitive. To further demonstrate that our obsessive patients identified with the refutatory vignettes more than they did with the corroboratory ones, for each patient and each pair of vignettes we subtracted the rating they gave to the corroboratory vignette from the rating they gave to the refutatory one. We then computed a Wilcoxon test on the mean difference for each patient. In this way, we were able to confirm that the obsessive patients recognised refutatory vignettes as being more similar than corroboratory ones to their own reasoning (Wilcoxon, $z=3.73$, $p < .001$, $\eta^2 = .08$). Males and females were similar in their performance (Mann-Whitney $U=18$, ns). By contrast, patients affected by other anxiety disorders felt the vignettes with a corroboratory reasoning to be more similar to their type of reasoning when worried on 95% of trials; this was considerably higher than by chance (binomial test, $p < .0001$). Also this group of patients was unable to describe the cues that they had used, and again their judgement were quite rapid and intuitive. Applying a similar procedure to that used for the obsessive participants, for each anxious patient and for each pairs of vignettes, we subtracted this time the rating of the refutatory vignette from the rating of the corroboratory ones. We thus further demonstrated that these patients recognize corroboratory vignettes as more closer to their way of reasoning than refutatory vignettes (Wilcoxon, $z=3.95$, $p < .001$, $\eta^2 = .08$). No difference was found between males and females patients in their performance (Mann-Whitney $U= 19$, ns).

INSERT TABLE 1 ABOUT HERE

The vignettes were thus readily identifiable by both groups. This result supports the theory's account of there being two characteristic ways of reasoning in patients. We therefore expected that OC patients and anxious patients would spontaneously reason in a refutatory and corroboratory form, respectively, during therapeutic sessions.

3. EXPERIMENT 2

This study examined the spontaneous reasoning of obsessive patients and other anxious patients during therapeutic sessions. Our theory predicted that obsessive patients would spontaneously use the refutatory strategy more often when reasoning on topics typical of obsessions compared with when reasoning about other topics eliciting simply anxiety, e.g. work or relationships. In contrast, anxious patients should use more often the corroboratory strategy in reasoning about topics pertinent to their illness as well as when reasoning with other topics eliciting anxiety.

3.1 Method

3.1.1 Participants

The experiment tested two groups of patients: 12 obsessive patients (Male: 6; age: $M=34.8$, $SD=10.9$) and 10 patients affected by panic attack (Male: 6; age: $M=33.9$, $SD=9.5$). The two groups did not differ in age (Mann-Whitney $U = 58.5$, ns) and educational level (obsessive patients: $M=14$ years, $SD=2.1$, anxiety patients: $M=14$ years, $SD=1.5$, Mann-Whitney $U = 68$, ns). Both groups were undergoing treatment at the Centre for Cognitive Psychotherapy in Rome, but were not on any psychopharmacological treatment. They were at the beginning of treatment and had been diagnosed using the Structured Clinical Interview and diagnosis for OCD and panic disorder in DSM-IV-TR (SCID; First et al., 1996).

3.1.2 Design, Materials and Procedure

We asked two colleagues in Rome, who had been trained in cognitive psychotherapy but were blind to the hypothesis being tested, to conduct this experiment. We asked them to instruct all the patients to put into words, during two different therapeutic sessions (i.e. thinking aloud) their ruminations and thoughts on 1) a topic that was pertinent to their illness. For example, for an obsessive patient an episode of possible contamination, and for an anxious patient an episode in which he had to use the elevator and 2) on a topic that was not pertinent to their illness. For example, for all patients episodes regarding general worries about money or their job. These two therapists were asked to help patients during the task by posing such questions as:

Put into words your thoughts while you are ruminating/thinking about the possibility of....'

'How are you reasoning about it?'

'What are you telling yourself?'

'What thoughts are crossing your mind?'

The questions were the same for both the topics (pertinent topic vs. not pertinent topic to the illness). The patients were required to think aloud as they reasoned spontaneously while the therapist recorded what they said. Psychotherapists started to audio record the first time that a patient started to talk about a worry that crossed her/his mind. Two verbal reports were obtained from participants: one on a topic that was relevant to their condition; the other on a nonrelevant topic.

