

Reduced Risk-Taking Behavior as a Trait Feature of Anxiety

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Affect can have a significant influence on decision-making processes and subsequent choice. One particularly relevant type of negative affect is anxiety, which serves to enhance responses to threatening stimuli or situations. In its exaggerated form, it can lead to psychiatric disorders, with detrimental consequences for quality of life, including the ability to make choices. This study investigated, for the first time, how pathological anxiety affects risk-taking behavior. In this study, 20 anxious participants meeting *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*, criteria for either generalized anxiety disorder ($n = 10$) and for panic attack disorder ($n = 10$), as well as 20 matched nonanxious controls, performed a gambling task. To investigate the tendency toward either a risk-seeking or a risk-averse behavior, we employed a task that did not allow for learning from outcomes. Anxious participants made significantly fewer risky choices than matched nonanxious participants. Specifically, they become risk-avoidant after gains. Moreover, anxious participants not only were less happy after gains but were also less sad after losses, and they also evinced less desire to change their choices after losses than did nonanxious participants. Importantly, whereas the desire to switch choice was followed by actual choice switch for all participants, happiness directly predicted subsequent risky choices, particularly in the nonanxious participants. Further analyses revealed that the anxious participants' risk-avoidance behavior was independent of different types of anxiety disorder (panic attack disorder and generalized anxiety disorder) as well as of the effects of psychotropic drugs treatment. This study demonstrates a specific role for anxiety in individual decision making. In particular, hypersensitivity to potential threats and pessimistic evaluation of future events reduced risk-taking behavior.

Keywords: anxiety, decision making, risk-taking behavior, threat-avoidance behavior, feedback sensitivity

Research in neuroscience and psychological science has demonstrated that affective states influence choices in important ways (e.g., Dolan, 2002; Damasio, 1994). Variation in personality traits or in psychopathological conditions can lead to individual differences in emotional reactivity, with direct results on decision making (e.g., Wischniewski, Windmann, Juckel, & Brüne, 2009). One

important and pervasive type of negative affect is anxiety, which is aimed at enhancing responses to threatening stimuli or situations in order to cope with them (e.g., Clark, 1999). When anxiety is experienced at a moderate level, it can help improve one's performance; however, in its exaggerated form, it manifests as a psychiatric disorder with detrimental consequences for quality of life (de

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Visser et al., 2010). This can have important implications for decision making. Abnormality in decision-making and, in particular, in risk-taking behavior have been observed across several psychiatric disorders (e.g., Rahman, Sahakian, Hodges, Rogers, & Robbins, 1999), with, for example, substance-dependent patients more likely to select risky alternatives (Bechara, 2003). In general, understanding anxious patients' risk-taking behavior can help highlight how this psychiatric population makes decisions, and can also provide insights for standard models of decision making.

Risky Decision Making and Anxiety

Though areas of the brain known to be involved in decision making, such as amygdala, ventromedial prefrontal cortex, anterior cingulate cortex, and insula, also play a major role in anxiety (e.g., Brambilla, Barale, Caverzasi, & Soares, 2002; Etkin & Wager, 2007), the relationship between anxiety and decision making has only recently received attention. Several of these studies used self-report measures of risk perception (e.g., Maner & Schmidt, 2006; Maner et al., 2007; Mitte, 2007), and highlighted that exaggerated anxiety is associated with avoidance of risky decisions and pessimistic risk appraisals. However, few of these studies have been conducted in a laboratory environment. In some of these efforts, researchers used the well-known Iowa Gambling Task (IGT) and showed that individuals with high trait anxiety perform poorly in decision-making tasks (e.g., Miu, Heilman, & Houser, 2008; de Visser et al., 2010). According to these researchers, this was due to a selective attention impairment: individuals with high anxiety traits focus more on the rewards themselves than on particular cues that point to a globally advantageous or disadvantageous choice. In a recent study employing different versions of the IGT, undergraduate students with high scores in a generalized anxiety disorder (GAD) questionnaire actually performed better than those with lower scores, learning more rapidly to avoid decisions with a probability of larger losses, thus suggesting that anxiety is related to enhanced future-oriented processing of cues that may signal punishment and/or reward (Mueller, Nguyen, Ray, & Borkovec, 2010). However, and most important, in all of these behavioral studies, researchers did not use actual clinical populations, but rather individuals with high anxiety traits. Although these populations may provide valuable clues about the performance of those with clinically diagnosed conditions, it is still unclear exactly what the relationship is between high trait anxiety and psychopathological conditions. Several studies have found differences between nonclinical and clinical participants using a Stroop paradigm (see Williams, Mathews, & MacLeod, 1996, for a review). Also, the threshold between what is and is not threatening is associated with vulnerability to anxiety, with extreme levels for anxious patients (Mathews & MacLeod, 2002). Differences between individuals with high trait anxiety and patients with anxiety disorder have been also found to be brain-related. Whereas anxious apprehension seems to be a function of left frontal regions, pathological anxiety seems to be related to chronic right hemisphere overactivity, in particular, the frontal and parietotemporal regions. This appears to alter affective style, characterized by lowered thresholds for avoidance behavior and negative affect, as well as the cognitive biases involved in the maintenance of fear (e.g., de Jong, Merckelbach, Bögels, & Kindt, 1998; Davidson, 1998; Heller, Nitschke, Etienne, & Miller, 1997). Taken together,

this suggests that it is relevant to test a real clinical population with anxiety disorder, because that population differs from the less extreme traits of anxiety found in the normal population. Because, to our knowledge, no studies in the laboratory setting have used patients with diagnosed anxiety disorders in order to understand how anxiety affects risk-taking behaviors, the present study used a diagnosed clinical population to investigate it.

