



THE OVERPREDICTION OF FEAR AND PANIC IN PANIC DISORDER

NORMAN B. SCHMIDT, KRISTINE JACQUIN and MICHAEL J. TELCH

Department of Psychology, The University of Texas at Austin, Austin, TX 78712, U.S.A.

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Summary—The present study examined changes in the prediction of fear and panic in a clinical sample of patients ($N = 25$) meeting DSM-III-R criteria for panic disorder with agoraphobia (PDA). Data were collected for approx. 2000 trials of *in vivo* exposure. As expected, PDA patients displayed a bias for overpredicting both the level of fear and the likelihood of panic during an exposure trial. This overprediction bias was evidenced across several domains including heights, transportation and social situations. Although patients learned to make more accurate predictions within an exposure session, the level of overprediction remained relatively stable after the third trial within a session. Changes in fear overprediction differed across fear domains. Patients showed significant reductions in overprediction during exposure to transportation and social situations, but failed to show reductions in overprediction during exposure to heights. Unexpectedly, patients did not show increased prediction accuracy across sessions. These findings concur with earlier laboratory studies indicating that anxiety patients show an overprediction bias for panic and fear which decreases with practice. However, our findings indicate that the overprediction bias does not remit even after significant practice. The persistence of the overprediction bias is discussed within an evolutionary context.

INTRODUCTION

There is increasing evidence pointing to the importance of cognitive appraisals in the maintenance of panic-related avoidance. Overestimation of the level of fear as well as overestimation of the likelihood of panic, appear to be especially relevant to avoidance behavior. Anticipated level of fear or panic has been shown to be a potent predictor of avoidance (Craske, Rapee & Barlow, 1988; Rachman & Lopatka, 1986; Telch, Brouillard, Telch, Agras & Taylor, 1989). For example, Craske *et al.* (1988) found that anticipated fear was a better predictor of avoidance than actual panic episodes. High levels of anticipated panic have also been associated with avoidance of feared situations (Rachman & Lopatka, 1986). Telch *et al.* (1989) studied a variety of cognitive appraisal factors and found anticipated panic to be the strongest correlate of agoraphobic avoidance.

There have been relatively few studies of overprediction with panic disorder patients, and those studies tend to be descriptive (Telch *et al.*, 1989) or to utilize a controlled laboratory design (Rachman, Lopatka & Levitt, 1988). Rachman *et al.* (1988) assessed overprediction in 20 PD patients during four behavioral tests prior to treatment. Results indicated a significant overprediction bias which declined over trials. Overprediction of fear resulted in decreases in predicted fear for the subsequent trial whereas underprediction of fear resulted in increases in predicted fear for the subsequent trial. Similarly, overpredictions of panic were followed by decreases in predicted panic whereas underpredictions of panic resulted in increases in subsequent predicted panic.

The present study sought to replicate and extend the Rachman *et al.* (1988) findings. We examined the overprediction of fear and panic across a large number of exposure trials ($N = 1977$) in a sample of panic disorder patients with moderate to severe levels of agoraphobia avoidance (PDA). Unlike the Rachman *et al.* (1988) study, we assessed patients during the course of treatment. This design allowed us to examine the presence and patterning of prediction bias during the course of treatment across multiple fear domains. We hypothesized that PDA patients would display an overprediction bias regardless of the feared domain (i.e. transportation, heights, social situations). In addition, we predicted that PDA patients would make more accurate predictions with practice. Specifically, we expected predictions to become more accurate across trials within an exposure session as well as across treatment sessions. We also examined the effect of