Two independent judges, both psychotherapists in Rome, who had also been trained in cognitive therapy and were blind to the hypothesis being tested, coded the pairs of recordings for the 22 patients. They were told to listen carefully as many times as they needed to in order to assign each recording to one of two mutually exclusive categories: patients using a refutatory reasoning strategy, and patients using a corroboratory reasoning strategy. They were given the following definitions of the two strategies:

-Refutatory: where the patient searches for counterexamples of the worst case under consideration.

-Corroboratory: where the patient searches only for examples of the worst case under consideration.

They also read two examples of each strategy, from two pairs of vignettes used in the earlier studies, each containing the same number of sentences. Where they disagreed in their judgments, which occurred in 3% of protocols, we asked a third judge (another psychotherapist in Rome) to make the final decision.

3.2 Results

Table 2 presents an example of the refutatory reasoning of an obsessive patient, and an example of the corroboratory reasoning of an anxious patient, both for a topic that was relevant for their disturbs.

INSERT TABLE 2 ABOUT HERE

The Cohen's kappa correlation coefficients between the two judges for the two reasoning strategies (refutatory or corroboratory) was .83 for reasoning related to patients' illness, and .65 for reasoning about other topics. Overall, Cohen's kappa for the reliability of their judgments was .73, which reflects a good agreement (Fleiss, 1981). For the few protocols on which they disagreed, the third judge cast the deciding vote.

As shown in Table 3, obsessive patients tended to use a refutatory strategy, whereas anxious patients tended to use a corroboratory strategy (Fisher Yates exact test: $p < .05$, $\eta^2 = .05$), when they reasoned on a topic the was relevant for their disturb. Differently when the two groups of patients thought about topics other than their illnesses, both of them tended to use the corroboratory strategy (Fisher-Yates exact test: $p > .5$).

INSERT TABLE 3 ABOUT HERE

4. Experiment 3

A number of studies have previously demonstrated that (hyper-) anxiety is responsible for the corroboratory pattern of reasoning (see de Jong et al., 1998). To date, no study has investigated the origin of the refutatory reasoning strategy in obsessive patients. In line with the hyper-emotion theory, with this study, we wanted to examine whether the latter form of reasoning actually stems from the (hyper-) guilt emotion. To this aim, we used two different vignettes: one in which the protagonist was guilty and responsible for the negative outcome (see below: vignette 1), and one in which a third person was responsible and guilty for the outcome (see below: vignette 2). According to the idea that obsessive symptomatology is based on the threat of being guilty, assessed as being imminent and the goal being to prevent it, we hypothesized that obsessive patients would use the refutatory strategy more than the Better Safe than Sorry strategy, more so in scenarios in which they were guilty concerning a negative outcome (see vignette 1), than in scenarios in which others were guilty of the same outcome (see vignette 2, below reported), and more than patients suffering from other anxiety disorders.

4.1 Method

4.1.1. Participants

The experiment tested two groups of patients: 13 obsessive patients (Male: 8; age: $M=33.5$, $SD=7.7$) and 11 patients affected by panic attack (Male: 7; age: 32.6 , $SD=7.4$). The two groups were similar in age (Mann-Whitney $U = 66.5$, $Z=2.95$, *ns*) and educational level (obsessive patients: $M=14$ years, $SD=2.1$, anxiety patients: $M=14.8$ years, $SD=1.7$, Mann-Whitney $U = 52$, $Z = 1.2$, *ns*). Both groups were undergoing treatment at the Centre for Cognitive Psychotherapy in Rome but were not on any psychopharmacological treatment. They were in the starting phase of treatment and had been diagnosed using the Structured Clinical Interview and diagnosis for OCD and panic disorder in DSM-IV-TR (SCID; First et al., 1996).

4.1.2 Design, Materials and Procedure

To recruit these two groups of patients, at the end of the first session of their clinical assessment, patients were asked whether they wanted to take part in a study on the way people reason about certain crucial topics. They were told that there were no right or wrong answers, and that we were only interested in their opinions. Four colleagues in Rome and in Palermo, who had been trained in cognitive psychotherapy and who were blind to the hypothesis being tested, were asked to carry out

the experiment. Patients were instructed to read two short vignettes, each leading to a negative outcome: one described a situation in which the protagonist of the story could be responsible or guilty for the negative outcome, while in the other the possible culprit was a third person. They were then asked to reason about both stories, writing down their thoughts in order to reassure themselves beyond any reasonable doubt about the negative outcome.