Based on known psychological and physiological dysfunction in anxiety disorder, we can hypothesize about the performance of this population on risk-taking tasks. Anxiety induces physiological responses, such as increased heartbeat, sweating, muscular tension, and shortness of breath, and it also activates typical behavioral and cognitive patterns (e.g., Ackerl, Atzmüller, & Grammer, 2002). In particular, anxiety leads to cognitive dysfunction due to altered processing of environmental information resulting in attentional, memory, and interpretative biases toward negative stimuli (e.g., Bishop, Duncan, Brett, & Lawrence, 2004; Barlow, 2002), as well as directly affecting cognition by potentially heightening the perception of a possible threat (Williams, Kinney, Harap, & Liebmann, 1997; Maner & Schmidt, 2006). Several studies have highlighted attentional biases for threat in anxious individuals, by using tasks, such as the Probe task (e.g., Mogg & Bradley, 2002; Mogg, Philippot, & Bradley, 2004) or the Stroop task (e.g., McNally et al., 1994). Selective attention to threat heightens anxiety, impairing performance, and it may also be involved in the maintenance of pathological anxiety (e.g., Clark, 2001; Clark & Wells, 1995; Rapee & Heimberg, 1997). Therefore, we hypothesized that anxiety patients would show risk-avoidance behavior, for several reasons.

First, threat and negative affective states (e.g., anxiety) elicit both specific physiological (e.g., increase in cortisol system activity) and cognitive (e.g., avoidant behaviors) responses. Contexts that are threatening, with the potential for loss, and negative affective states are most likely to activate a cortisol response (Blascovich & Tomaka, 1996; Dienstbier, 1989). The cortisol system is also activated under conditions in which central goals, such loss avoidance, are threatened (Blascovich & Tomaka, 1996; Carver & Scheier, 1999; Dienstbier, 1989; Lazarus & Folkman, 1984) and the process for attaining this goal is uncontrollable (Dickerson & Kemeny, 2004). These mechanisms therefore predict risk-avoidance behavior in anxious patients. Moreover, anxiety leads to pessimistic evaluations of future events (Savitsky, Medvec, Charlton, & Gilovich, 1998; Shepperd, Grace, Cole, & Klein, 2005) and higher perception of negative outcomes (e.g., Maner & Schmidt, 2006), both of which can be reduced by choosing safer options. Indeed, anxious individual pay particular attention to threat-relevant information or stimuli (e.g., Mathews & MacLeod, 1985, 1986; Mogg, Millar, & Bradley, 2000). In contrast to nonanxious individuals, anxious individuals consistently show an attentional bias to threat (e.g., MacLeod & Mathews, 1988; Mogg & Bradley, 2005; Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007), also showing greater negative emotion when faced with such threatening stimuli (MacLeod, Rutherford, Campbell, Ebsworth, & Holker, 2002). In turn, these attentional biases toward threat-relevant information contributes to the maintenance of the anxiety symptoms experienced in anxious individuals (Amir, Weber, Beard, Bomyea, & Taylor, 2008; Amir, Beard, Burns, & Bomyea, 2009). As a consequence, these attentional biases contribute to the vicious cycle:

the increase in negative emotions makes threatening stimuli more salient, heightening the evaluation of the probability of harm, with the subsequent further increase of negative emotional states (Williams et al., 1996). This is what happens, for example, in patients with panic disorder: the increase of normal bodily sensations is evaluated with the heightened possibility of real danger, such as a death or collapse, which increases anxiety and, as a consequence, the attentional bias toward these bodily sensations themselves (Clark, 1988). An analogous vicious cycle happens in people with generalized anxiety disorder (GAD), though here focused on general worries.

Because the source of the threat varies across different types of anxiety disorders (see Chambless & Hope, 1996, for a review), to further test the association between threat avoidance and risk-avoidance behavior, we used two clinical populations: one with GAD and one with panic attack disorder (PAD). Patients with GAD are characterized by anticipation of possible failures, avoiding worry-inducing situations in order to avoid negative future outcomes (Wells, 1999). They show exaggerated processing of uncertain or probabilistic negative events that occur in the future (Borkovec, Alcaine, & Behar, 2004; Dugas, Gagnon, Ladouceur, & Freeston, 1998; Wells, 1999). Patients with PAD are characterized by thoughts about physical and mental catastrophe (Clark, 1989). They interpret ambiguous information coming from both external and internal environments as threatening (Clark, 1988; Beck, 1988), and as a consequence actively avoid potentially dangerous situations.

Despite the cognitive specificity of anxiety disorders, in a risky choice domain these two clinical populations should show less risk-seeking behavior than nonanxious participants due to their excessive worry about negative consequences (GAD) and due to their need to avoid potentially dangerous situations (PAD). Finally, we also controlled for the effect of pharmacological treatment in the relationship between pathological anxiety and decision making by exploring differences between on- and off-drug patients.

The Current Study

The goal of the present study was therefore to build on the aforementioned findings by exploring the actual risk-taking behavior of patients with diagnosed anxiety disorders. We investigated this question by using well-characterized tasks previously developed in the field of decision science (e.g., Gehring & Willoughby, 2002; Yeung & Sanfey, 2004; Ponzetti et al., 2010) that measure risk taking. With this aim, we did not use a task with an objectively more advantageous or disadvantageous strategy (e.g., the IGT), but rather employed a “risky choice” paradigm, where participants had to choose between two gambles, each of which had the same probability of win or loss: one had smaller associated wins and losses (safe option) and one had larger associated wins and losses (risky option). Both options were uncertain, and therefore threatening, although this varied due to the size of the associated outcomes. Risk taking is defined as the propensity to select an option with the potential for a relatively large gain, if the outcome is positive, or large loss, if the outcome is negative, over an alternative option with the potential for a relatively small gain or loss (Slovic, 1987; Mellers, Schwartz, Ho, & Ritov, 1997). We also explored whether, and how, the emotional reactions and

cognitive thoughts related to decision making and to the obtained outcomes would differ between clinical and control populations. We expected that this study would help not only in understanding risk-taking differences between anxious and nonanxious participants, but would also examine whether patients’ behavior can be attributed to either differential valuations (e.g., sensitivities to losses and gains), to differential weighting and perception of risk (e.g., risk could be seen as a threatening stimulus for patients, and therefore losses expected more than gains), or to another factor.