Table 1. Clinical variables describing the patient sample

Variable	(N)
Panic severity (%)	
Mild	4 (1)
Moderate	60 (15)
Severe	36 (9)
Ago. severity	
Moderate	84 (21)
Severe	16 (4)
Chronicity (yr)	
M	7.0
SD	6.7
Treatment for panic (%)	
Psychosocial TX (lifetime)	84 (21)
Psychosocial hospitalization (lifetime)	8 (2)
Psychosocial meds at intake	80 (20)
Panic frequency (past month)	
M	3.0
SD	4.0
Anxiety (SPRAS)	
M	60.7
SD	25.8
Agoraphobia (FQ-AGO)	
M	20.9
SD	7.6
Fear of fear (ASI)	
M	36.0
SD	11.0
Depression (BDI)	
M	16.9
SD	8.6

discrepancies between actual and predicted fear and panic on subsequent actual and predicted fear and panic. Based on Rachman's earlier work, we predicted that patients who overestimate their fear or panic would show a decrease in their predicted fear or panic on the subsequent trial, whereas patients who underestimate their fear or panic would show an increase in their predicted fear or panic on the subsequent trial. We further predicted that overestimation and underestimation should not affect subsequent actual fear or panic.

METHOD

Subjects

The sample consisted of 25 patients participating in an 8 wk cognitive-behavioral group treatment for panic disorder. All subjects met DSM-III-R (APA, 1987) criteria for PDA. Patients' mean age was 34 with a range from 18 to 50 yr. The majority of patients were female (92%) and caucasian (92%). Most of the patients had completed college (40%) or were currently in college (40%) while 20% had completed a high school education. Most (56%) were married, 24% were divorced or separated, and 20% were never married. The sample exhibited moderate to high levels of anxiety and agoraphobic avoidance, moderate frequency of panic attacks, as well as clinically significant levels of anxiety sensitivity and depression (see Table 1).

Procedure

Patients were selected from a pool of 442 applicants who had undergone evaluation for panic disorder as part of an NIMH sponsored treatment outcome study. Diagnostic assessment was based on an initial phone screening interview followed by a face-to-face structured clinical interview using the SCID-NP (Spitzer, Williams, Gibbon & First, 1987).

Patients meeting the following criteria were invited to participate in treatment: (a) principal* Axis I diagnosis of panic disorder with agoraphobia; (b) at least one panic attack during the past month; (c) no change in medication status in the past 30 days; (d) aged 18–65; and (e) no current diagnosis of psychosis, bipolar disorder, or substance abuse/dependence.

*If comorbid Axis I diagnoses were present, the principal Axis I diagnosis was determined by clinical evidence and the patients' self-report of which Axis I condition was creating the greatest distress and disturbance.

Subjects were randomly assigned to receive either Panic Inoculation treatment (see Telch, Lucas, Schmidt, Hanna, Jaimez & Lucas, 1993 for a description of the treatment) or *in vivo* exposure. Both treatments were administered in a small-group format meeting 12 sessions over an 8 wk period.

All patients received three sessions of therapist assisted *in vivo* exposure which included instruction regarding effective exposure practice (e.g. repeated trials, defining specific treatment targets, seeking out moderately anxiety provoking situations, graduating to more difficult targets, and fading safety aids such as the use of companions). To increase the consistency of the treatment administration, the majority of patients were required to target common fear-provoking domains including heights, transportation and social situations. Subjects who reported minimal or no fear of these domains were given alternative exposure domains appropriate to their pattern of avoidance. Patients were also instructed to practice several times per week between treatment sessions for the duration of the treatment.

Assessments

Patients provided the following information for each exposure trial: date of exposure, trial number, description of the activity, and duration of the trial. In addition, prior to each exposure trial patients rated: (a) *predicted level of fear* from 0 (no fear) to 100 (extreme fear), and *predicted likelihood of panic* from 0 (no chance of panic) to 100 (definitely would panic). Following each exposure trial, patients rated: (a) *maximum fear level* during the trial from 0 (none) to 100 (extreme); and (b) whether they experienced a *panic attack* during the trial (yes or no).