The story concerning the culpability of the protagonist was for example (vignette 1):

Imagine that it's Sunday afternoon and I'm with my niece. I'm playing with her on the sofa, when my nose starts itching and I sneeze. I don't care and keep on playing with her. Later, it strikes me that my niece might be sick because of my sneeze. It would be because of my carelessness. I should have been more careful.

The story concerning the culpability of a third person was for example (vignette 2):

Imagine that I took my niece to the kindergarten. I see her playing with other kids and the teacher. While I'm reaching them, the teacher's nose starts itching and she sneezes so many times. She doesn't care and keep on playing with my niece. Later, it strikes me that my niece might be sick because of her teacher's sneeze. It would be because of her carelessness. She should have been more careful.

After having read each story, all participants were told:

Try to reassure yourself about this possibility, beyond any reasonable doubt. Write all the thoughts that come to your mind.

The participants in each group read the two stories in a different random order and in two different therapeutic sessions.

Two independent judges, both psychotherapists in Palermo who were blind to the hypothesis being tested, categorised the two protocols from each participant in terms of whether they exhibited a refutatory or a corroboratory reasoning strategy (see Study 2 for their instructions). Where they disagreed on their judgments, a third judge (another psychotherapist in Palermo) cast the deciding vote.

4.2 Results

Table 4 shows two typical protocols of the two sorts of reasoning from two representative obsessive patients. Agreement between the two judges for the two forms of reasoning (corroboratory vs. refutatory) was .73 for the stories concerning the protagonist's guilt, and .83 for the stories concerning another person's guilt (Cohen's kappa = .78). They disagreed on only four protocols.

INSERT TABLE 4 ABOUT HERE

As shown in Table 5, obsessive patients who were prone to explain a story engaging a guilt tended to use a refutatory strategy, more than anxious patients (Fisher Yates exact test: $p < .05$, $\eta^2 = .04$), while, with the story describing another person's guilt, they tended to reason in a corroboratory way, as did the anxious patients (Fisher Yates exact test: $p > .5$).

INSERT TABLE 5 ABOUT HERE

5. Discussion

With our studies we have demonstrated that individuals affected by psychological disorders produce characteristic reasoning strategies that depend on the hyper-emotion elicited by a threat. In particular, in our first study we showed the ability of anxious patients and obsessive patients to recognize the refutatory and the corroboratory patterns of reasoning, respectively, as more similar to their own, regardless of the content of the inference. In the second study, we further demonstrated that obsessive patients spontaneously produce the refutatory pattern of reasoning, while the other anxious patients produce the corroboratory pattern, when thinking about topics that were condition-relevant. Finally, in accordance with hyper-emotion theory (Johnson-Laird et al. 2006), we showed that corroboratory reasoning was elicited by anxiety, while a refutatory form of reasoning stemmed from the (hyper-) guilt emotion (Experiment 3). The former result is in line with the wider literature showing that, in the face of exposure to a threat eliciting anxiety, individuals suffering from hypochondria or other anxiety disorders are inclined to focus on the danger and to search for examples confirming it (e.g. de Jong et al. 1998; Gilbert 1998).

The latter finding is significant because, as above anticipated, no other study has investigated either the refutatory form of reasoning or its origin in obsessive patients, except for Giele and colleagues' study (Giele, van den Hout, Engelhard, Dek, and Klein Hofmeijer, 2011). This obsessive-like step-by-step reasoning is the only one comparable to our refutatory pattern of reasoning. It is worth noting that both their and our study demonstrate that this form of reasoning leads to a paradoxical effect. The obsessive-like creation of small steps leading from an innocuous situation to a catastrophic consequence increases the feared outcome's plausibility, potentially maintaining the obsessive condition. Such reasoning begins with thoughts about the possible danger (Johnson-Laird et al. 2006), whereby patients try to defend against this possible danger and attempt to consider the situation in a comprehensive way. As a consequence, the obsessive patient begins to make a series of steps toward this self-created danger. However, this strategy has the ironic effect of strengthening the belief that the feared event will actually happen. Our findings appear to add to the growing list of studies showing that the effects of reasoning in psychological disorders run counter to the real intentions of patients: the safety strategies used by patients are counterproductive and lead to a decrease, instead of an increase, in confidence that there will be no negative outcome.