Method

Participants

Twenty outpatients with anxiety disorder, either GAD ($n = 10$) or PAD ($n = 10$), who met *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; American Psychiatric Association, 2000)*, criteria, were recruited from the Psychiatric Clinic of the University Hospital of Udine, Italy, as diagnosed with the Structured Clinical Interview for Axis I *DSM-IV* disorders (First, Spitzer, Gibbon, & Williams, 1994) and with the Hamilton Rating Scale for Anxiety (Hamilton, 1967). Diagnoses were confirmed by the clinical consensus of two staff psychiatrists. Twelve anxious participants were receiving regular antidepressant treatment at the time of the study (see Table 1 for details) and the remaining 8 anxious participants were drug-free. Patients with comorbid Axis I disorders, including current major depressive episodes, alcohol or substance abuse, history of traumatic head injury with loss of consciousness, and neurological or medical illnesses were excluded. Matched nonanxious participants without a history of either psychiatric or neurological symptoms were recruited to act as controls (see Table 2 for details). Positive Affect Negative Affect Scales (PANAS; Watson, Clark, & Tellegen, 1988) were administered to all participants. This study was approved by the local biomedical ethics committee, and written informed consent was obtained from all participants.

Experimental Procedures

Task. We used a gambling task that required participants to choose between a *safe* and a *risky* option. This task was modified from previous tasks (e.g., Mellers et al., 1997; Gehring & Willoughby, 2002; Yeung & Sanfey, 2004). To begin, participants were seated comfortably in front of a computer screen.

On each experimental trial (see Figure 1 for an example), participants first saw a fixation point that lasted for 500 ms, and then were presented with two gambles displayed on either side of the screen. Participants were asked to choose one option. In one of the choices, they could win more but also lose more (the risky option); in the other, they could win, but also lose, less (the safe option). For both gambles, the probability of winning and losing was the same ($p = .5$). The pair of gambles remained on the screen until the participant selected one of them by pressing the C or N keys on the keyboard with either their left or their right index finger (C for the alternative on the left and N for the one on the right). After their response, a fixation point was again presented for 500 ms. Then, the chosen gamble was presented in the center of the screen. If its arrow stopped on the white side of the gamble, this indicated a win; if the arrow stopped on its gray side, this

Table 1
Psychotropic Drug Treatment

Anxious participants	Diagnosis	Type	Drugs	Dosage
1	GAD	SSRI	Escitalopram (Cipralex)	20 mg/day
2	PAD	SSRI	Sertraline (Zoloft)	25 mg/day
3	GAD	SNRI	Venlafaxine (Efexor)	75 mg/day
4	GAD	SNRI	Venlafaxine (Efexor)	37.5 mg/day
5	GAD	SSRI	Citalopram (Elopram)	10 mg/day
6	PAD	SSRI	Sertraline (Zoloft)	50 mg/day
7	PAD	SNRI	Duloxetine (Cymbalta)	120 mg/day
8	GAD	SSRI	Sertraline (Zoloft)	100 mg/day
9	PAD	SSRI/anxiolytic	Paroxetine + alprazolam (Xanax)	20 mg/day + 0.5 mg \times 3/day
10	PAD	SSRI	Citalopram (Elopram)	24 mg/day
11	PAD	Anxiolytic	Alprazolam (Xanax)	0.25 mg \times 1-2/day
12	PAD	SSRI	Sertraline (Zoloft)	50 mg/day

Note. GAD = generalized anxiety disorder; PAD = panic attack disorder; SSRI = selective inhibitor of serotonin.

indicated a loss. Additionally, a label saying either “You win!” or “You lose!” in green or red ink, respectively, appeared above the gamble. After participants observed the outcome, they pressed a button to move on with the task. They were then asked to answer an “emotion” rating and a “choice” rating, which measured both intensity and valence (Camille et al., 2004; Chua, Gonzalez, Taylor, Welsh, & Liberzon, 2009). In the “emotion” rating, they indicated how they felt about the outcome on a 9-point scale, ranging from 1 (*sad*) to 9 (*happy*). In the “choice” rating, they indicated their desire to have changed their choice on a 9-point scale, ranging from 1 (*definitely yes*) to 9 (*not at all*).

Following Gehring and Willoughby (2002), the risky option was the one with the larger outcomes and the safe option was the one with smaller outcomes. We used two different sets of gambles: choosing between a gain or a loss of 5 points (the safe option) and a gain or loss of 25 points (the risky option); choosing between a gain of 10 points or a loss of 5 points (the safe option) and a gain of 25 points or a loss of 20 points (the risky option). To make the task as straightforward as possible, we fixed the probabilities of winning or losing in the gambles (each at $p = .5$). Thus, the expected value (EV) of both options in each pair was always equal, and were, respectively, zero for the first set of gambles and + 2.5 for the second set. This task is in line with previous “decision under risk” experiments (see Yeung & Sanfey, 2004).

The gamble outcome in each trial was determined pseudo-randomly, with the overall constraint that each participant experienced an equal number of wins and losses. The number of small or large outcomes depended on the participants’ safe or risky choices and thus was not controlled. Participants were not told about these experimental contingencies; they were simply instructed to earn as many points as possible. Because the probability of receiving a positive or a negative outcome was equal in any given trial, it was not possible for the player to devise any helpful strategy to win in the game. Thus, in contrast to other gambling games like the IGT (Bechara, 2004), participants could perform the task multiple times without learning any meaningful strategy. To ensure the ecological validity of the task and to enhance motivation, participants were informed that they would be paid according to what they won in 10 trials, which were randomly selected by the computer at the end of the experiment. This random selection of 10 trials was introduced to ensure subjects treated all trials as having an equal impact on their financial gain. There were 32 trials in total, divided into two equal blocks ($EV = 0$; $EV = 2.5$), counterbalanced across participants. Stimulus presentation and data acquisition were controlled using E-prime software package (Psychology Software Tools Inc.), running on a computer using Windows. Instructions were presented in written form, and the entire experiment lasted about 40 min.