Data on 1977 exposure trials within 394 exposure sessions were used in the analyses. An exposure session consisted of two or more consecutive trials of the same activity. Each patient conducted an average of 15.8 sessions and 91.9 trials. Only trials one through six were included in data analyses due to the low frequency of the latter trials. The majority of exposure trials were conducted in social situations (32%), transportation (29%) and heights (21%) with 76% of the patients completing exposure trials in all three domains. The vast majority of patients (24/25) conducted exposure trials in at least two of three domains.

PREDICTION INDEXES

Prediction bias was indexed by a continuous format as well as by a categorical format. A continuous fear prediction bias was calculated for each trial by subtracting the maximum level of actual fear from the maximum predicted level of fear. Trials were also categorized using three classification groupings: *overprediction*, defined as trials in which the predicted fear exceeded the actual fear by 10%; *underprediction*, defined as trials in which the actual fear exceeded the predicted fear by 10%; and *match*, defined as trials in which the actual and predicted fear fell within 10% of each other. An additional classification was used to categorize the congruence between predicted panic and actual panic during a trial. *Panic overprediction* was defined as high predicted panic (i.e. panic expectancy ≥ 50) with no actual panic. *Panic underprediction* was defined as low predicted panic (i.e. panic expectancy < 50) with an actual panic. *Match-Panic* was defined as high predicted panic with an actual panic, and *Match-No Panic* was low predicted panic with no actual panic.

RESULTS

The prediction of fear

An average score of patients' fear prediction bias across all trials indicates an overprediction of fear ($M = 12.4$, $SD = 17.1$).

A repeated measures ANOVA across the six trials revealed that patients' predictions became significantly more accurate. The Fear Index at Trial 1 is approx. 15 which falls to approx. 8 points by Trial 6. The overprediction differential at Trial 1 is significantly greater than the differential at Trials 4, 5 and 6. This overprediction differential appears to stabilize at approx. 9 points after Trial 3 (see Fig. 1).

Using the categorical index, overpredictions declined from 52% at Trial 1 to 30% at Trials 5

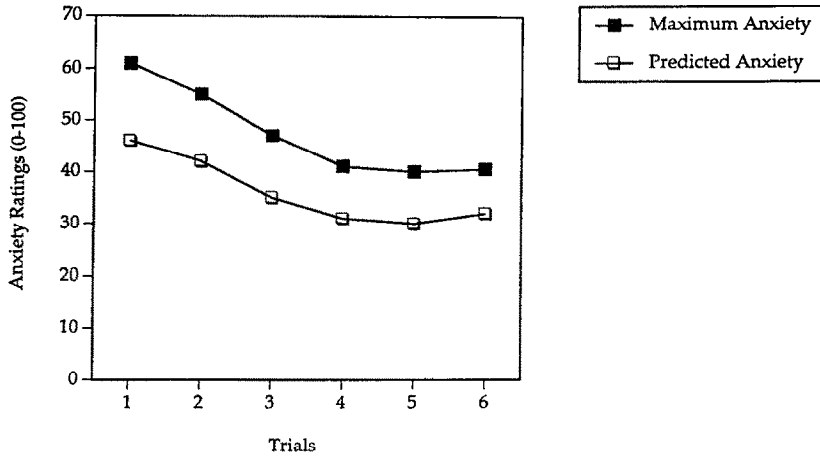


Fig. 1. Predicted and maximum fear across trials.

and 6. Underpredictions remained at approx. 3–5% across all trials. Matches significantly increased from 43% at Trial 1 to 67% at Trial 6 indicating that patients learn to accurately predict level of fear over trials. More conservative classification of matching (i.e. actual fear falling within 5% of actual fear) results in 21% of trials matching at Trial 1 increasing to 45% of all trials matching at Trial 6.

To assess the consistency of overprediction across different situations, separate one-way repeated measures ANOVAs across trials were conducted for each of the three exposure domains including heights, transportation and social situations. Examination of the fear prediction bias revealed a clear overprediction bias across all three domains. However, significant reductions in overprediction were evident only in the transportation and social situation domains (see Fig. 2).