5.1 Limitations and Future Research

Our studies have several limitations. Although our aim was to investigate the reasoning strategies of patients affected by certain psychological disorders, a first limitation is that we did not have any healthy control group. Therefore future studies should investigate what style of reasoning do non-clinical individuals use or what style of reasoning, if any, they recognise as being their style.

A second limitation, again pertaining to all our studies, is that we did not include at least a clinical control group characterised by an emotion other than either anxiety or guilt—for example depressed people with sadness. Hyper-emotion theory (e.g. Johnson-Laird et al. 2006) predicts that depressed people's reasoning strategy is different from the two analysed in this paper. Such individuals pay particular attention to a person or situation assessed as being lost, and for this they feel intense sadness. Individuals attempt to infer the more positive conclusion that the loss is not permanent (positive hypothesis) and try to corroborate it. But the more they pay attention to the lost person or entity, the higher their standards for what would be acceptable for a substitute are set. As a consequence they infer that the loss is irreplaceable (falsifying the positive hypothesis) (see also Mancini & Gangemi, 2015). According to this, we could expect that depressed patients would recognize neither of our two reasoning strategies (corroboratory and refutatory) as similar to their own, and would reason in a different way. Future studies should thus investigate other styles of reasoning, in order to verify whether-and-how changing the emotion, changes also the reasoning strategy.

A third critique is pertinent to Experiment 3, specifically. Here, we used the same experimental procedure we had used in earlier experiments (see Johnson-Laird et al., 2006; Gangemi et al., 2013), where we asked participants to read stories whose contents were designed to elicit guilt in the protagonist. Sceptics may argue that how emotions explain reasoning in such an experiment is something of a mystery. However, hyper-emotion theory does propose an explanation. It states that emotions stimulated by the topic of the story (guilt of the protagonist vs. guilt regarding other persons) lead individuals to be motivated to reason in a way pertinent to their source, in order to reassure themselves about the damage. This effect together with the standard inferential ability yields the pattern of inferences in our experiment. However, future studies should further verify whether guilt actually elicits the refutatory strategy and anxiety elicits the corroboratory strategy in this study. For example, by assessing the level of both the emotions, before and after having read each story, with a manipulation check questionnaire.

5.2 Clinical implications

This study may have some clinical implications. In general, if hyper-emotion theory is correct, then in the psychological disorders there are transitions from normal life emotions to abnormal ones. Therefore the therapeutic goal should have as its focus the disengagement of these transitions and of patterns of inference that would otherwise boost the aberrant emotions. For example, it appears that, when patients acquire the ability to accept the possibility of being guilty, there is a decrease of obsessive symptoms, even when guilt acceptance is not related to the patient's symptomatic domain (Cosentino et al., 2012). Moreover, it is common for patients to experience a feared situation, quickly imagine a catastrophic outcome, and to be engaged in one of the two forms of reasoning. A sort of meta-cognitive intervention, focused on leading patients to become aware of the way they reason on the disorder-related threat could be very helpful. Explaining for example that the refutatory reasoning in the case of catastrophes feared by OCD subjects will be counterproductive may be actually effective.

Finally, in certain cases the steps leading from a neutral situation to a catastrophic outcome are not properly elaborated by the anxious or obsessive patient or may appear particularly implausible to the therapist. Therapists might in such cases attempt to test these catastrophic scenarios by asking how exactly the patient imagines that the particular transitions could take place (e.g., 'how exactly might HIV be transmitted from the door to the hat?'). Such therapeutic intervention may be risky, in the sense that it could foster the process that is examined in this paper: it may paradoxically increase the plausibility of the feared outcome.

6. Conclusions

In sum, patients develop characteristic strategies of reasoning that depend on the (hyper-) emotion elicited by the threat: anxious patients make corroboratory inferences, adducing only evidence that confirms the risk (*corroboratory strategy*), while obsessive patients make refutatory inferences, adducing counter-examples disconfirming the risk (*refutatory strategy*). There is a paradoxical effect of these reasoning strategies that contributes to the maintenance of psychological disorders, systematically leading to the confirmation of the dysfunctional beliefs that are central to these illnesses.