Table 2
Demographic and Clinical Assessment

Variables	Anxious participants	Nonanxious participants	<i>p</i>
Number	20	20	—
Age (years)	$M = 41.25$ ($SD = 14.07$)	$M = 41.7$ ($SD = 9.36$)	.9
Education (years)	$M = 12.6$ ($SD = 3.87$)	$M = 13.2$ ($SD = 3.07$)	.6
Sex	16 women, 4 men	16 women, 4 men	—
Ethnicity	All White	All White	—
Handedness	18 right, 1 left, 1 ambidextrous	18 right, 1 left, 1 ambidextrous	—
Diagnosis (<i>DSM-IV</i>)	12 GAD, 8 PAD	—	—
Psychotropic treatment	12 on psychotropic drug treatment	—	—
HARS score	$M = 15.33$ ($SD = 8.88$)	—	—
PANAS score (Negative Affect Scale)	$M = 23.3$ ($SD = 9.08$)	$M = 17.1$ ($SD = 4.48$)	.01
PANAS score (Positive Affect Scale)	$M = 30.28$ ($SD = 5.58$)	$M = 32.65$ ($SD = 6.4$)	.23

Note. Value in bold is significant. *DSM-IV* = *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*; GAD = generalized anxiety disorder; PAD = panic attack disorder; HARS = Hamilton Rating Scale for Anxiety; PANAS = Positive Affect Negative Affect Scales.

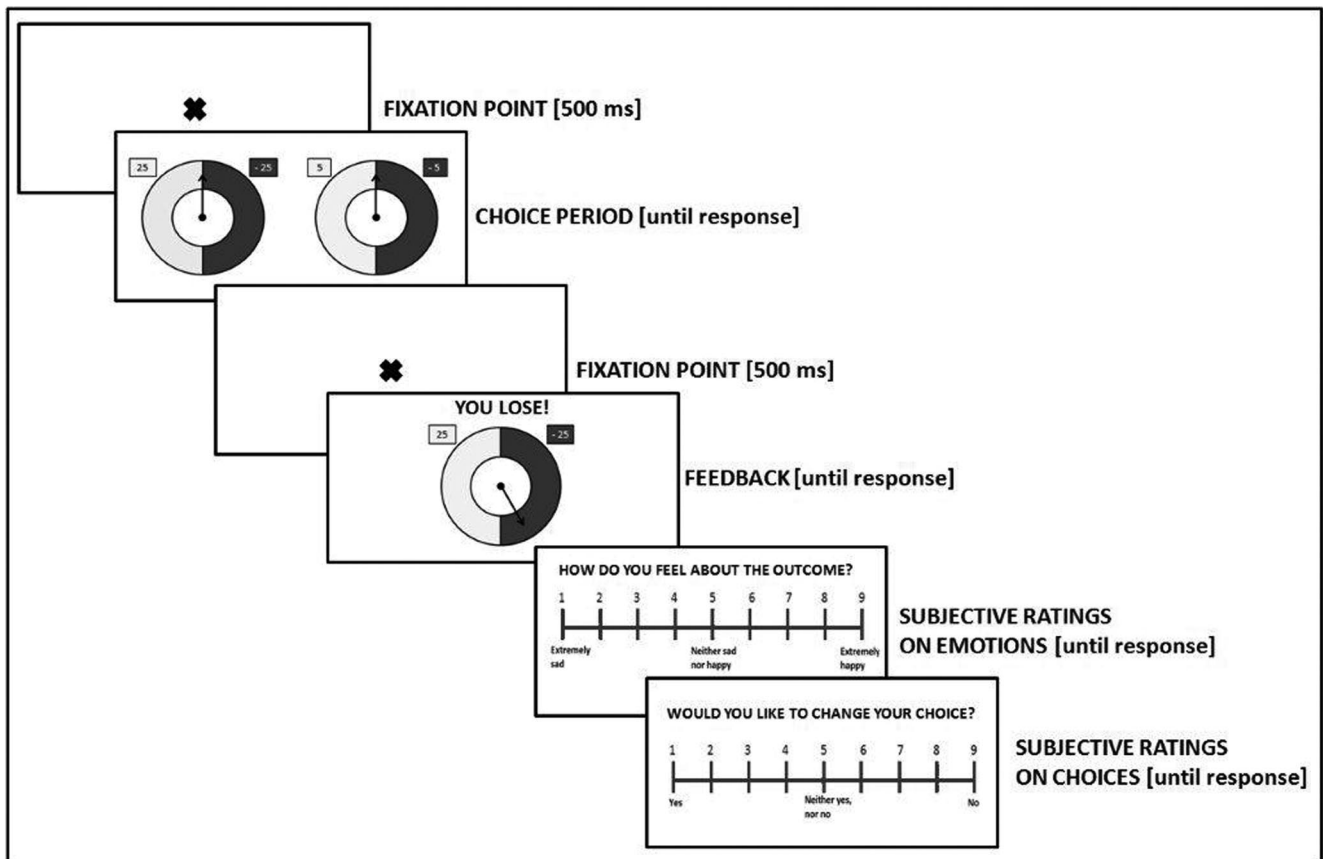


Figure 1. One example of the gambling task. Participants had to choose between a safe (± 5 points) and a risky (± 25 points) gamble. They chose the risky gamble and received a loss. After that, they were asked to answer two questions on how they felt about the outcome and on their desire to change the choice made.

