Future-oriented decision-making in Generalized Anxiety Disorder is evident across different versions of the Iowa Gambling Task

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Generalized Anxiety Disorder (GAD) and excessive worrying are characterized by a preoccupation with the future. Thus, enhanced identification of potential future punishments or omissions of reward may be related to the disorder. To test this hypothesis, n = 47 students meeting GAD criteria according to the GADQ-IV (GAD analogues) or not (control participants) performed the Iowa Gambling Task, which has been related to sensitivity to future consequences. In order to disentangle sensitivity to future loss and sensitivity to high short-term loss magnitudes, which could also lead to enhanced Iowa Gambling Task performance, participants also performed a modified version of the task with reversed contingencies. In both versions, GAD analogues learned to avoid decisions with high probability of long-term loss significantly faster than control participants. Results, therefore, indicate that GAD is characterized by enhanced processing of potential future losses rather than sensitivity to large short-term loss.

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1. Introduction

Worry can be defined as a mental preoccupation with potential negative events that may occur in the future. According to this definition, there are three important elements of worrying. First, worrying is associated with negative events that are, in terms of learning theory, some kind of punishment or omission of reward. Second, these negative events are to some extent unpredictable and thus follow a probabilistic as opposed to deterministic schedule. Third, worrying is mostly future-oriented. Similarly, Brown, O’Leary, and Barlow (1993) describe worry as “a future-oriented mood state in which one becomes ready or prepared to attempt to cope with upcoming events” (p. 139). From these perspectives, it could be hypothesized that people suffering from GAD (characterized by excessive worrying and being overly concerned with the future; Borkovec, Robinson, Pruzinsky, & DePree, 1983) would deploy attentional (e.g. Mathews & MacLeod, 1985; Mogg & Bradley, 1998) and working memory (Hayes, Hirsch, & Mathews, 2008) capacities to constantly search for cues of possible future losses, thus leading to a failure to enjoy life or to live in the present moment (Borkovec, 2002; Borkovec, Alcaine, & Behar, 2004; Borkovec & Sharpless, 2004).

The above specified elements of worrying can be found across different models of Generalized Anxiety Disorder. For example, Wells (1999) has proposed a cognitive model of Generalized Anxiety Disorder according to which there are two types of worry. Type 1 worry refers to worry about external events and non-cognitive internal events (e.g. “my boyfriend will break up with me”). Type 2 worry or metaworry refers to worry about one’s own thinking (e.g. “I must stop worrying or I’ll lose control.”). Metaworry is a critical part of the model because it explains why individuals with GAD avoid worry-inducing situations: they fear that worrying leads to negative future consequences. Thus, a common feature of both types of worry is that they are related to the anticipation of possible negative futures (i.e. loss of a beloved person and losing control).

From a different perspective, Dugas, Gagnon, Ladouceur, and Freeston (1998) emphasize that worrying is characterized by intolerance to uncertainty, including uncertainty about the future (i.e. “My mind can’t be relaxed if I don’t know what will happen tomorrow”); Freeston, Rheume, Letarte, Dugas, & Ladouceur, 1994). Obviously, not knowing what lies ahead should be especially aversive to those individuals who overly process possible negative futures (Dugas, Freeston, & Ladouceur, 1997). In other words, states of uncertainty may encourage the mental processing of negative probabilistic futures, which according to the above definition reflects worrying.

Finally, the avoidance theory of GAD (Borkovec et al., 2004) assumes that worrying is motivated by its ability to (a) suppress somatic aspects of anxious experience and (b) to remove the perceived threat itself. This perceived threat generally is an
anticipated bad event in the close or distant future, as opposed to a real danger in the present situation (Borkovec et al. 1983). Thus, according to the avoidance theory of worry and GAD, worrying is strongly related to the anticipation and avoidance of future bad events that are probabilistic and rarely happen in reality (Borkovec, Hazlett-Stevens, & Diaz, 1999). Taken together, Borkovec et al.’s (2004), Dugas et al.’s (1998), and Wells’ (1999) and models of GAD are consistent with the hypothesis that individuals with GAD show exaggerated processing of uncertain/probabilistic negative events that occur in the future.