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Table 1. Percentages of refutatory and corroboratory vignettes that obsessional patients and anxious patients rated as more similar to their own reasoning (>3 on the Likert scale), in Experiment 1.

	Obsessive patients N=18	Anxious patients N=20
Refutatory versions (n=6)	98%	55%
Corroboratory Versions (n=6)	74%	95%

In review

Table 2. Two typical protocols describing problems relevant to the patients' illness, in Experiment 2. One from an obsessive patient using the refutatory strategy and one from an anxious patient using the corroboratory strategy. Comments in parentheses highlight the crucial cues to the strategy.

Obsessive patient	Anxious patient
<p>-I get off the bus and I touch someone. I physically feel that my hand, or rather my fist, punched him. I think I hit him on the head. I think he could be dead <i>(the patient focuses on his action, seeking to corroborate its negative consequences; he makes a transition to the emotion of guilt)</i>.</p> <p>I looked back, but the bus was already gone. I keep thinking about it... If I had hit him he would have at least reacted, he would have called for help, he would have beaten me <i>(he tries to infer counter-examples to the negative outcome of his having harmed the other person)</i>.</p> <p>Yes, but it all happened so fast. But people would have said something, they would have stopped me <i>(he searches again for counter-examples to the negative outcome)</i>.</p> <p>What if no-one noticed it until it was too late? <i>(He thinks again of a corroboration)</i></p>	<p>I am always thinking that I could die. I imagine dying <i>(individual focuses on a danger, which in patients leads to intense anxiety)</i>.</p> <p>Yesterday I remembered that my grandfather suffered from two heart attacks, and I often feel pain in my left arm <i>(he searches for evidence confirming his hypothesis)</i>.</p> <p>Moreover, last week I moved, and so I have also carried many heavy boxes. I was very tired and stressed. I felt tachycardia, and my heart beat so fast also when I was driving home <i>(he searches for further corroboratory evidence)</i>.</p> <p>I know that my doctor thinks I'm exaggerating, but I couldn't ignore what I felt. I kept thinking: it could be a real heart attack this time <i>(he continues to corroborate the hypothesis)</i>.</p>

Table 3. Frequencies of protocols reflecting a refutatory reasoning strategy and those reflecting a corroboratory reasoning strategy on a topic pertinent to the patients' obsessive or anxiety illness in Experiment 2.

	Relevant topics (n=22)		Not relevant topics (n=22)	
	Refutatory strategies	Corroboratory strategy	Refutatory strategies	Corroboratory strategy
OC patients (N=12)	10	2	1	11
Anxious patients (N=10)	1	9	0	10

In review

Table 4. Two typical protocols of the two sorts of reasoning from two representative obsessive patients, reasoning about the story eliciting guilt (refutatory strategy) and the story describing other's guilt (corroboratory strategy) in Experiment 3. Comments in parentheses highlight the crucial cues to the strategy.

Refutatory strategy for story eliciting protagonist's guilt	Corroboratory strategy for story describing other's guilt
<ul style="list-style-type: none"> - Surely it doesn't depend on that, but if I was cold it is. The mere fact that I sneezed made the air full of germs (<i>the participant corroborates the negative outcome</i>). - Maybe the window was open. Therefore, the germs could have gone out (<i>to refute the negative outcome</i>). - Nevertheless, they could have contaminated the kid; they could have been everywhere in the air (<i>to corroborate the negative outcome</i>). - Surely it was a coincidence. Maybe she already had a cold (<i>a refutation</i>). - But what if this is not the case? (<i>A corroboration</i>.) 	<p>The teacher had a cold and she sneezed. So, the probability that she contaminated my niece is very high (<i>the participant corroborates the negative outcome</i>).</p> <p>Moreover, she was playing with the kid (<i>a corroboration</i>).</p> <p>So, the air was contaminated. I cannot see how it could have not been contaminated, although they were in the playground (<i>a corroboration</i>).</p> <p>Moreover, they were so close (<i>a corroboration</i>).</p> <p>So, if my niece was ill, she was truly contaminated by the sneezes (<i>a corroboration</i>).</p>

Table 5. Frequencies of protocols reflecting a refutatory reasoning strategy and those reflecting a corroboratory strategy in obsessive and anxious patients trying to refute the outcome that the story's protagonist might be guilty., in Experiment 3.