Results

Affective States

The Negative Affect Scale of the PANAS questionnaire (Watson et al., 1988) was significantly higher, $t(38) = 2.73$, $p < .01$, Cohen's $d = .97$, for nonanxious participants ($M = 17.1$) than for anxious participants ($M = 23.3$). Interestingly, nonanxious participants were below, and anxious participants above, the mean of the Italian population ($M = 20.9$; Terracciano, McCrae, & Costa, 2003). Because this scale correlates strongly with neuroticism and anxiety (Clark & Watson, 1991; Terracciano et al., 2003), our results further confirm the absence of anxiety symptoms in non-anxious participants. No differences were found in the Positive Affect Scale ($p > .05$), which usually correlates with depression. See Table 2 for details.

Decisions Under Risky Choice

Because the task consisted of a series of choices over time, to test for possible autocorrelation, which can lead to incorrect computation of standard errors, the Durbin–Watson (DW) test was conducted. We first tested for autocorrelation for each choice (safe vs. risky) with the subsequent choice (safe vs. risky), and then with

the group (anxious vs. nonanxious), with different expected values (zero vs. positive), and with the choice outcome (win vs. loss). No significant autocorrelation was found when considering only choices ($DW = 2.029$), when also considering the group ($DW = 2.016$), when we added the expected value ($DW = 2.014$), or when we added the outcome ($DW = 2.021$). Therefore, this lack of autocorrelation permitted us to perform standard analyses on all the data.

To assess whether there was a difference in risk-taking behavior between anxious and nonanxious participants, and between the two different expected values used in the task, the mean percentage of risky choices for each participant was determined (Figure 2a). Results from the analysis of variance (ANOVA), with risky choices as dependent variable and expected value (zero vs. positive) and group (nonanxious participants vs. anxious participants) as independent variables, showed a main effect only of group: nonanxious participants made an higher number of risky choices than anxious participants, $F(1, 38) = 9.01$, $p < .005$, partial $\eta^2 = .2$. No significant effect for the expected value conditions, $F(1, 38) = 1.09$, $p = .3$, partial $\eta^2 = .03$, and no interaction effect between group and expected value conditions, $F(1, 38) = 1.54$, $p = .2$, partial $\eta^2 = .04$, were found. Therefore, hereinafter, we will not take into consideration the expected value as a factor in the analyses.

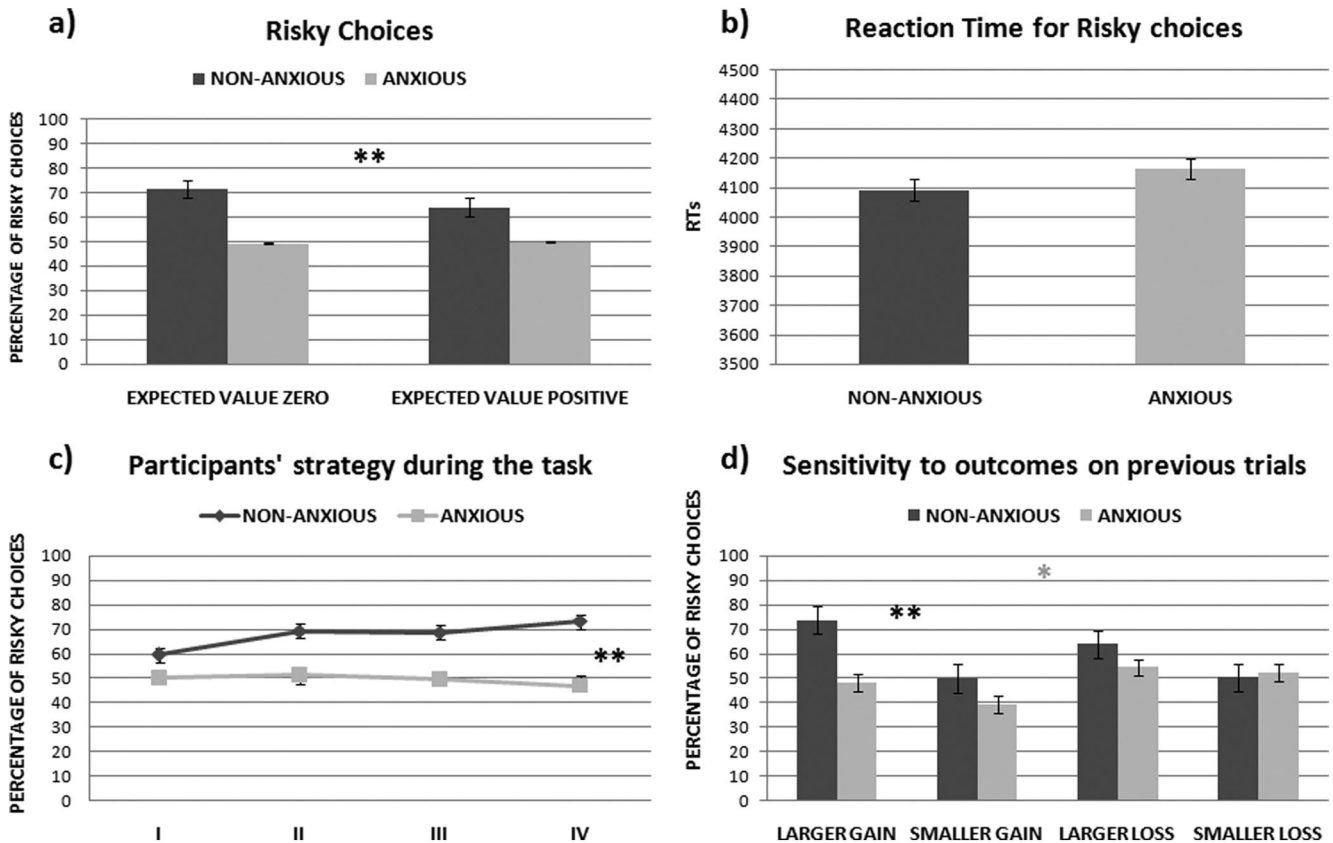


Figure 2. Decision under risk. Data represent the percentage of risky choices made by both groups in the whole task (a) and the average of the reaction time (RT) spent to make these choices (b). Panels c and d represent, respectively, the percentage of risky choices made during the task, as divided into four consecutive blocks of eight trials each, and the effect of the preceding feedback on the risky behavior. * $p < .05$. ** $p < .005$. The black asterisk means that the effects reported are for both anxious and nonanxious participants. The light gray asterisk means that the effect reported is only for anxious participants (bar also in light gray).

