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Assessing the perceived predictability of anxiety-related events: a report on the perceived predictability index

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Abstract

Predictability, or lack thereof, is believed to play a critical role in the development and maintenance of anxiety, with unpredictability being associated with heightened levels of anxious and fearful responding. Despite the potential importance of predictability in theoretical accounts of emotional dysregulation, currently no standardized assessment instrument exists to assess predictability perceptions for anxiety-related events. The present series of four investigations report on an initial attempt to develop a self-report instrument (i.e., Perceived Predictability Index, PPI) that can measure predictability perceptions for the occurrence, duration, and termination of anxiety-related events. Initial item selection and factor structure of the instrument was based on a large sample of participants and yielded a two-factor solution: (1) prediction of anxiety-related environmental events and (2) prediction of internal events. Our subsequent studies show that the PPI possesses adequate levels of internal consistency and temporal stability over time. Additionally, the PPI demonstrated adequate divergent and convergent validity relative to other standard anxiety and fear measures. The internal dimension of the scale also demonstrated predictive validity for emotional responding during a biological challenge test. We discuss these findings in relation to the role of perceived predictability in the study of anxious and fearful responding, and offer directions for future research. © 2001 Elsevier Science Ltd. All rights reserved.

Keywords: Anxiety; Fear; Panic attacks; Predictability; Controllability

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Predictability of negative life events has been recognized as a central process variable that may determine, in part, individual susceptibility to pathological anxiety. Indeed, basic laboratory studies with animals suggest that unpredictable stressors produce a wide range of negative emotional consequences at many levels of analysis that are not produced by predictable stressors (Rossellini, Warren, & DeCola, 1987; Seligman, 1968). In fact, Mineka and Zinbarg (1996), in a recent review, concluded that environmental events of vital importance to the organism that are unpredictable or uncontrollable or both are "the two most prominent themes that ran through the myriad of paradigms that all seemed to produce this common set of [anxiety] symptoms" (p. 173).[1]

Based largely upon nonhuman animal research, contemporary models of anxiety disorders have emphasized the importance of unpredictability, broadly defined, in anxious and fearful responding (Barlow, Chorpita, & Turovsky, 1996; Bouton, Mineka, & Barlow, 2001). Specifically, greater anxiety-related responding typically is produced and sustained when it is associated with exteroceptive or interoceptive events that involve greater degrees of unpredictability (Katz, 1984). Accordingly, the more objects or events are perceived as unpredictable, the more likely it is that they will evoke anxiety and produce fear sensitization (Riskind, 1997). It is perhaps not surprising, then, that predictability has been applied to understanding the nature of anxiety-related responding in a number of clinically important ways.

In regard to structural aspects of anxiety-related responding (e.g., symptom presentation), degrees of predictability have been used as a key criterion to distinguish between different types of anxious responding as well as between anxiety disorders. For example, panic attacks frequently are categorized by distinguishing whether they are expected or unexpected and whether they are "uncued" (unpredictable) or "cued" (predictable) by identifiable events such as specific physiological sensations that precede or occur in close temporal proximity to panic attacks (Barlow, Brown, & Craske, 1994). Further, the degree of predictability of these attacks differs across disorders (Klien & Klein, 1989). Whereas most individuals with panic disorder cannot identify a reliable cue for an attack, individuals with specific and social phobias typically can detect stimuli that cue a fear response (Craske, 1991).

Predictability of aversive events also has been found to be directly associated with anxious and fearful responding (Krantz, Baum, & Wideman, 1980; Miller, 1987). For example, people who perceive threatening events as more unpredictable than they actually are more likely to experience greater levels of anxiety and fear in response to such events compared to persons who perceive those same events as relatively more predictable (Armfield & Mattiske, 1996). In fact, research indicates that unpredictability ratings for a wide array of stimuli are, as one might expect, positively related to greater self-reported fear for those stimuli (Merckelbach, van den Hout, Jansen, & van der Molen, 1988; Rachman & Cuk, 1992).

[1] Although control is an interesting vulnerability factor in its own right (see Chorpita & Barlow, 1998, for a review), the present investigation focused exclusively on the assessment of predictability.

Rachman and colleagues have led efforts to link predictability-based expectancies to fear responding (Rachman & Loptaka, 1986; Taylor & Rachman, 1994; Telch, Ilai, Valentiner, & Craske, 1994). This research suggests people with anxiety disorders often overpredict how much fear/panic they will experience in a given situation. Over time, such estimations are presumed to be maladaptive because they serve to maintain anxious and fearful responding in future situations (Arntz, Hildebrand, & van den Hout, 1994; Arntz & van den Hout, 1988; Rachman, 1990). For example, panic disorder patients' reports concerning the likelihood of panicking in one situation strongly influence the intensity and likelihood of panic as well as avoidance behavior in future situations (Craske, Rapee, & Barlow, 1988). Furthermore, an initial underprediction of danger often contributes to fear, avoidance, and the tendency to ovepredict harm in future circumstances (Arntz & van den Hout, 1988; Schmidt, Jacquin, & Telch, 1994).