In order to experimentally test in the present experiment whether GAD and/or chronic worrying is associated with hypersensitivity for future (probabilistic) outcomes, participants with and without GAD symptoms performed the Iowa Gambling Task (IGT, Bechara, Damasio, Damasio, & Anderson, 1994). In the IGT, participants are instructed to pick cards from four different decks. Each card of a given deck always leads to the same fictional reward, which is $100 for decks A and B, and $50 for decks C and D. In addition, each card can also lead to a loss, which is unpredictable on a trial-by-trial basis. However, in the long run, the losses of decks A and B sum up to be proportionally higher than the losses of decks C and D. Accordingly, participants must learn to avoid decisions that lead to high short-term but low long-term gain (i.e. decks A and B) and to make decisions instead that lead to low short-term but higher long-term gain. In sum, successful IGT performance requires processing of exactly those elements (i.e. probabilistic future losses) that are hypothesized above to relate to GAD and chronic worrying.

The IGT was initially developed in conjunction with the somatic marker hypothesis from Damasio (1994), which relates decision-making to the ventromedial region of the prefrontal cortex (VMPFC) and states that signals from the body may influence decision-making under conditions of ambiguity. It was based on the observation that patients with lesioned VMPFC in real life often (a) do not produce physiological responses to anticipated emotional events and (b) show a failure to act in a future-oriented manner despite intact intelligence (Bechara et al., 1994). Even though some aspects about the hypothesis have been a matter of debate (for review see Dunn, Dalgleish, & Lawrence, 2006), the IGT has been able to experimentally establish the lack of future-oriented behavior in individuals with lesioned VMPFC (Bechara et al., 1994; Bechara, Damasio, Damasio, & Lee, 1999). Moreover, this test has been intensively used to demonstrate hyposensitivity to future outcomes in impulsive, pathological conditions such as pathological gambling (Cavedini, Riboli, Keller, D’Annucci, & Bellodi, 2002), attention deficit/hyperactivity disorder (Garon, Moore, & Washbusch, 2006; Toplak, Jain, & Tannock, 2005), delinquency (Schmitt, Brinkley, & Newman, 1999), and substance abuse (e.g. Bechara Dolan et al., 2001; Bechara, Dolan, & Hindes 2002) (for reviews see Buelow & Suhr, 2009 and Dunn et al., 2006).

In contrast to these disorders, which are characterized by a failure to act in a future or long-term oriented manner, it has been hypothesized above that GAD is rather related to enhanced future-oriented processing of cues that may signal punishments and/or reward omissions. Accordingly, one would expect that individuals who frequently worry are better than non-worriers in the IGT. Interestingly, one study (Garon et al., 2006) found that children suffering from ADHD performed worse than healthy children, but this was not the case if they had a comorbid diagnosis of GAD. In addition, some other studies have reported preliminary evidence for positive relationships between IGT performance and conditions related to worrying and anxiety (van Honk, Hermans, Putman, Montagne, & Schutter, 2002; Peters & Slovic, 2000; Schmitt et al., 1999; Smoski et al., 2008; but see Miu, Heilman, & Houser, 2008). In sum, even though decision-making deficits with stimuli unrelated to reward and punishment have been reported in GAD (Metzger, Miller, Cohen, Sofka, & Borkovec, 1990), there is theoretical and empirical support for the hypothesis that worrying would be associated with enhanced performance on a decision-making task that measures future orientation with regard to probabilistic punishment.

However, as described above, the upper, long-term disadvantageous decks in the IGT also have larger loss magnitudes in single trials (e.g. $200 or $300 for deck A, $1250 for deck B) than the lower, advantageous decks (e.g. $50 or $25 for deck C, $250 for deck D). Thus, if an individual avoids the upper decks of the IGT, it cannot be judged whether this reflects an enhanced sensitivity for long-term loss or an enhanced sensitivity for short-term loss magnitudes. In order to test whether GAD would rather be associated with the avoidance of short-term loss magnitudes or an enhanced sensitivity for future loss we included an additional IGT version in which future loss could only be avoided by accepting relatively large consistent short-term loss magnitudes (Bechara, Tranel, & Damasio, 2000; Crone, Vendel, & van der Molen, 2003). In this version, the contingency table of the original IGT was inverted (see Table 1). Thus, there were decks with high consistent loss magnitudes and with low consistent loss magnitudes. While the former also brought proportionally higher inconsistent rewards (which made it long-term advantageous) the latter was associated with proportionally smaller inconsistent rewards (which made it long-term disadvantageous).