	Story eliciting protagonist's guilt		Story describing other's guilt	
	Refutatory strategy	Corroboratory strategy	Refutatory strategy	Corroboratory strategy
Obsessive patients (N=13)	12	1	2	11
Anxious patients (N=11)	4	7	1	10

In review

Appendix

The vignettes used in Experiment 1, translated from Italian. They were formerly used by Johnson-Laird, Mancini and Gangemi (2006).

A1. A vignette in the refutatory form of reasoning of a person suffering from obsessive-compulsive disorder, with content concerning illness:

I'm afraid of the little pain that I'm feeling in my abdomen, on the same side as my liver. It could be a symptom of cancer, a liver cancer. I remember an uncle of mine who died from liver cancer after suffering a lot. But he was in his eighties and I'm thirty, and a liver cancer at my age is rare. On the other hand, it's not impossible. Moreover, I think I look unhealthy; my tongue is dirty; sometimes my mouth tastes bitter. I look pale, and I could have anaemia. Of course, these are common symptoms and they could be trivial. I have had them many other times. But they are there, and they are not incompatible with cancer. Moreover, they don't exclude it. My doctor prescribed several tests for me and the results were all negative. But, the results could be those of another person—sometimes laboratories mix up test-tubes, or the secretary makes a mistake writing the patient's name or puts one person's results in somebody else's folder. A mistake can always occur. The laboratory may be very professional, but there cannot be a one-hundred-percent guarantee that it didn't make a mistake. Moreover, I am the main person responsible for my own health. Imagine how I would feel if I really had cancer and left it too late. The best thing to do is to go back to my doctor.

A2. A vignette in the corroboratory form of reasoning of a person suffering from, e.g. hypochondria, with content concerning illness:

I'm afraid of the little pain that I'm feeling in my abdomen, on the same side as my liver. It could be a symptom of cancer, a liver cancer. I remember an uncle of mine who died from liver cancer after suffering a lot. In the beginning, his symptoms were the same as mine: he had a similar stomach ache. He didn't care, and the doctors told him that he wasn't ill. But meanwhile, the cancer was spreading. Now, in the same way, the cancer may be spreading in my abdomen. Indeed, my symptoms seem to have become worse during the last few weeks. Nobody believes me, and nobody takes me seriously. When they do start to treat me, it will be too late! Moreover, I think I look unhealthy; my tongue is dirty; sometimes my mouth tastes bitter. I look pale, and I could have anaemia. What a trauma it will be for me and my family when the cancer is correctly

diagnosed and it's too late! Afterwards, my life will be one of suffering, drugs, medical tests, checks and surgical operations. The best thing to do is to go back to my doctor.

B1. A vignette, in the refutatory form of reasoning, of a person suffering from obsessive-compulsive disorder (OCD), with content concerning contamination:

I touched a magazine with a close-up of Rock Hudson, a famous gay actor dying of AIDS, on the cover page and I may have caught AIDS. The photographer was near RH and the photo is a close-up. But AIDS is not contagious simply by being close; there has to be intimate contact. Yet, there may have been intimate contact, for all I know. The photographer could have been gay. In fact, it seems unlikely that there could have been any intimacy in a hospital ward with a seriously ill patient, but I wasn't there so how can I rule it out? They might simply have kissed, and no-one has ever been able to find out with complete certainty whether a kiss is dangerous. The photographer, being a professional, certainly developed the film and printed the photos himself and so may have contaminated them. Indeed, he may not have washed his hands after a sexual act or he may have had a cut on his hand that bled and actually contaminated the photos and the negatives. But even if he had contaminated the negatives and photos, viruses die! Yes, but some may have survived; I cannot be sure they were all killed and so some may have survived. The contamination may even have occurred when the photographer was taking the photos and negatives to the printers of the magazine. The photos and negatives were then received by a printer who may himself have contaminated them. This scenario seems absurd too, but you cannot actually be certain that the printer was not contaminated. If this was the case, then you cannot rule out the possibility that the printing press was contaminated, and that the printed copies of the magazine, and thus the copy I am holding too, was contaminated too. By touching it I may have been contaminated myself.