Then, the average reaction time (RT) for participant decisions between groups was tested (see Figure 2b). Data were analyzed using an independent-sample t test, with participants' average RT as the dependent variable and the two groups as the grouping variable. The average time taken to make risky choices did not differ significantly, $t(38) = 0.12$, $p = .91$, $d = .04$, between nonanxious and anxious participants.

To investigate whether the choice behaviors differed between the two groups over time, we divided the 32 trials into four blocks of eight trials each (see Figure 2c). We performed a mixed ANOVA on risky choices, with the four blocks as a within factor and group (nonanxious vs. anxious participants) as a between factor. Interestingly, we found only a main effect of group, $F(1, 38) = 9.01$, $p < .005$, partial $\eta^2 = .2$, showing that nonanxious participants made an higher number of risky choices than anxious participants across the whole duration of the task. No effect of blocks, $F(3, 114) = .76$, $p = .52$, partial $\eta^2 = .02$, or of an interaction between blocks and group, $F(3, 114) = 1.34$, $p = .26$, partial $\eta^2 = .03$, was found.

With the aim of investigating whether participants were differentially sensitive to the choice outcome, we compared the risky choices that followed smaller and larger losses to those that followed smaller

and larger gains, in both groups. Importantly, participants' choices indicated that they were sensitive to the outcome of their gambles (see Figure 2d). To show this, we performed a mixed ANOVA on risky choices, with outcome (losses vs. gains) and previous choices (safe vs. risky) as within factors and group (nonanxious vs. anxious participants) as a between factor. Results showed a significant interaction between outcome and group, $F(1, 38) = 6.51$, $p < .01$, partial $\eta^2 = .15$. In particular, post hoc analyses (Duncan test) showed that non-anxious participants chose the risky option more often than anxious participants when they had previously received a gain ($p < .005$). No differences ($p > .05$) between the two groups were found in choice patterns after obtaining a loss. Moreover, we also performed two separate ANOVAs for each of the two groups with outcome (losses vs. gains) and previous choices (safe vs. risky) as factors. Results showed that anxious, but not nonanxious, participants became more risk-avoidant after gains ($M = 43.72$, $SD = 24.22$) than after losses ($M = 53.32$, $SD = 23.56$), $F(1, 19) = 5.73$, $p < .05$, partial $\eta^2 = .23$.

Subjective Ratings on Emotions and Choices

With the aim to verify whether and how anxious and nonanxious participants differed on their emotional experience and desire to

change the choice made, we performed two mixed ANOVAs on the “emotion” and “choice” ratings, respectively, with outcome (losses vs. gains) and choice (safe vs. risky) as within factors, and group (anxious vs. nonanxious participants) as a between factor. Figures 3a and 3b illustrate the results from the “emotion” and “choice” ratings, respectively, in both groups.

Both sets of ratings showed an interaction effect between outcome and group, $F(1, 38) = 16.59, p < .001$, partial $\eta^2 = .3$, for “emotion” rating and, $F(1, 38) = 4.8, p < .05$, partial $\eta^2 = .11$, for “choice” rating. Post hoc analyses (Duncan test) showed that both anxious and nonanxious participants were sadder after a loss than after a gain ($p < .001$), and that both wanted to change their choices more after a loss than after a gain ($p < .001$). Interestingly, anxious participants were less sad than nonanxious participants when they lost ($p < .001$), less happy when they won ($p < .05$), and also wanted to change the choice less after a loss ($p < .001$).

Moreover, both rating scales showed an interaction effect between choices and group, $F(1, 38) = 5.3, p < .05$, partial $\eta^2 = .12$, for “emotion” rating and, $F(1, 38) = 4.55, p < .05$, partial $\eta^2 = .11$, for “choice” rating. Post hoc analyses (Duncan test) showed that only nonanxious participants were sadder after having chosen

a safe as opposed to a risky option ($p < .01$), and that they wanted to change their choice when it was the safe option ($p < .02$).

Role of Emotion and Choice Ratings on Subsequent Risky Decisions

To examine the relationship between participants’ emotions, choice ratings, and subsequent risky decisions, we also performed several panel logit regression analyses, where subsequent choice ($t + 1$) (safe vs. risky) was the dependent variable.

In the choice rating analyses, the desire to change choice and the actual choice itself (t) were the independent variables. Results showed a main effect of choice ($\beta = .882, p < .001$) and, interestingly, an interaction effect between choice made and choice valuation ($\beta = 1.29, p < .05$), meaning that participants switched choices when they indicated a strong desire to do so. No significant effects ($p > .05$) were found when adding group as an independent variable. Therefore, the choice evaluation affected the subsequent choice, independent of group.

When considering the emotion itself, results showed that higher emotional ratings affected risky choices. That is, when participants were happier, they made a higher number of risky choices than when they were sadder ($\beta = .778, p < .01$). Subsequent analysis, including group as an independent variable, showed that this was particularly true for nonanxious group ($\beta = 2.24, p < .001$). Therefore, happiness directly predicted subsequent risky choices, particularly in the nonanxious participants.

Additional Analyses: Differences in GAD and PAD Populations and Treatment

We also performed a one-way ANOVA with the percentage of risky choices as dependent variable and groups (GAD vs. PAD vs. nonanxious participants) as independent variable (between-subjects factor), to test whether there were differences in the two clinical populations. Results showed an effect of groups, $F(2, 37) = 4.5, p < .018$, partial $\eta^2 = .2$. Post hoc analyses (Duncan test) showed that nonanxious participants ($M = 67.66, SD = 20.6$) made a significantly higher number of risky choices than subjects with PAD ($M = 45.83, SD = 15.78$) ($p < .05$) and GAD ($M = 51.25, SD = 20.42$) ($p < .05$). No differences between PAD and GAD were found ($p = .64$).