Taken together, if GAD is characterized by increased sensitivity to short-term loss, lowered IGT performance would be expected in the modified version (in which avoiding decks with larger short-term loss leads to overall long-term loss), whereas enhanced performance would be expected in the standard version (in which sensitivity to both long and short-term loss would lead to advantageous selections). In contrast, if GAD is related to hypersensitivity to inconsistent future long-term losses, these participants should perform better in both versions of the IGT. To test these competing hypotheses, the present study investigated participants with and without GAD symptoms who performed both versions of the IGT in a repeated-measures design.

The pair of advantageous decks (C and D) and the pair of disadvantageous decks (A and B) of the standard IGT each consists of one deck with frequent low punishments (C and A) and one deck with infrequent high punishments (D and B). To test whether GAD is associated with avoidance of infrequent high punishments (regardless of long-term advantage), we also compared groups with regard to the pooled selections from decks D and B of the standard IGT. Because this score is insensitive for long-term consequences, we had no particular hypotheses for these analyses.

2. Method

2.1. Participants

Three cohorts of undergraduate students (N = 1882) completed a battery of questionnaires during group screening procedures at the beginning of the semester. Of these, 155 students met GAD criteria according to the GADQ-IV (see below) and agreed to be contacted for participation in later studies. These 155 students and a similar number of students who did not meet GAD criteria were contacted by email and offered class credit for participation in 1
a decision-making study. Participants who were selected according to the DSM-IV criteria had an average score in the Penn State Worry Questionnaire (PSWQ, Meyer, Miller, Metzger, & Borkovec, 1990) of 66.5 (SD = 7.6), whereas participants who did not meet DSM-IV criteria had a mean PSWQ score of 45.1 (SD = 12.3). The final sample consisted of N = 27 students meeting GAD criteria (23 female, 4 male; age: M = 19.35 years; SD = 1.3 years; 4 left-handed; one Asian, one Hispanic) and 20 control participants (12 female, 8 male; age: M = 18.90 years; SD = 0.8 years; 3 left-handed, two Asian, one Hispanic) who also met an average of 1.2 GAD criteria (SD = 1.3) in the GADQ-IV. As expected, GAD participants of the final sample had higher scores in the PSWQ (M = 65.9, SD = 12.6) than control participants (M = 43.8, SD = 8.1), (t(42) = 0.703, p < 0.001) and also had higher scores in the social interaction anxiety scale (SIAS, Mattick & Clarke, 1998) (M = 37.7, SD = 10.4 vs. M = 26.3, SD = 11.7), (t(42) = 3.34; p < 0.005). Groups did not differ with regard to handedness (p > 0.9), age (p > 0.15) or ethnicity (p > 0.6). However, there were significant differences in the number of females (χ²(1) = 3.83; p = 0.05). The factor ‘Gender’ was, therefore, included in all subsequent analyses. In addition, we re-conducted the main analyses with subsamples of the two groups (n = 14) that were matched according to gender, age and handedness.

2.2. Materials

2.2.1. Questionnaires

The GADQ-IV is a 9 item self-report measure that assesses DSM-IV GAD criterial symptoms and reliably identifies participants who meet criteria for GAD (Newman et al., 2002). Because the suggested cutoff score of the GADQ-IV has been found to overdiagnose individuals (Behar, Alcaine, Zuellig, & Borkovec, 2003), we used the more conservative criterion that all of the following DSM-IV criteria had to be satisfied2: (a) excessive worry, (b) difficulty in controlling their worrying once it started, (c) having at least two topics of worry, (d) being bothered by excessive and uncontrollable worries more days than not during the past six months, and (e) reporting at least three out of six associated symptoms. In addition to the GADQ-IV, participants filled out the Penn State Worry Questionnaire (Meyer et al., 1990) and the Social Interaction Anxiety Scale (SIAS, Mattick & Clarke, 1998) during the group screening procedure and for 44 participants of the present study this data was also available for analysis. The SIAS is a measure of social anxiety, which shows moderate correlations with depression questionnaires (Mattick & Clarke, 1998) and lower correlations with the GADQ-IV (Newman et al., 2002). The SIAS and the PSWQ were included in the present study to test the specificity of the hypothesized role of worrying.