Collectively, research has indicated that greater degrees of unpredictability may serve to promote anxious and fearful responding. Such findings have led some to suggest that perceived predictability represents an important psychological process variable that may relate to the development, maintenance, and/or severity of anxious and fearful responding (Krantz et al., 1980; Miller, 1987). If this is the case, then persons with a tendency to view threatening or stressful events as more unpredictable may be more prone to experience elevated anxiety in response to those events compared to persons with a tendency to view such events as more predictable. For example, researchers have suggested that persons who experience a panic attack as "out of the blue" (i.e., unpredictable) are at the greatest risk for fear conditioning to internal bodily events and perhaps developing panic disorder (Craske, Zarate, Burton, & Barlow, 1993; Forsyth & Eifert, 1996, 1998). In actuality, the available empirical evidence suggests panic attacks are cued in the vast majority of these cases (Rapee, Litwin, & Barlow, 1999; Roy-Byrne, Geraci, & Uhde, 1986). Thus, it is the tendency to perceive abrupt bodily arousal as unpredictable that appears to be an integral component to their fear-provoking nature (Craske, 1991).

To date, few attempts have been made to refine our understanding of the psychological processes of predictability–unpredictability. One such psychological dimension of predictability may relate to the degree to which a person perceives the onset, offset, and/or duration of a threatening event to be signaled (Zvolensky, Lejuez, & Eifert, 2000). Although this operational definition does not encompass all possible ways in which predictability may relate to anxiety and fear states (see Craske, 1991), it has the advantage of being closely tied to the way in which predictability has been studied in basic experimental research with nonhuman animals (e.g., Seligman, 1968). This is particularly important because the large majority of research documenting the effects of predictability on anxiety-related responding have been directly derived from laboratory studies with nonhuman animals in which cues for aversive events are directly manipulated (see Foa, Zinbarg, & Rothbaum, 1991 for a review). This predictability definition also is closely aligned with Barlow's (1988) typology of panic, in which the discriminability of cues for panic is a primary feature. Finally, this operationalization helps avoid the confounding between the closely related constructs of predictability and

controllability (Lejuez, Eifert, Zvolensky, & Richards, in press). That is, although control most often implies prediction, prediction does not necessarily imply control (see Zvolensky et al. (2000) for a further discussion of this issue). For instance, a person may be able to predict when an aversive event will begin but may not be able to control if and when it occurs.

Taken together, it would be useful to have a standardized measure that can measure perceived predictability over anxiety-related events, and to examine the influence of this construct in relation to anxious and fearful responding. In this way, the relative contributions of individual differences in predictability perceptions can be further clarified and better integrated with our existing knowledge of processes associated with anxiety-related responding. In the present paper, we operated under the assumption that predictability could be measured by assessing the relative frequency with which individuals report perceiving anxiety-related events as either predictable or unpredictable. Toward this end, we report on four separate investigations that represent an initial attempt to develop a measure of perceived predictability that is specific to anxiety-related events.

1. Study 1

The aim of the first study was to develop the final version of the Perceived Predictability Index (PPI) for anxiety-related events. For this purpose, we tested the initial item and factor structure of the PPI in a large sample of nonclinical participants to retain only internally consistent items.

1.1. Method

1.1.1. Scale development

The authors generated 30 items pertaining to predictability of anxiety-related events for the scale from three sources: (1) select items ($n = 11$) from an earlier 60-item piloted version of the PPI tested with a mixed sample of anxiety disorder patients ($n = 16$) and nonclinical college students ($n = 81$) that had corrected item-total correlations that were greater than 0.3; (2) clinical and theoretical descriptions of predictability of anxiety-related events in the literature (Craske, 1991); and (3) semi-structured interviews assessing, in part, panic-related episodes conducted with nonclinical participants (Zvolensky, Eifert, Lejuez, & McNeil, 1999). The items were aimed at addressing perceptions of predictability cues for a wide variety of anxiety-related events. We limited the number of items to 30 on the scale to decrease the opportunity of reporting fatigue (DeVellis, 1991).