A repeated measures ANOVA across sessions was used to assess the prediction of fear over the course of treatment. The fear prediction bias was averaged for all trials within a session. This analysis did not reach significance and indicated a relatively stable overprediction across sessions. The average fear prediction bias at Session 1 was 9.8 (SD = 20.9) which stabilized at approx. 11 for Sessions 4 and beyond. Similarly, analyses using the categorical distinction revealed a slight increase in overprediction across sessions with an overprediction of 36% of the trials at Session 1 to approx. 43% of the trials at Sessions 4, 5 and 6. Matches stayed relatively consistent ranging from 52 to 56% across sessions. Underpredictions gradually decreased from 10% at Session 1 to

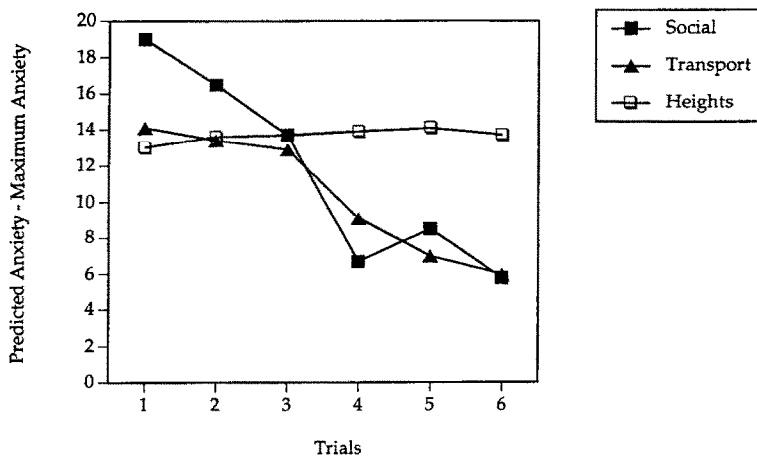


Fig. 2. The differential between predicted fear and maximum fear during exposure to social situations, transportation and heights.

Table 2. Prediction of panic likelihood by trial

	Trial					
	1	2	3	4	5	6
Overprediction (%)	41	34	26	14	13	19
(N)	(286)	(143)	(91)	(32)	(22)	(21)
Underprediction (%)	1	1	1	0	1	0
(N)	(9)	(3)	(3)	(1)	(1)	(1)
Match-Panic (%)	6	4	2	3	1	2
(N)	(40)	(15)	(7)	(6)	(2)	(2)
Match-No Panic (%)	52	61	71	83	85	79
(N)	(368)	(254)	(253)	(188)	(141)	(88)

1% at Sessions 6 and beyond. These findings indicate that underprediction errors decrease over sessions, but the overall accuracy of predictions does not significantly increase across sessions.

The prediction of panic

Consistent with prediction, patients' predictions of panic indicated an overprediction bias. The average panic likelihood prediction across all trials was 36% whereas the actual frequency of panic was only 4%. Examination of panic prediction across trials revealed a significantly greater percentage of matches over time. Forty-one percent of all trials were Overpredictions at Trial 1 which decreased to 19% at Trial 6. There were very few Underpredictions (1%) across all trials. Match-Panic trials were also relatively low ranging from 6% at Trial 1 to 1% at Trial 5. Match-No Panic trials significantly increased from 52% at Trial 1 to approx. 80% for Trials 4, 5 and 6 (see Table 2).

There was a significant increase in the accuracy of panic predictions across domains. At Trial 1, Overpredictions were found in 43, 40 and 37% of all trials for heights, transportation and social situations, respectively. Overprediction errors occurred in less than 10% of the trials in Trials 5 and 6. Match-No Panic trials were found in 50, 56 and 57% of all trials at Trial 1 for heights, transportation and social situations, respectively. Match-No Panic trials increased to over 90% of all trials at Trials 5 and 6. Underprediction errors were extremely rare and Match-Panic trials occurred in less than 5% of all trials.