2.2.2. Iowa Gambling Task

The IGT was adapted from the descriptions in Bechara et al. (1999) study. A trial began with a display of four decks of cards (A, B, C and D) and immediately after the participant selected a card by button press, feedback on the amount won and lost in that trial and on the total amount lost was given. For the standard version of the IGT, the selection of the upper (A and B) and lower (C and D) decks always lead to a gain of $100 and $50, respectively. The amount of losses per trial was non-systematic (see Bechara et al., 1994). However, over 10 selections, losses summed up to $1250 for the upper and $250 for the lower decks, leading to a net loss of $250 for the upper ($1250 – 10 × $100) and a net gain of $250 for the lower decks. Therefore, every selection of a lower deck in the standard version G and H vs. E and F were arranged vertically in the modified version in order to reduce effects of learning. Contingencies and positions of the decks for the two versions are further illustrated in Table 1.

Table 1

Contingency table for the first 12 selections of the standard and modified versions of the IGT.

<table>
<thead>
<tr>
<th>Deck</th>
<th>Standard version</th>
<th>Modified version</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upper left</td>
<td>Upper right</td>
</tr>
<tr>
<td><strong>A</strong></td>
<td>+100</td>
<td>+100</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>−200</td>
<td>0</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>E</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>F</strong></td>
<td>−250</td>
<td>−1250</td>
</tr>
<tr>
<td><strong>G</strong></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>H</strong></td>
<td>−350</td>
<td>0</td>
</tr>
</tbody>
</table>

For example, every time deck A was chosen in the standard version the participant received a gain of $100. The third time deck A was chosen (regardless of whether other decks were selected in between) the participant also received a loss of $150. Thus, 10 selections from deck A lead to a net loss of $−250 (10 × $100 = $−150 − $300 − $200 − $250 − $350). In contrast, 10 selections from deck E in the modified version lead to a net gain of $1250 (10 × $100 = $150 + $300 + $200 + $250 + $350). Note, that the positions of advantageous decks were different in the two versions in order to reduce learning effects. The complete contingency table for the standard version can be found in Bechara et al. (1994) and by its inversion (multiplication by −1) the contingency table for the modified version can be constructed.

2 To validate the increased specificity of the all-criteria vs. standard composite score, we compared the PSWQ scores of the two GAD groups that would result from either method in the first cohort. As expected, the GAD group according to the all-criterion score had a higher average PSWQ (M = 66.7; SD = 9.9) than the GAD group that would result from applying the composite score (M = 63.4; SD = 9.9).
Each version consisted of a total of one hundred selections, separated into five blocks of 20 trials. After a block, there was a subjective awareness check asking the participants which deck they believed lead to the highest overall gain. Due to a software problem, this variable was not recorded for $n = 9$ (GAD: $n = 4$; Control: $n = 5$) participants.

2.3. Procedure

Participants reported to the laboratory and read and signed an informed consent form. They were then brought to a small sound-shielded room where participants read the instructions for the gambling task and performed one practice trial. Half of the participants in each GAD and non-GAD group began with the standard version of the gambling task, and the other half with the modified version, followed by a 1-min break. After the break, participants engaged in the other version of the task. The order of the conditions was randomly assigned within the GAD- and the control group.