For each item, responses were made on a five-point Likert-type scale, anchored from 0 (never) to 4 (always). In the construction of the scale items, we operated under the assumption that the construct of predictability can be measured by assessing the relative frequency with which individuals endorse anxiety-related events that vary in terms of their predictability status (e.g., "My unpleasant thoughts or bodily reactions seem to begin suddenly or without warning"). For example, a

person should theoretically endorse having more frequent experiences with unpredictable bodily sensations if they perceive such events as more unpredictable relative to their counterpart who perceives such events as more predictable. This method of item construction was chosen based upon the results of the earlier piloted version of the scale in which over 98% of the nonclinical participants ($n = 81$) and 100% of the anxiety disorder patients ($n = 16$) indicated having had at least two or more experiences with the types of anxiety-related events listed in the scale items (e.g., "stressful events", "bodily sensations", "threats to personal safety", "feelings of nervousness"). Thus, despite nonsignificant differences in terms of the frequency of anxiety-related events in each sample, participants were rating these experiences differently in terms of their perceived predictability. Scoring involved totaling the values for each item, reverse scoring when appropriate, such that higher total PPI scores indicate higher levels of perceived predictability and vice versa.

1.1.2. Participants and procedure

Participants were 366 undergraduate students (232 women), ranging in age from 18 to 40 years ($M = 20.7$ years, $SD = 2.1$), and recruited from classes at West Virginia University. The ethnic background of the participants was 88% Caucasian, 5% African American, 3% Asian American, 1% other, and 3% did not specify. Participants were awarded extra credit in return for their participation. Participants completed the PPI and a demographic questionnaire anonymously in a mass testing format.

1.2. Results

1.2.1. Initial exploratory factor analysis

We first conducted an exploratory factor analysis to investigate the factor structure of the PPI. We employed a principal components analysis as this method of factor analysis uses sums of the observed variables to optimally weight the maximal variability and reliability of the resultant factor solution (Floyd & Widaman, 1995). Kaiser's index of sampling adequacy was 0.76, indicating that the PPI was appropriate for a principal component factor analysis. In our analysis, we performed a varimax rotation because we hypothesized that any observed dimensions would not be highly correlated with one another. The number of factors to retain were evaluated using (a) Kaiser's (1961) eigenvalue >1 factor extraction rule, (b) examination of the scree plot (Cattell, 1966), and (c) the interpretability of the resulting factor structures.

Factor analysis identified two factors with eigenvalues greater than one (4.7 and 3.3). Scree plot analysis indicated that the factor structure could be described as either having a one or two-factor solution. Accordingly, we specified one and two-factor solutions using Varimax rotation for subsequent factor analyses. These factor analyses, in conjunction with Scree Plot inspection, suggested the two-factor solution was most easily interpretable. The two-factor solution yielded six items that appeared to assess perceived predictability of external events (e.g., stressful life situations) and six items addressing perceived predictability of internal

anxiety-related events (e.g., racing heart). The range of factor loadings after varimax rotation was 0.79–0.01. Ten of the items failed to load on any of the factors and eight items loaded evenly on both factors; for both of these scenarios, these items were deleted (DeVellis, 1991). In total, then, 51.5% of the variance was accounted for by the two-factor solution consisting of 12 items. The first factor accounted for 30.1% of the variance, and the second accounted for 21.4% of the variance.

1.2.2. Item analysis

As recommended by DeVellis (1991), we then used item-analyses to identify items with poor item-total correlations and/or high levels of redundancy. Toward this end, corrected item-total correlations were computed for the 12-item scale.[2] This data analytic procedure correlates the item being evaluated with all scale items, excluding the item itself. Items that produced corrected item-total correlations below 0.3 were removed ($n = 5$). We then removed redundant items. Redundancy was defined as items with (1) a high inter-item correlation ($r > 0.4$) and (2) similar wording (Rapee, Craske, Brown, & Barlow, 1996). Specifically, when a pair of items met both of these criteria, we deleted the item with the lower item-total correlation coefficient and retained the item with the higher coefficient. This procedure excluded an additional 4 items. Overall, a total of 8 items were left for the remaining analyses.

1.2.3. Subsequent factor analysis

We then completed a subsequent factor analysis similar to the one reported earlier in an effort to re-evaluate the factor structure of the 8-item PPI with only the most psychometrically sound items identified through the item analysis being utilized (DeVellis, 1991). Results indicated that there were two factors with eigenvalues greater than one (2.5 and 2.1). The Scree plot analysis also indicated that the factor structure could be best described by a two-factor solution. For this reason, we specified a two-factor solution using Varimax rotation for a subsequent factor analyses. The analysis indicated that a two-factor solution was apparent (see Table 1), with four items that appeared to assess perceived predictability of external events and four items addressing perceived predictability of internal anxiety-related events. The range of factor loadings after varimax rotation was 0.73 to 0.01. Overall, 56.3% of the variance was accounted for by the two-factor solution, with 29.6% variance accounted for by factor one and 26.7% variance accounted for by factor two. These two factors, as indexed by a zero order correlation, did not share much relation with one another, $r = 0.04$, $p = 0.5$). For this reason, we utilized the subscales in subsequent analyses as opposed to the total score.