To determine whether there were differences in risk-taking behavior between anxious participants with and without pharmacological treatments, we conducted a one-way ANOVA with the percentage of risky choices as dependent variable and groups (on drug vs. off drug vs. nonanxious participants) as the independent variable (between-subjects factor). Results showed a significant effect of groups, $F(2, 37) = 4.75, p < .01$, partial $\eta^2 = .2$. Post hoc analyses (Duncan test) showed that nonanxious participants ($M = 67.66, SD = 20.6$) made a higher number of risky choices than on-drug anxious participants ($M = 52.08, SD = 18.76$) ($p = .06$) and also a significantly higher number of risky choices than off-drug anxious participants ($M = 45.31, SD = 16.79$) ($p < .01$). No difference between on- and off-drug were found ($p = .41$).

Discussion

The aim of this study was to explore potential differences in risky behavior between individuals with and without anxiety dis-

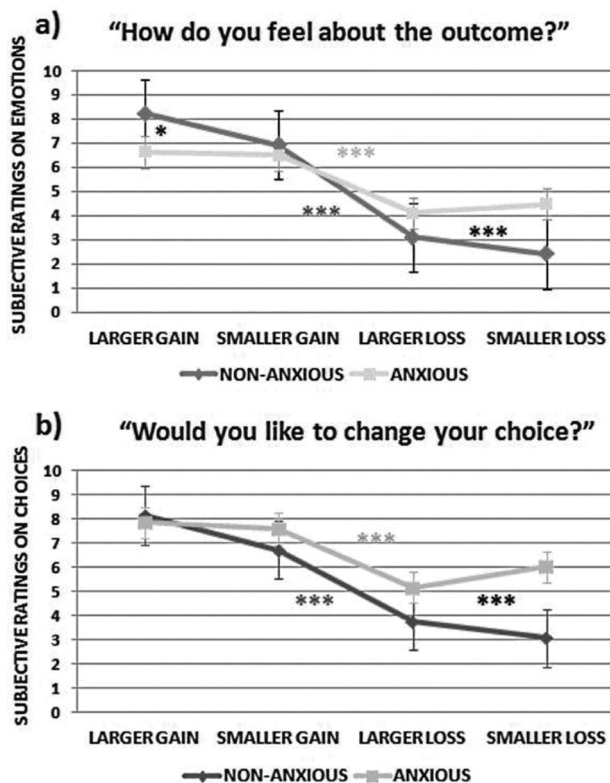


Figure 3. Subjective ratings. Participants’ average emotions ratings (a) and choices ratings (b) after participants chose risky gamble and had won (larger gain), safe gamble and had won (smaller gain), risky gamble and had lost (larger loss), and safe gamble and had lost (smaller loss). * $p < .05$. *** $p = .001$. The black asterisk means that the effects reported are for both anxious and nonanxious participants. The light gray asterisk means that the effect reported is only for anxious participants (bar also in light gray). The dark gray asterisk means that the effect reported is only for nonanxious participants (bar also in dark gray).

order. To date, few studies (e.g., Maner & Schmidt, 2006; Maner et al., 2007; Mitte, 2007; Miu et al., 2008; de Visser et al., 2010; Mueller et al., 2010) have investigated the relationship between high and low anxiety traits and risky behavior and, most important, these studies have not used an actual true clinical population. This does not allow for a clear assessment of risk behavior in pathological anxiety disorder. Moreover, the few studies in the laboratory that have explored risky behavior have used the IGT (e.g., de Visser et al., 2010; Mueller et al., 2010), which can detect how players choose between strategies, but makes difficult the measurement of an inherent tendency to be either risk-seeking or risk-averse. With this aim, we employed a task without any predictive learning strategy, that is, each trial was independent from the previous one.

Our results showed that anxious and nonanxious participants decided differently with respect to risky choices. Anxious participants were more risk-averse than nonanxious participants across the duration of the task. This risky behavior was only affected by the perception of risk, independent of the expected value and/or of the variability of win/loss trials. This finding clearly shows that anxiety, and its focus on threat-avoidance, shapes people's choices. Congruent with our hypothesis, this study demonstrates, by using a standard "risky-choice" paradigm, that pathological anxiety strongly affects decision-making processes by leading patients to avoid risky choices to a larger extent as compared to a nonanxious population. Anxiety informs about the presence of a potential threat (Schwarz & Clore, 2003), and thus influences cognition (Shepperd et al., 2005). In turn, these cognitive processes, such as attentional biases toward threat, cause and maintain anxiety (Amir et al., 2008, 2009). Indeed, risky choices are seen as more threatening than safe choices, and anxious participants are characterized by attentional biases continuously directed to avoid threatening situations (e.g., MacLeod & Mathews, 1988; Mogg & Bradley, 2005; Bar-Haim et al., 2007), and therefore avoiding risk. Interestingly, participants also showed a differential sensitivity to the outcome of their chosen gambles and thus to previous negative and positive feedbacks. Anxious, but not nonanxious, participants became more risk avoidant after a gain. Moreover, they showed less happiness after gains than did non-anxious participants. Anxious participants typically have a pessimistic valuation of future events (Savitsky et al., 1998; Shepperd et al., 2005), and they tend to form negative expectations about situations and events (e.g., Gilboa-Schechtman, Franklin, & Foa, 2000). The perception that an event is uncontrollable increases apprehensive expectation of negative outcome, and in turn can lead to risk-avoidance behavior (Horswill & McKenna, 1999; Skinner, 1996). Thus, anxious participants' risk-avoidance behavior after gains can be due to the fact that, in contrast to nonanxious participants, anxious participants' expectations of negative outcomes are much higher. Indeed, anxious participants are also less sad and want to change their choices less than nonanxious participants after a negative outcome, as if this bad outcome was "already expected." Anxious participants seem to be strongly concerned about the possibility that subsequent trials may lead to the loss of points already won, and their behavior seems to be aimed at avoiding this eventuality. This might explain why they became more risk-avoidant after obtaining a gain than a loss. Their strategy follows the *mood maintenance hypothesis*, which claims that people in positive moods are associated with risk-averse