2.4. Statistical analyses

For both versions, the primary dependent variable was the number of advantageous selections within a block of 20 trials (C and D in the standard version and E and F in the modified version). Repeated-measures ANOVAs with between-subject factors GROUP and GENDER and the within factors BLOCK and VERSION were performed to analyze the number of advantageous decisions (i.e. the main hypothesis) and to analyze the number of selections from decks B + D (i.e. the disadvantageous and advantageous infrequent high loss decks). Preliminary tests were conducted prior to these main analyses. First, independent t-tests on the number of advantageous decisions in the first block were performed to assure that there were no group differences at the beginning of the task. To further confirm that participants in both groups had taken similar amounts of time to come to their decisions, and to confirm that groups did not differ in the cognitive penetration of the task we also compared reaction times (measured from the beginning of a trial until the button press and averaged across conditions) and the number of correct answers in awareness checks between groups with independent t-tests. Because it has recently been criticized that not enough is known about the reliability of the IGT (Buelow & Suhr 2009), we also assessed internal consistency of the five blocks (across groups). This also allowed investigating whether performance in each block was related to a homogenous construct (cf. Brand, Labudda, & Markowitsch, 2006). All statistical analyses were conducted using SPSS version 11.5.1.

3. Results

3.1. Preliminary analyses and reliability of the measure

Groups did not differ in the number of advantageous decisions in the first block of the standard ($t(45) = 1.05; p > 0.3$) or the modified version of the IGT ($t(45) = 0.08; p > 0.9$), indicating that there were no a priori differences in preference for particular choices. In addition, participants in the two groups did not differ in the time they took to make a decision ($t(45) = 0.12; p > 0.9$) and for those participants where subjective awareness data was recorded, there were no GAD vs. control group differences in awareness of advantageous decks ($t(36) = .79; p > .4$). A preliminary Order × Version × Block ANOVA revealed no main effect or interaction involving order (all $p > 0.2$), suggesting that there were no substantial test re-test effects. Cronbach alphas for the standard ($\alpha = 0.83$) and the modified ($\alpha = 0.86$) versions were high.

3.2. Advantageous selections

As shown in Fig. 1, GAD participants showed a more pronounced increase of advantageous selections over the five blocks than did the control participants. Statistically this was confirmed with the Group × Gender × Block × Version ANOVA which revealed a significant Group × Block interaction ($F(1, 43) = 3.14; p < 0.023$; partial $\eta^2 = 0.07$). This interaction was characterized by a group difference in the linear increase across blocks ($F(1, 43) = 5.07; p < 0.03$; partial $\eta^2 = 0.11$), with a steeper slope in the GAD than non-GAD group. In addition, there were main effects for Block ($F(1, 43) = 17.42; p < 0.0001$; partial $\eta^2 = 0.28$) and Version ($F(1, 43) = 13.78; p < 0.001$; partial $\eta^2 = 0.24$), which were further qualified by a Version × Block interaction ($F(1, 43) = 2.79; p < 0.033$; partial $\eta^2 = 0.06$), indicating that learning (i.e. a linear increase in advantageous decisions over the five consecutive blocks) occurred faster in the modified version of the task. Group × Version and Group × Version × Block interactions were not significant ($p > 0.9$).

To further test whether enhanced learning was specifically related to worrying, we divided the sample into learners (i.e. individuals that made less than 50% disadvantageous decisions in the final block of both versions) and non-learners (i.e. individuals that made less than 50% advantageous decisions) and then compared the PSWQ and SIAS scores of these groups. Consistent with the previous analyses, learners ($n = 35$) had higher mean PSWQ scores ($M = 58.6; SD = 15.3$) than non-learners ($n = 9$, $M = 47.7$, $SD = 10.5$) ($t(42) = 2.01; p < 0.05$). In contrast, learners and non-learners did not differ in their SIAS scores ($t(42) = 1.08; p > 0.2$).

3.3. High vs. low frequency loss selections in the standard version of the IGT

To test whether aside from long-term advantageous selections, GAD vs. control participants also differed in their avoidance of infrequent large loss magnitudes (as opposed to more frequent but smaller losses) we analyzed the sum of selections from decks A

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When analyses were re-conducted with subsamples of the two groups (both: $n = 14$) which were matched according to age, gender and handedness this effect (i.e. group × block interaction) was replicated ($F(1,24) = 3.55; p < 0.018$).
(disadvantageous, high frequency of relatively low losses) and C (advantageous, high frequency of relatively low losses) for the five blocks of 20 trials. When we conducted a Group x Gender x Block ANOVA on these scores there was a main effect for Group ($F(1, 43) = 9.37, p < 0.01$, partial $\eta^2 = 0.18$), indicating that GAD analogues avoided decks with large infrequent loss (Fig. 2). In addition, there was also a Gender x Group interaction ($F(1, 43) = 8.67, p < 0.01$, partial $\eta^2 = 0.17$), indicating that the group difference was stronger in male vs. female participants.