1.2.4. Reliability analyses

The assessment of the internal consistency of the PPI yielded a Cronbach alpha of 0.76 for the external scale, and 0.72 for the internal scale. These reliability levels are

[2] We also completed the item analysis per scale because the factors appeared relatively orthogonal in their structure. The results for this analysis did not meaningfully differ from those reported from the overall item analysis in terms of the outcome for item removal.

Table 1
Rotated varimax factor loadings for the two-factor solution of the PPI[a]

	Factor I	Factor II
I. *Predictability of external events*		
1. When will have stressful conflicts	0.62	0.01
3. Frightening events will occur	0.72	−0.11
5. Stressful situations are over	0.76	0.03
8. How long conflicts will last	0.69	0.20
II. *Predictability of internal events*		
2. Feelings of nervousness will arise	−0.09	0.65
4. Heart races for unpredictable periods of time	0.19	0.67
6. Can tell when mind will slow down	0.27	0.58
7. Unpleasant thoughts begin suddenly	0.17	0.73

[a] Note. $n = 366$.

acceptable, particularly considering the number of items that comprise each scale (Nunnally, 1978).

1.3. Discussion

The results of Study 1 suggest that the PPI is comprised of two scales which are internally consistent. Although we originally expected the PPI to be unidimensional, results of the factor analyses indicated that the questionnaire appears to assess two relatively distinct domains of perceived predictability: predictability of environmental events and predictability of internal events.[3] Given these preliminary findings regarding the factor structure and internal consistency, we next sought to evaluate the reliability of the scale over time.

2. Study 2

Whereas Study 1 established the basic factor structure and internal consistency of the PPI, Study 2 explored the stability of the PPI over time. Previous research has indicated that individual differences in predictability preferences interact with situational variables (Miller, 1987), often attenuating retest reliability. Thus, we hypothesized that the PPI retest reliability for the two predictability factors identified in Study 1 would only be moderately high, but still stable over a two-week time period. This test–retest time period was chosen because it was considered to be long enough in duration to establish temporal reliability at this stage of research development.

[3] Contact the first author to attain a copy of the PPI.

2.1. Method

2.1.1. Participants and procedure

Participants were 60 undergraduate students (34 women) recruited from undergraduate psychology classes at West Virginia University who received course credit in return for their participation. Participants ranged in age from 18 to 35 years ($M = 20.5$ years, $SD = 2.3$) and 90% were Caucasian, 5% were African American, 2% were Asian American, 1% were other, and 2% did not specify. Participants completed the PPI as part of a larger assessment study in university classrooms. After the first assessment, participants were asked to complete the PPI again two weeks after the first assessment.

2.2. Results

2.2.1. Test–retest reliability and stability

Zero-order correlations were computed between the first and second administrations for the PPI scores. Moderately high correlations were observed between Time 1 and Time 2 for the PPI internal subscale ($r = 0.65$, $p < 0.001$) and external subscale ($r = 0.64$, $p < 0.001$), suggesting an adequate degree of test–retest reliability (Nunnally, 1978). Because test–retest correlations do not detect systematic changes in scores over time, we used paired *t*-tests to then assess the relative degree of temporal stability of the PPI. As expected, no differences were observed between the two assessments for the PPI internal subscale [$t(59) = 1.4$, n.s.] and external subscale [$t(59) = 0.5$, n.s.].

2.3. Discussion

Study 2 provides evidence that the PPI is reliable over a period of two weeks. Test–retest correlations were adequate, and the PPI scores showed stability over the two-week testing period. Thus, it seems reasonable to conclude that the PPI has demonstrated satisfactory levels of consistency over time. One reason that may relate to why the test–retest correlations were only moderately high is that predictability perceptions may interact with situational factors (Miller, 1987). That is, specific events or contexts may differ, sometimes even quite drastically, in terms of cues that provide information as to when an impending reaction of threatening event will occur, how long it will last, and when it will end (Craske, 1991; Zvolensky et al., 2000). Thus, respondents may rate higher or lower degrees of predictability depending on the stressful life events that they have most recently experienced, and/or one that was particularly salient, possibly attenuating the retest coefficients. To better examine this issue, future research may benefit by examining the relative temporal stability and test–retest reliability of the PPI over longer time intervals (e.g., 1 month, 12 months). To be sure, such longer retest evaluations are necessary if the PPI were to be employed in treatment outcome studies and to help clarify whether or not predictability perceptions reflect more of a trait or state construct.