B2. A vignette in the corroboratory form of reasoning of a person suffering from, e.g. general anxiety disorder, with content concerning contamination:

I touched a magazine with a close-up photo on the cover page of Rock Hudson, a well-known gay actor who was dying of AIDS and I may have caught AIDS. The photographer was near RH and the photo is a close-up. As they were close together they may have touched each other, perhaps even in an intimate fashion; for instance, they may have kissed. The photographer could have been gay. He may have caught AIDS in this way. The photographer, being a professional, certainly developed the film and printed the photos himself and thus may have contaminated them.

Indeed, he may not have washed his hands after a sexual act or may have had a cut on his hand that bled and actually contaminated the photos and the negatives. The contamination may even have occurred when the photographer was taking the photos and negatives to the printers of the magazine. The photos and negatives must have been touched by the printers printing the magazine; and so the virus may have also contaminated the printers who certainly touched the photo, perhaps with dirty or injured hands, and then contaminated the printing press and the copies of the printed magazine including the copy I am holding. By touching it I may have been contaminated myself.

C1. A vignette in the refutatory form of reasoning of a person suffering from obsessive-compulsive disorder (OCD), with content concerning threat:

I've just left the house and the thought comes to me that I have left the gas on. I remember turning it off and checking it but I am not completely sure, and maybe I am getting confused with the check I made the other day. Perhaps I should go back and check. The gas might leak! I know there are safety valves but they are not 100% secure, and all you need is a tiny spark for everything to explode. It is true that I think I will be back in 20 minutes, but that could be long enough for an explosion. And if there is an explosion it might destroy the whole building as well as the neighbouring buildings, killing dozens of people! Of course, catastrophes are rare events but this one is possible. I'd better to go back and check.

C2. A vignette in the corroboratory form of reasoning of a person suffering from, e.g. general anxiety disorder, with content concerning threat:

I've just left the house and the thought comes to me that I have left the gas on, as has already happened to me once and as happened to the Foligno family whom I saw yesterday evening on the news. Nothing happened to me the other time, but their house blew up. The poor things ended up in a charity home! A month ago, the man came to check the meter and said that I should be very careful because for this particular period—I don't know for what technical reason—the gas company is delivering a particularly inflammable and odourless gas. And so the neighbours might not notice a possible leak. I'd better go back and check.

D1. A vignette in the refutatory form of reasoning of a person suffering from obsessive-compulsive disorder (OCD), with content concerning spiders:

I have to go down to the cellar but I am afraid of finding one of those big, hairy, poisonous and aggressive spiders. Spiders prefer damp cellars and one might prefer to hide under crates like the ones I have to move in order to look for some old documents that I need. However, I recall that spiders are not dangerous, although perhaps some South American species are. Yes, but we are not in the tropics; however, it is also possible that some inhabitants of the building might have kept some spiders as pets—perhaps the young fellow who is a steward and who may also travel to South America. He would keep them in a case and certainly not free in the house! But what if the case was broken, and a spider, one of those big, hairy, poisonous ones, escaped and the steward failed to catch it or was away travelling? And suppose that the spider has hidden in my cellar—perhaps right under the crates with my documents. I think I'd better not go down to the cellar.

D2. A vignette in the corroboratory form of reasoning of a person suffering from, e.g. a specific phobia, with content concerning spiders:

I have to go down to the cellar but I am afraid of finding one of those big, hairy, poisonous and aggressive spiders. I have read that spiders prefer damp cellars, where they hide under crates, just like the ones I have to move in order to find some old documents that I need. How awful! I would certainly be petrified with fear. Above all, I would be alone and there would be no-one to help me as the spider came nearer. Moreover, on the first floor there is a shop that sells aquaria, tropical fish, reptiles and insects of the most exotic, large, and odd variety. A month ago, when I leant out to ask about the condominium meeting, I remember there was a glass case with a horrible big hairy spider from South America, just like the one I saw later in an encyclopaedia that said it was poisonous. Now that I think of it, I heard the doorman say a few weeks ago that the new Philippine shop assistant had broken some glass cases containing insects, which then escaped. Just think if one of them was under the crates! Perhaps I'd better forget about going down into the cellar.