4. Discussion

The present study used a decision-making paradigm to assess sensitivity to future reward and loss among participants with and without GAD symptoms. GAD analogues learned significantly faster than control participants to avoid selections associated with long-term loss. This effect was observed regardless of whether long-term loss was due to decisions associated with a larger probability of high punishments (standard version) or with a smaller probability of high rewards (modified version). Moreover, groups did not differ in their reaction times and subjective awareness scores, making it unlikely that GAD analogues simply took more time to decide on which choice to make or that GAD analogues had a higher level of cognitive penetration of the task. Finally, GAD participants in the standard IGT also showed significant avoidance of decks with infrequent large vs. frequent small punishments when selections were collapsed across long-term advantageous and disadvantageous decks but separated with regard to loss frequency.

Previous studies have found a relationship between performance in the standard IGT and anxiety (Schmitt et al., 1999; Werner, Duschek, & Schandry, 2009) or depression (Smoski et al., 2008). This study not only replicated these prior results in a different clinical sample but also extended the finding of superior IGT performance in anxious participants to the modified version. Here, even though the long-term advantageous decks were associated with large consistent short-term loss, participants with GAD symptoms selected from them. This pattern of findings suggests that improved IGT performance in anxious individuals is not due to enhanced sensitivity for short-term loss. Instead, in line with that improved IGT performance in anxious individuals is not due to symptoms selected from them. This pattern of findings suggests, associated with large consistent short-term loss, participants with GAD here, even though the long-term advantageous decks were associated with a different clinical sample but also extended the finding of superior IGT performance in anxious participants to the modified version. Finally, GAD participants in the standard IGT also showed significant avoidance of decks with infrequent large vs. frequent small punishments when selections were collapsed across long-term advantageous and disadvantageous decks but separated with regard to loss frequency.

At least two separate processes are involved in complex real-life decision-making as simulated by the IGT. Individuals must learn about probabilistic contingencies between stimuli and outcomes, and they must make a decision based not only on this learning experience but also on general motivational tendencies (e.g. to avoid punishment or approach reward). The present findings may reflect either one or both of these processes, because both enhanced acquisition of negatively valenced associations (Zinbarg & Mohlman, 1998) and related motivational aspects (Maner & Schmidt, 2006) have been related to anxiety before. However, the group difference in the linear increase of advantageous selections across blocks suggests that enhanced learning to avoid decks associated with long-term losses plays a major role in the present findings and thus may potentially be a characteristic of GAD behaviour in general.

Additional support for the involvement of learning differences comes from recent electrophysiological studies. Error-related negativity (ERN; Gehring, Coles, Meyer, & Donchin, 1995), or specifically the feedback-related negativity (Miltner, Braun, & Coles 1997), is an EEG-component that is enlarged for negative as opposed to positive feedback. It is likely triggered by dopamine signals involved in learning via negative (Holroyd & Coles, 2002) and possibly also positive reinforcement (Santesso et al., 2008) and has been shown to be sensitive to feedback in similar gambling tasks (e.g. Gehring & Willoughby, 2002; Hajcak, Moser, Holroyd, & Simons, 2006, 2007). Importantly, potentiated ERN amplitudes have also been associated with GAD (Ladouceur, Dahl, Birmaher, Axelson, & Ryan, 2006), worrying (Hajcak, McDonald, & Simons, 2003), and related personality traits (e.g. Boksem, Tops, Wester, Meijman, & Lorist, 2006; Hajcak, McDonald, & Simons, 2004). Thus, investigating whether the behavioural results reported here are mediated by the ERN may not only yield important insight on long-term oriented reward and punishment processing in excessive worriers but also information concerning the hypothesized role of dopaminergic transmission in GAD (Stein, Westenberg, & Liebowitz, 2002) and IGT performance (Bechara, Damasio, & Damasio, 2001).