3. Study 3

The purpose of Study 3 was to examine the convergent and divergent validity of the PPI with other self-report instruments. If predictability is related to anxiety and fear constructs, it should share significant positive relation with other scales that tap theoretically relevant concepts in a content-specific fashion. For instance, the PPI internal subscale should theoretically correlate in a more robust manner, relative to the PPI external scale, with a measure that taps a fear of private events because of their negative consequences. That is, there should be evidence of a greater relation between constructs that relate to similar content (e.g., internal events). This type of conceptualization is consistent with contemporary accounts of anxiety and stress that emphasize a content-specificity effect (Clark, Beck, & Brown, 1989). To empirically examine this issue, we evaluated responses to standardized self-report measures related to concerns about the negative consequences of anxiety-related events, trait anxiety, fears of suffocation, and attitudes about somatic and health-related events.

3.1. Method

3.1.1. Participants

Participants included 79 undergraduate psychology students (49 women) enrolled at West Virginia University. The mean age of participants was 20.4 years ($SD = 3.4$). The sample consisted of 70 Caucasians (89%), 3 African Americans (4%), 2 Hispanics (2.5%), 2 Asian Americans (2.5%), and 2 others (2.5%). All individuals received course credit in return for participation.

3.1.2. Procedure and materials

In addition to the PPI, participants completed the Anxiety Sensitivity Index (ASI; Reiss, Peterson, Gursky, & McNally, 1986), State-Trait Anxiety Inventory-Trait form (STAI; Spielberger, Gorsuch, Lushene, Vogg, & Jacobs, 1983), Illness Attitudes Scale (IAS; Kellner, 1987), and the Suffocation Fear Survey (SFS; Rachman & Taylor, 1995). The ASI is a 16-item questionnaire in which respondents rate, on a 5-point Likert-type scale (0 = very little to 4 = very much), the degree that they are concerned about possible aversive consequences of anxiety symptoms. This measure has been demonstrated to be a good predictor of anxious responding in both laboratory and naturalistic settings (Schmidt, Lerew, & Jackson, 1997). The STAI is a reliable and valid measure of trait anxiety (Spielberger et al., 1983). The IAS consists of 29 items designed to assess attitudes and fears related to illness, disease, and hospitalization. Reliability and validity of the IAS has been well documented (Speckens, Spinhoven, Sloekers, Bolk, & van Hemert, 1996). Finally, the SFS is a 16-item questionnaire that measures fears related to claustrophobic-related sensations and is scored on a five-point Likert-type scale (0 = no anxiety to 4 = maximum anxiety). The SFS is internally consistent and is an accurate predictor of fear-related responding (Zvolensky, Lejuez, & Eifert, 1998).

4. Results

4.1. Convergent and divergent validity

Zero-order correlations were examined between the PPI subscales and all other assessment instruments (see Table 2). As shown in Table 2, the PPI internal subscale showed essentially no relation with the PPI external subscale, reiterating that predictability perceptions for internal and external events are at least partially different concepts. For the PPI internal subscale, moderate correlations were observed between all of the other instruments, with the most robust relation being apparent for the ASI and STAI. In contrast, the PPI external subscale was unrelated to scores on the other assessment measures.

5. Discussion

The PPI internal subscale evidenced convergent validity, correlating significantly with measures of anxiety sensitivity, trait anxiety, and suffocation/claustrophobia fear as well as health attitudes. Yet, it never shared more than 25% of variance with any of the other measures and therefore is unlikely to be assessing the same construct as these other measures (Nunnally & Bernstein, 1994). The external scale did not correlate significantly with these same measures. On the one hand, this finding indicates divergent validity. On the other hand, our selection of measures that primarily related to somatic or private events likely diminished the chance for observing evidence of convergent validity for the PPI external scale. To address this issue, future research aimed at ascertaining whether the PPI external scale correlates with anxiety and fear about specific public, social, or environmental events would be useful. Another possibility would be to provide an evaluation of anxious and fearful responding to a social threat challenge in which participants are selected pre-experimentally on the basis of high and low external perceived predictability scores. In this way, one could determine how PPI external scale scores relate to anxious and fearful responding in an evocative social situation.

Table 2
Relations between PPI and other psychological instruments[a]

Instrument	1	2	3	4	5	6
1. PPI-I	—	0.05	0.47**	0.46**	0.24**	0.38**
2. PPI-E	—	—	0.03	0.09	0.11	−0.03
3. ASI	—	—	—	0.56**	0.51**	0.43**
4. STAI	—	—	—	—	0.24*	0.43**
5. IAS	—	—	—	—	—	0.21
6. SFS	—	—	—	—	—	—

[a] Note. $n = 79$. PPI—I, Perceived Predictability Index for Anxiety-Related Events (Internal Subscale); PPI—E, PQ (external subscale); ASI, Anxiety Sensitivity Index; STAI, State Trait Anxiety Inventory; IAS, Illness Attitude Scale; SFS, Suffocation Fear Survey. $*p<0.05$, $**p<0.01$.