behavior, especially when they are focused on potential losses or where there is the possibility that a loss may occur (e.g., Arkes, Herren, & Isen, 1988; Johnson & Tversky, 1983). Anxious participants seem to be highly protective of their obtained gain and, for this reason, they behave cautiously and avoid taking risks. According to Andrade and Cohen (2007), positive mood leads to risk-seeking behaviors when there are no salient threats in the decision frame; but when there are signals of possible threats, positive mood leads to negative mood avoidance through risk-averse behaviors. Therefore, our study suggests that anxiety, which leads to hypersensitivity to potential dangers such as negative outcomes (e.g., Lerner & Keltner, 2001; Maner & Schmidt, 2006; Stöber, 1997), may play an important role in the relationship between mood and risk behavior. In contrast, after a gain, non-anxious participants increased their risk-seeking behavior. This behavior may reflect the *house-money effect* (Thaler & Johnson, 1990; Weber & Zuchel, 2005), whereby risk taking increases in presence of a prior gain. Nonanxious participants' strategy also follows the *affect infusion model*, which proposes that positive mood leads one to be less aware of the potential losses and therefore to increase risk taking (Leith & Baumeister, 1996; Forgas, 1995). We also found that happiness directly predicted subsequent risky choices, particularly in nonanxious participants.

Though it may seem surprising that participants are relatively risk seeking in this task, these results are in line with the literature using similar tasks (e.g., Gehring & Willoughby, 2002; Yeung & Sanfey, 2004; Polezzi et al., 2010). In these previous studies, people made up to 50% of risky choices, similar to the nonanxious participants here. Although we make no explicit claim that non-anxious participants were objectively risk seeking here, but rather that they were more risk seeking than anxious participant, Camerer and Weber (1992) have shown that information about the outcome probabilities can lead to an increase in risk taking, which here can perhaps explain nonanxious participants' choices. Importantly, both groups appeared equally engaged in the task, with no differences observed in RTs, and both groups were sadder after losses than gains, would have liked to have chosen differently more often following a loss than a gain, and also actually changed their subsequent choices when they indicated a higher desire to do so. Finally, we showed that both subjects with GAD and PAD are more risk-averse than nonanxious participants, but there were no significant differences between them. Thus, despite studies demonstrating that there are different negative thought orientations among different groups of patients with anxiety disorders (see Chambless & Hope, 1996, for a review), these different thoughts seemingly do not affect risk attitudes. In the present study, and in line with previous findings, both subjects with GAD and PAD appeared to focus on the threat of negative outcomes and had concerns about the severity of those outcomes (cf. Eisenberg, Baron, & Seligman, 1998), thereby avoiding a number of risky options. Thus, the pathological avoidance of threat leads to risk-avoidance decisions, independent of the specific type of anxiety considered in this study.

This behavior is also in line with the literature on social anxiety traits: Participants with high social anxiety traits are overly sensitive to the threat of embarrassment in social situations (e.g., Brockner, 1979) and, as a consequence, they prefer to declare, in front of the others, more personal responsibility for failure than for success (e.g., Arkin & Maruyama, 1979), and they present them-

selves modestly to protect themselves from the risk of embarrassment (Arkin, Appelman, & Burger, 1980). Anxiety in our participants was not socially oriented, nonetheless, it appears as if our anxious participants wanted to protect themselves from the risk of negative outcomes by choosing safe options. Indeed, all anxiety disorders show an irrational and fearful avoidance of threatening objects or situations (e.g., Griez et al., 2001), and here we showed that anxious individuals protect themselves from losses by avoiding risk. Furthermore, we found no differences when controlling for the effect of pharmacological treatment. This finding is consistent with previous evidence that did not support a role for synaptic serotonin (5-HT) in modulating risky decision making (Anderson, Richell, & Bradshaw, 2003). Thus, greater risk-averse behavior may represent a trait feature of anxiety disorders, independent of diagnosis and treatment.

In summary, this study supports a specific role for anxiety in individual risky decision making. It clearly highlights how anxiety, by its activated attentional biases toward risk, alerts us to the presence of potential threats in our environment and thus strongly affects cognition, including decision-making processes. This mechanism in turn elevates levels of anxiety, which appears to maintain the fear of a loss and strengthens the tendency to avoid the threatening situation (by choosing a higher number of safe options). Therefore, we show, for the first time, not only a different risk-taking behavior, related to threat-avoidance, but also a differential feedback sensitivity, between nonanxious individuals and individuals with pathological anxiety, and demonstrate how the feedback sensitivity interacts with choice behavior. These findings suggest promising new avenues of research with clinical populations that could be usefully employed in standard models of decision making, as well as in clinical treatment.

Study Limitations and Future Direction

Each of the two subgroups of the anxious sample used here is of a relatively small size, which can be seen as a study limitation because it may partially restrict the generalization of the results. However, this study is in line with the sample size of other studies in this field (e.g., Miu et al., 2008), and the two subgroups were composed of very homogeneous patients with quite “pure” GAD and PAD, respectively, which share threat-avoidance and therefore risk-averse behavior as a consequence. Future studies can extend these findings to other anxiety disorders, such as posttraumatic stress disorder or obsessive-compulsive disorder. This will greatly assist in deepening our knowledge about the behavior of anxiety patients with respect to risky decision making. Also, comparisons with other disorders, such as depression, could help to extend knowledge on how dysfunction in emotions affects risky behavior, shedding light on decision-making behavior in psychiatric patients, the results of which could be usefully employed in both fields of decision making and clinical treatment.

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