Independent of IGT performance, GAD analogues chose less often decks with infrequent large losses (i.e. decks B and D) than control participants. On average, control participants selected 15 out of 20 cards from large infrequent loss decks, which is consistent with prior reports that healthy participants fail to recognize the infrequent loss deck B as disadvantageous (Lin, Chiu, Lee, & Hsieh, 2007). In contrast to the controls, GAD participants selected only 10 out of 20 cards from large infrequent loss decks. This pattern may reflect that non-anxious participants have an optimistic bias during the task (e.g. “I will not receive another large punishment when choosing deck B/D”), whereas chronic worriers may show a more pessimistic (or in this case realistic) anticipation of loss contingencies. Because this pattern was more pronounced in the male participants, who constitute a smaller part in the GAD population (and similarly, in the present sample) it should be interpreted with some caution. Note, however, that a pessimistic/realtistic anticipation of loss contingencies in GAD is consistent with an enhanced sensitivity for future loss as reflected in the performance related analyses.

![Fig. 2. Estimated marginal means ± SEM of the total number of cards selected from infrequent loss decks (B and D) in each block of 20 cards for GAD (squares) and control participants (diamonds) in the standard version of the IGT.](image_url)
The present results indicate that chronic worrying does not have to be non-adaptive per se. By showing that GAD analogues outperformed non-GAD participants, these findings contribute to reports that trait worrying in combination with high mental ability may be associated with relatively better job performance than trait non-worrying (Perkins & Corr, 2005). These types of findings are crucial to the understanding of GAD and related disorders, as they provide a candidate mechanism for how excessive worrying may be strengthened by positive reinforcement. It has been noted that most individuals believe that worrying may prevent disaster (Freeston et al., 1994) and that positive meta-beliefs about worry play a crucial role in the initiation and maintenance of worry (Borkovec et al., 2004; Wells, 1999). Heightened awareness of possible future punishments and opportunities that could be missed may sometimes indeed lead to more advantageous decisions in real life. However, the cost may be reduced awareness for the present, and thus an appropriate therapeutic strategy is to teach clients to focus more on the present moment (Borkovec, 2002; Borkovec & Sharpless, 2004). This may be achieved through cognitive therapy or applied relaxation techniques (Borkovec et al., 2004), both of which have been found effective for the treatment of GAD (Arntz, 2003).

Two limitations of the present study should be acknowledged. First, although the groups were formed on the basis of a reliable self-report diagnostic measure (Newman et al., 2002), the GAD participants were not treatment seeking. However, the relatively high point-prevalence of students meeting GAD criteria in the present study (8%) compared to GAD patients in the general population (3%, e.g. Kessler, Chiu, Demler, Merikangas, & Walters, 2005) is similar to other studies using student samples (e.g. 7% in Rusico, 2002). Moreover, GAD patients identified with the Anxiety Disorders Interview Schedule for DSM-IV (ADIS-IV; Di Nardo, Brown, & Barlow, 1994) have been shown to have average PSWQ score of 67 (Behar et al., 2003) and 68 (Fresco, Mennin, Heimberg, & Turk, 2003), which closely resemble the values of the present sample (66). Second, we did not control for depression, which based on very recent reports (Smoski et al., 2008) that could have been another variable of interest. However, the relationship between IGT and depression is inconsistent (Buelow & Suhr, 2009) and we did not find an association between IGT performance and a measure for social anxiety, which is also closely related to depression (Mattick & Clarke, 1998). Moreover, in a recent study (manuscript in preparation) with German college students, we were able to show a significant positive correlation between trait-anxiety, PSWQ score, and IGT performance, thus replicating the present findings on a subsclinical sample. Importantly in that study, depression scores and negative mood scores were unrelated to IGT performance. Together these and the present findings support the interpretation that IGT performance is rather related to worrying and/or anxiety than to depression or negative affect per se. Aside from these limitations, the present study shows that GAD is related to superior performance in gambling tasks in which probabilistic punishment and reinforcement histories must be integrated in order to achieve high long-term gains. The results suggest that GAD is not necessarily characterized by a tendency to avoid consistent short-term losses, but rather by an increased sensitivity for unpredictable future losses.

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