6. Study 4

Study 4 sought to evaluate the predictive validity of the PPI internal dimension because unpredictability perceptions arguably are most emphasized in theoretical accounts of panic and related interoceptive fears. For instance, Bouton et al. (2001) suggest that unpredictability perceptions may foster elevations in anxiety, which in turn, increases the probability of panic. In a related way, recent experimental studies using biological challenge strategies such as that by Lejuez et al. (in press) have found that high anxious persons more often choose predictable as opposed to unpredictable alternatives during recurrent bodily distress. Collectively, these findings highlight the important role of predictability perceptions in determining the nature and patterning of emotional reactivity to bodily sensations. Yet, it is unclear whether predictability perceptions, as measured by the PPI, relate to differential degrees of anxiety-related responding during a biological challenge. Such information would be useful in both further establishing the predictability construct in anxiety-related states generally, and as it pertains to bodily fear specifically.

Toward this end, we tested whether high and low responding on the PPI internal dimension discriminates between individuals on a biological challenge test. For this purpose, groups of high and low PPI internal dimension responders were identified. These persons were then subjected to an overbreathing challenge test that produces autonomic activity present that defines, in part, states of anxiety and panic. Due to the voluntary nature of voluntary overbreathing, this task involves a greater degree of predictability than other biological challenge tasks (Rapee, 1995; Zvolensky & Eifert, in press). Thus, in the present context, we considered this challenge test a more conservative evaluation of the predictive validity of the PPI internal dimension in that voluntary overbreathing is a highly predictable (and perhaps controllable) provocation. Based on previous research (Craske, Glover, & DeCola, 1995; Lejuez et al., in press), we hypothesized that persons classified as low in perceived predictability over internal events would report greater anxiety and panic symptoms to the challenge compared to individuals classified as high in predictability for internal events. Additionally, we hypothesized that these differences would still be apparent even after controlling for baseline levels of anticipatory anxiety.

6.1. Method

6.1.1. Participants

Participants were 196 students (112 females; $M = 20.8$ years; $SD = 1.7$; 182 Caucasian, 9 African American; 5 Asian American) enrolled in introductory psychology classes at West Virginia University who received extra credit in return for their participation. From this sample, 40 were identified for inclusion in two gender-balanced groups ($n = 20$ per group) based upon their PPI internal score. We utilized the PPI internal score because it allowed us to capture predictability perceptions for internal events. Low predictors (PPI internal score 1 SD above the mean) and high predictors (PPI total score 1 SD below the mean). Based on selection criteria, the demographic distribution for low predictors ($M = 20.5$ years; $SD = 1.2$;

19 Caucasian; 1 African American) was similar to high predictors ($M = 21.2$ years of age; $SD = 1.7$; 18 Caucasian; 1 African American; 1 Asian American).

In total, 211 student volunteers completed the PPI. Ten participants (6 females and 4 males) were excluded from the data analyses due to incomplete PPI data. Eligibility criteria for participation in the challenge were evaluated with an individual interview that has previously been used to screen health status in other biological challenge studies (Zvolensky et al., 1998). Participation was denied if students reported any of the following conditions: abnormal heart conditions, epilepsy, hypertension, lung disorders (e.g., asthma), pregnancy, history of psychopathology, panic attacks, or use of psychotropic medication. Five students met the exclusionary criteria and were not permitted to participate; four of these persons were from the low predictor group and one was from the high predictor group. All participants completed a written consent prior to beginning the investigation and were debriefed at the end.

6.1.2. Materials

Prediction questionnaire. The PPI was used as the selection measure.

Panic attack questionnaire—revised. The Panic Attack Questionnaire (PAQ—R; Cox, Norton, & Swinson, 1992) provides a brief description of panic attacks, followed by items concerning the frequency and intensity of panic symptoms. The PAQ—R was administered as a screening instrument to assess panic attack history. Persons reporting previous panic attacks were excluded from participation in the hyperventilation challenge.

Subjective units of distress. A Subjective Units of Distress scale (SUDs; Wolpe, 1958) was used to index self-reported anxiety, ranging from 0 (no anxiety) to 8 (extreme anxiety). A SUDs rating was attained before the hyperventilation breathing task to assess anticipatory anxiety and a rating also was attained after the hyperventilation.