Panic prediction across sessions indicated a persistent overprediction bias. Overprediction errors occurred in 28% of the trials in Session 1 and 34% of the trials in Sessions 6 and beyond. Underprediction errors were rare across all sessions. Match-Panic trials slightly decreased from 5% at Session 1 to 2% at Sessions 6 and beyond. Match-No Panic trials occurred in 65% of the trials in Session 1 and 64% of the trials in Sessions 6 and beyond.

Effects of prediction accuracy on the subsequent prediction of actual fear and panic

Regression analyses were utilized to explore the relationship between the magnitude of overprediction and underprediction at Trial 1 and predicted and actual fear/panic at Trial 2.

The underprediction and overprediction* indices for fear or panic at Trial 1 were entered with predicted fear or panic ratings at Trial 1 as independent variables with predicted fear or panic at Trial 2 as the dependent variable. As expected, Trial 2 predicted fear and panic was significantly influenced by the magnitude of underprediction and overprediction at Trial 1. Specifically, level of fear overprediction at Trial 1 was negatively associated with Trial 2 fear prediction even after controlling for Trial 1 fear prediction (par $R = -0.26$, $P < 0.001$), whereas the level of fear underprediction at Trial 1 was positively associated with Trial 2 fear prediction after controlling for Trial 1 fear prediction (par $R = 0.41$, $P < 0.001$). Similarly, level of panic overprediction at Trial 1 was negatively associated with Trial 2 panic prediction after controlling for Trial 1 panic

*Overprediction and underprediction indexes were calculated for the regression analyses. The fear overprediction index was computed by subtracting Trial 1 actual fear from Trial 1 predicted fear (negative sums were coded as zero). The fear underprediction index was computed by subtracting Trial 1 predicted fear from Trial 1 actual fear (negative sums were coded as zero). The overprediction index for panic was computed by subtracting zero from the Trial 1 panic prediction when a panic did not occur. The underprediction index for panic was computed by subtracting the Trial 1 panic prediction from 100.

Due to the dichotomous nature of the actual panic variable, logistic regression was used for those analyses.

prediction (par $R = -0.21$, $P < 0.001$), whereas level of panic underprediction at Trial 1 was positively associated with Trial 2 panic prediction after controlling for Trial 1 panic prediction (par $R = 0.18$, $P < 0.001$).

Consistent with prediction, fear overprediction and fear underprediction at Trial 1 were not significantly associated with actual fear at Trial 2 after controlling for Trial 1 fear. Similarly, panic overprediction and panic underprediction at Trial 1 were not significantly associated with the occurrence of panic at Trial 2 after controlling for Trial 1 panic.

DISCUSSION

The present findings are consistent with those of Rachman *et al.* (1988) and offer additional support for the existence of an overprediction bias in panic disorder patients. The present study is the first to document an overprediction bias in panic disorder patients during *in vivo* exposure treatment. Level of fear and likelihood of panic were overestimated across a variety of feared situations. Also consistent with earlier findings was that the overestimation of fear and panic resulted in decreases in predicted but not actual fear and panic whereas the underestimation of fear and panic resulted in increases in predicted but not actual fear and panic.

Unlike Rachman *et al.*'s (1988) earlier study, we were able to assess prediction bias across several domains. Although patients overpredicted across each of the fear domains, changes in fear overprediction differed across domains. Whereas the overprediction of fear in transportation and social situations significantly decreased across trials, the overprediction of fear during exposure to heights did not decrease with practice.