E1. A vignette in the refutatory form of reasoning of a person suffering from obsessive-compulsive disorder (OCD), with content concerning threat:

There are a lot of Arabs in town, many of whom are young and always have scowling expressions on their faces that I would describe as resentful. But there could be a thousand reasons why they have those expressions. Yes, but among those various reasons could be a hatred of the West. There might also be terrorists among them. It is true that there is police surveillance, but I read in the paper that terrorists are sometimes 'sleepers' for years, and so escape police attention completely. It is not inevitable that an attack will be carried out near my son's school. Yes, but

the school my son goes to is near a very busy shopping mall, an ideal place for an attack—hard to keep under surveillance and packed with people. And my son has to go past it to get to school. Yes, these are very general reasons for concern; but on the other hand, the fact that they're general doesn't mean that they are not real. The other day I was passing by there, and now that I think of it I got the impression that there were some Arabs nearby in a van. They may have been Italians, but I cannot rule out that they were Arabs. I think I've seen that same van in the neighbourhood two or three other times. Perhaps they simply work around there; yes, but they might also have been doing reconnaissance before an attack. It is a fact that to plan an attack it is necessary to carry out numerous inspections. How could I possibly rule this attack out? The van didn't seem to be solid enough to transport many explosives. However, it did closely resemble the one that the TV reporter said had been used in an attack. Yet, goodness knows how many vans of this kind there are. But, why couldn't it have just been that one? Of course, there'd be a tremendous explosion because there'd be a huge quantity of explosives. My son would be blown to pieces like all those poor children I saw on TV.

E2. A vignette in the corroboratory form of reasoning of a person suffering from, e.g. general anxiety disorder, with content concerning threat:

There are a lot of Arabs in town, many of whom are young and always have scowling expressions on their faces that I would describe as resentful. There might be terrorists among them; among other things, I read in the paper the other day that terrorists can sometimes be 'sleepers' for years, and so escape police attention completely. Then, the school my son goes to is near a very busy shopping mall, an ideal place for an attack—hard to keep under surveillance and packed with people. And my son has to go past it to get to school. The other day I was passing by there and, now that I think of it, I got the impression that there were some Arabs nearby in a van. Then, I think I later saw the same van in the neighbourhood another two or three times. It may have been doing reconnaissance before an attack. They may use the van to transport explosives. It did closely resemble the one that the TV reporter said had been used in an attack. There'd be a tremendous explosion because there'd be a huge quantity of explosives. My son would be blown to pieces like all those poor children I saw on TV.

F1. A vignette in the refutatory form of reasoning of a person suffering from obsessive-compulsive disorder (OCD), with content concerning mickey-taking (persecution)

And if my students take the mickey out of me? Of course, I cannot prove it as they could make fun of me behind my back without me seeing them. But, why would they waste their time on me? Yes, but it is a fact that students are cruel to teachers and like to have fun at their expense. I remember that when I was at high school there was a teacher, probably gay, and my friends and I had fun at his expense for years. And I remember how my friends made fun of him as soon as his back was turned. Yes, but I would have noticed! In actual fact, however, last week I saw a little group laughing amongst themselves as I came into the lecture room. But they may have been laughing over something else, possibly a joke. Yet, I cannot be sure, and indeed what grounds do I have for ruling out this possibility? Perhaps they were not making fun of me on that occasion, but they could have done it without me realising it when I was preoccupied or thinking of something else. Perhaps I simply cannot remember properly.

F2. A vignette in the corroboratory form of reasoning of a person suffering from, e.g. paranoia, with content concerning mickey-taking (or persecution):

As soon as I entered the lecture room I saw the students chatting together and among their almost imperceptible words I caught the word 'queer'. They were taking the mickey out of me. Did you see how they were sniggering yesterday at the lecture and in the corridors as I was going past? Then the other day one of them was sitting in the first row right in front of me; I was about to start the lecture and he addressed the student next to him in an effeminate tone of voice. He was clearly referring to me. It is a known fact that students are cruel to teachers and like to have fun at their expense. I remember that when I was at high school there was a teacher, probably gay, and my friends and I had fun at his expense for years. And I remember how my friends made fun of him as soon as his back was turned. Of course they are taking the mickey out of me!