Hyperventilation questionnaire. The 33-item Hyperventilation Questionnaire (HQ; Rapee & Medoro, 1994) was implemented to assess panic symptoms induced by the hyperventilation challenge. The HQ lists seven affective, six cognitive, and 20 somatic symptoms and respondents are asked to rate the severity of each symptom on a four point Likert-type scale, ranging from zero (not at all) to three (markedly). The HQ has been successfully employed to index panic symptoms in biological challenge studies and has shown good internal consistency (Rapee & Medoro, 1994). We administered the HQ before and after the hyperventilation test.

Control and prediction ratings. Although prediction and control over aversive stimuli appear to have independent effects on anxious responding, there may be some overlap between the variables (Zvolensky et al., 1999). Therefore, we independently assessed control and prediction in this investigation. After the hyperventilation task, participants completed a nine-point Likert-type scale (0 = no control to 8 = complete control) to assess perceived control over their breathing and bodily sensations during the study. In a similar way, participants completed a nine-point Likert-type scale (0 = no prediction to 8 = complete prediction) to assess the

degree of prediction of their breathing and bodily sensations during the challenge. These scales have been used in previous research (Zvolensky et al., 1999).

6.1.3. Procedure

Experimental sessions were conducted in a $2\,m \times 6\,m$ room that contained a chair for the participant, a desk, an intercom, and a one-way mirror. Upon arrival, eligible participants were seated in a chair and then completed a consent form outlining the breathing task. Participants were informed that they could discontinue participation at any time. Following completion of the consent form, the SUDs and the HQ were administered. After the experimenter left the participant room, participants listened to audiotaped instructions pertaining to the breathing challenge. Any questions were then answered by the experimenter prior to the breathing task. Our procedure followed the format used in other challenge studies (e.g., Rapee & Medoro, 1994). Audiotaped breathing instructions were played that paced the breathing of participants at the rate of 30 breaths per minute for a total of 180 seconds. Immediately after the challenge, participants completed the postexperimental SUDs and then the HQ. Then, participants provided predictability and controllability ratings for the challenge test.

6.2. Results

6.2.1. Selection of groups and preexperimental responding

As expected, the low predictor group ($M = 3.8$, $SD = 1.2$) significantly differed from the group high in prediction in regard to their PPI internal dimension ($M = 13.2$, $SD = 1.7$) scores, $t(38) = 16.2$, $p < 0.001$. Nevertheless, the low prediction group ($M = 2.2$, $SD = 1.0$) did not significantly differ from the high prediction group ($M = 1.8$, $SD = 0.8$) in terms of preexperimental SUDs ratings ($p > 0.1$). Thus, although the groups significantly differed in terms of their ratings of predictability for interoceptive events, they did not differ in their anticipatory anxiety levels prior to the challenge.

6.3. Experimental manipulation

As a manipulation check of the biological challenge, preexperimental SUDs and HQ ratings were compared with postexperimental ratings; reported alpha levels were adjusted using the Bonferroni procedure to control for family-wise error rate for these four comparisons ($0.05/4 = 0.01$). There was a significant difference for SUDs ratings, such that postexperimental scores were greater compared to preexperimental scores [$t(39) = 9.5$, $p < 0.001$]. There also was a significant difference for the affective [$t(39) = 11.9$, $p < 0.001$], cognitive [$t(39) = 8.4$, $p < 0.001$], and somatic [$t(39) = 22.1$, $p < 0.001$] subscales of the HQ between assessment time periods, with postexperimental scores being greater than preexperimental scores. The two groups did not differ in their postexperimental ratings of control/prediction of breathing and bodily sensations during the challenge [both $t < 0.1$, n.s.], suggesting that similar levels of controllability and predictability were evoked by the procedure. These findings are

important because they indicate that the observed between group differences cannot be attributed to the challenge, but rather differences in the groups, as indexed by the selection criteria.

6.4. Postexperimental group comparisons

Scores for the dependent measures were compared using independent sample *t*-tests; alpha levels were adjusted using the Bonferroni procedure to control for family-wise error rate for these four comparisons ($0.05/4 = 0.01$). As expected, persons low in predictability ($M = 4.7, SD = 1.0$) reported significantly greater SUDs ratings compared to persons high in predictability ($M = 2.8$, $SD = 0.5$), $t(38) = 7.8$, $p < 0.001$. Individuals low in predictability ($M = 2.3$, $SD = 0.69$) also reported significantly higher scores on the affective subscale of the HQ compared to those high in predictability ($M = 3.7$, $SD = 1.2$), $t(38) = 4.6$, $p < 0.001$. Participants low in predictability also endorsed more ($M = 2.3$, $SD = 0.7$) cognitive symptoms on the HQ compared with persons with high predictability ratings for internal events ($M = 1.0$, $SD = 0.6$), $t\,(38) = 5.8$, $p < 0.001$. There were no significant differences for the HQ somatic subscale between high ($M = 10.1$, $SD = 5.6$) and low ($M = 11.5$, $SD = 6.7$) predictability groups.