What might account for the observed specificity in overprediction biases? One factor may be patients' ability to utilize safety resources across different domains. Telch, Valentiner and Bolte (1993) have shown that the availability of safety resources in feared situations influences fear prediction bias. Telch *et al.* (1993) hypothesize that overprediction occurs when *Ss* fail to take into account the presence of safety resources when estimating their predicted level of fear. They speculate that one's ability to attend to safety features will be compromised when attentional resources are heavily focused on danger cues. In the present study, exposure to heights may present a more salient danger cue (i.e. large open hotel lobby viewed from a balcony) than exposure to other feared domains. The independent contributions of danger cues and safety features to prediction biases awaits further study.

The present study allowed us to examine changes in prediction bias across many trials. The findings support our hypothesis that the overprediction bias decreases across trials. However, the overprediction bias did not consistently decrease with each subsequent trial. Instead, we found that overpredictions of both fear and panic stabilized after the third trial. In addition, the level of overprediction did not significantly decrease across sessions. Together, these findings suggest a strong persistence of the overprediction bias.

The persistence of an overprediction bias is inconsistent with the findings of Rachman *et al.* (1988). In this earlier report, panic patients' overprediction of fear was consistently reduced such that overprediction was not evidenced by the fourth and final exposure trial. Differences in methodology may account for this discrepancy. Our study represents the first assessment of patients in the context of treatment whereas the Rachman *et al.* study assessed patients under controlled laboratory conditions. The conditions of *in vivo* exposure treatment are likely to have impacted fear and panic appraisals in a number of ways. First, exposure targets were designed to be consistently challenging. Although the exposure activity remained consistent within a session, exposure activities were varied across sessions as patients habituated to earlier targets. Patients were given explicit instructions to choose targets from their fear hierarchy which would produce at least moderate levels of anxiety. Because our patient sample exhibited moderate to severe levels of avoidance, they were typically conducting exposure to the most challenging targets toward the end of treatment. Second, safety cues were reduced across trials and across sessions. Patients were instructed to fade out safety cues (e.g. carrying medication, using companions) as their anxiety decreased. Thus, safety aids were reduced during the later trials and during the later sessions. Perhaps our attempt at making the exposure task more challenging combined with successive reductions in safety aids, maintained the patient's attentional focus on danger. As we have already discussed, an attentional bias toward danger cues is likely to contribute to an overprediction bias.

On the other hand, we expect that a more controlled exposure design, such as that utilized by Rachman *et al.* (1988), which stabilizes danger cues and safety aids across trials should produce more consistent reductions in overprediction because patients do not have to account for changes in these parameters when making their predictions.

There may be adaptive underpinnings to the persistence of overprediction errors. From an evolutionary perspective, it is better to overpredict threat than to underpredict it. We would hypothesize an asymmetrical effect of overprediction versus underprediction on subsequent predictions of threat. Specifically, the effect of an underprediction error on subsequent increases in predicted fear should be relatively greater than the effect of an overprediction error on subsequent decreases in predicted fear. Rachman and Bichard (1988) describe this asymmetry in a discussion of the pervasiveness of overprediction biases. They state that overprediction will naturally decrease over time. However, large decreases in overprediction will only occur after many episodes of disconfirmation, but a single underprediction episode will lead to dramatic increases in subsequent predicted fear. One method of testing the asymmetry hypothesis would be to assess the magnitude of change in predicted fear and panic following overestimation and underestimation errors. We would expect a relatively larger change in predicted fear and panic following an underprediction error than following an overprediction error. This hypothesis is partially supported by our findings. The magnitude of underprediction exerted a stronger effect on subsequent predicted fear (par $R = 0.41$) compared to the effect of overprediction on subsequent predicted fear (par $R = -0.26$). On the other hand, underprediction and overprediction of panic exerted approximately the same effect on subsequent predictions of panic.

In sum, PDA patients display an overprediction of fear and panic across multiple fear domains. Further work is needed to explore the factors which contribute to the persistence of the overprediction including the asymmetrical effects of underprediction versus overprediction errors.

Address correspondence to Michael J. Telch, Department of Psychology, Mezes 330, University of Texas at Austin, Austin, TX 78712, U.S.A.

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