In supplementary analyses, we conducted separate follow-up ANCOVAs for SUDs and HQ scores using preexperimental anticipatory anxiety ratings (i.e., preexperimental SUDs rating) as the covariate. Results indicated the significant differences between predictor groups were still apparent for both the postchallenge SUDs ratings [$F(2, 37) = 5.2$, $p < 0.01$] and HQ cognitive [$F(2, 37) = 3.2$, $p < 0.05$] and affective dimensions [$F(2, 37) = 5.1$, $p < 0.01$] after controlling for anticipatory anxiety.

6.5. Discussion

The results of Study 4 suggest that the PPI internal scores can be used to identify persons with differential responses to a biological challenge test. Specifically, the group with low perceptions of predictability for internal events responded with significantly greater anxiety, and more cognitive and affective distress compared to their counterparts with relatively higher levels of predictability for those same events. Similar to other researchs, we did not find significant between-group differences for somatic items of the HQ (Asmundson, Norton, Wilson, & Sandler, 1994). It should be noted that although the groups were selected on the basis of high and low predictability levels, the groups did not differ with regard to preexperimental anticipatory anxiety. Thus, there is preliminary evidence that the observed differences for the dependent measures are related to differences in perceived predictability. Still, given the vast literature documenting the importance and utility of anxiety sensitivity and related constructs (e.g., suffocation fear, trait anxiety) in relation to challenge response, a more stringent test of the predictive validity of the PPI internal dimension awaits future research attention. Finally, although we attempted to control for differential respiration rates during the study by

standardizing the pace of the breathing procedure, we did not measure breathing rate during the challenge. Thus, it is possible that our results could be affected by breathing rate differences between groups. However, as both groups failed to differ in terms of reported somatic symptoms in response to the challenge task, it is unlikely that individual differences in respiration accounted for the observed effects across other assessed domains.

7. General discussion

The purpose of the preceding series of investigations was to provide an initial attempt to develop a measure of perceived predictability for anxiety-related events. Based on the results of these four studies, there is evidence that the PPI assesses perceived predictability pertaining to anxiety-provoking internal and external events. The internal consistency of the PPI was adequate, and it appears relatively reliable and stable over a two-week resting period. The PPI internal subscale showed a relatively low positive correlation with measures of anxiety and fear concerning private experiences (e.g., thoughts, bodily reactions), suggesting the index assesses a related but still distinct construct. The PPI external scale did not show the same type of relation, and more convincing tests of its convergent validity properties await future research attention. Future research is in a good position to examine the relation between the PPI and other measures of negative emotional states such as depression that also implicitly emphasize the role of unpredictability perceptions (Frijda, 1986). In this way, it will be possible to better understand the relative similarities and differences between the PPI and other negative affect-laden measures. As one illustrative example, one might expect that predictability perceptions pertain to differences in identifying cues that signify the onset, duration, or offset of an aversive event, whereas catastrophic thinking encompass responding that relates to the assumed negative consequences of the event itself.

The predictive validity of the PPI internal dimension was examined in Study 4. Using the PPI internal scores for selection of high and low predictability groups, we found that these groups responded differently to a biological challenge test. Specifically, persons low in perceived predictability of internal events responded with greater cognitive and affective distress compared to their counterparts high in predictability for that same dimension, despite no differences in baseline levels of anticipatory anxiety or bodily arousal. We conducted Study 4 in a panic-analogue format because predictability, broadly considered, arguably is most often highlighted in models of panic attacks and panic disorder, whereby discrete episodes of fear typically arise "out of the blue" (Craske, 1991). Although the predictive validity of the PPI certainly requires future systematic investigation, the present results offer an initial basis for such research. For instance, future research should attempt to clarify how individual differences in perceived predictability for external events may affect anxious and fearful responding to other types of threatening events that are often associated with concept of unpredictability (e.g., social threat challenges).

Taken together, it is likely that individuals vary along a perceived predictability continuum for internal and external events, and that this psychological dimension may be an important feature of anxious and fearful responding for certain events (Craske, 1991). Although our series of investigations provide important initial evidence that predictability perceptions are relevant to anxious and fearful responding, a number of important research questions remain. First, confidence in the factor structure and internal consistency would be strengthened with replication in other independent studies, particularly with anxiety disorder samples (Cronbach & Meehl, 1955). Additionally, future research should assess whether the PPI can detect differences in predictability perceptions for anxiety-related events across different classes of anxiety disorders and nonclinical populations (i.e., discriminate validity). Thus, although further study is clearly needed to understand the role of predictability perceptions in anxious and fearful responding, the preceding series of investigations can function as a necessary springboard for future research in this domain.

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