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Distress Tolerance and Psychopathological Symptoms and Disorders: A Review of the Empirical Literature among Adults

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Abstract

In the present paper, we review theory and empirical study of distress tolerance, an emerging risk factor candidate for various forms of psychopathology. Despite the long-standing interest in, and promise of work on, distress tolerance for understanding adult psychopathology, there has not been a comprehensive review of the extant empirical literature focused on the construct. As a result, a comprehensive synthesis of theoretical and empirical scholarship on distress tolerance including integration of extant research on the relations between distress tolerance and psychopathology is lacking. Inspection of the scientific literature indicates that there are a number of promising ways to conceptualize and measure distress tolerance, as well as documented relations between distress tolerance factor(s) and psychopathological symptoms and disorders. Although promising, there also is notable conceptual and operational heterogeneity across the distress tolerance literature(s). Moreover, a number of basic questions remain unanswered regarding the associations between distress tolerance and other risk and protective factors and processes, as well as its putative role(s) in vulnerability for, and resilience to, psychopathology. Thus, the current paper provides a comprehensive review of past and contemporary theory and research and proposes key areas for future empirical study of this construct.

Keywords

Distress tolerance; Psychopathology; Negative Mood; Mechanism; Regulation

Distress tolerance has, and continues to be, a focus of interest for clinical scientists and practitioners for a variety of reasons (Zvolensky, Bernstein, & Vujanovic, in press). Principally, the distress tolerance construct has been purported to contribute to the development and maintenance of several forms of psychopathology (e.g., substance use, anxiety, mood, and personality disorders). Inspection of research over the past century indicates that researchers and clinicians have, in fact, had a long-standing interest in elucidating the role of distress

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tolerance focused on a wide range of aversive internal states (e.g., negative emotions, uncomfortable bodily sensations; Frenkel-Brunswik, 1948, 1951; Hajek, 1991; Hajek, Belcher, & Stapleton, 1987; Linehan, 1993; Simons & Gaher, 2005). These accounts are often focused on distinct conceptualizations of the distress tolerance construct(s) as a putative risk or maintenance factor(s) among persons with, or at-risk for, various psychological disorders (Gross & Munoz, 1995; Lynch & Bronner, 2006; Mennin, Heimberg, Turk, & Fresco, 2002; Zvolensky & Otto, 2007). In the study of substance use and dependence, as one example, intolerance of emotion and somatic sensations has been suggested as a key explanatory mechanism underlying maintenance of use (Brown, Lejuez, Kahler, Strong, & Zvolensky, 2005; Chaney, Roszell, & Cummings, 1982; Otto, Powers, & Fischmann, 2005). Additionally, Linehan's (1993) seminal theoretical work on borderline personality disorder has posited that one of the central mechanisms underlying this personality disorder is a persistent unwillingness or inability to tolerate emotional distress.

Interest in distress tolerance in the context of psychological disorders has been paralleled by the growth and dissemination of psychosocial interventions designed to promote tolerance for distress originating from internal and external sources (e.g., physical discomfort, stressful life events) (e.g., Barlow, Allen & Choate, 2004; Hayes, Strosahl, & Wilson, 1999; Linehan, 1993; Orsillo & Roemer, 2005). Many of these psychosocial treatments have begun to show promising outcomes for historically difficult-to-treat populations (e.g., Kabat-Zinn, Lipworth, Burney, & Sellers, 1986; Orsillo, Roemer, & Barlow, 2003; Ramel, Goldin, Carmona, & McQuaid, 2004; Roemer & Orsillo, 2002; Williams, Teasdale, Segal, & Soulsby, 2000). For example, Gratz and Gunderson's (2006) acceptance-based emotion regulation group therapy for borderline personality disorder therapeutically targets distress tolerance by emphasizing the benefits of emotional willingness. In fact, many behavioral therapies target distress tolerance directly or indirectly, such as Acceptance and Commitment Therapy (Hayes et al., 1999), Functional Analytic Psychotherapy (Kohlenberg & Tsai, 1991), Integrative Behavioral Couples Therapy (Christensen, Jacobson, & Babcock, 1995), and Mindfulness Based Cognitive Therapy (Segal, Williams, & Teasdale, 2002).

Despite broad interest in the role of distress tolerance in the onset and maintenance of psychopathology and its treatment, there has not been a comprehensive review of the empirical literature focused on the construct. As a result, theoretical and empirical integration of extant distress tolerance research and related knowledge is lacking. As one example, there are numerous conceptualizations, assessment models and tools, and presumably, inferences about the construct(s) derived from distinct bodies of distress tolerance research. Overall, the lack of a comprehensive review of the distress tolerance literature impedes our ability to clearly ascertain from the extant literature (a) the scope of distinct conceptual models of distress tolerance and methodologies employed to assess them; (b) the role(s) of distress tolerance in the onset and maintenance of psychopathology; (c) the possible impact of psychological symptoms and disorders on distress tolerance; and (d) how to most effectively translate this knowledge to inform efficacious prevention and treatment approaches.

The overarching aim of the present review is to systematically distill information on the nature of distress tolerance among adults and its relation(s) to psychological symptoms and disorders. We have organized the review into four key sections. (1) We first define our search selection strategy and clarify the basic terminology employed in the current review. We then (2) present theoretical bases of current perspectives on distress tolerance. Subsequently, we (3) present contemporary perspectives regarding specific distress tolerance constructs and their measurement. In this third section, we clarify the conceptual boundaries and relations between different perspectives on distress tolerance and offer a critical analysis of existing work. Here, we also review extant work on specific distress tolerance constructs and their role(s) in the onset and/or maintenance of psychological symptoms and disorders, and, as applicable,

findings relevant to the possible role(s) of psychopathology in the development and expression of distress tolerance. Finally, we (4) attempt to synthesize findings and thereby highlight formative conceptual gaps across the existing literature and discuss specific directions for future research on distress tolerance.

Review Study Selection Criteria and Terminology

Prior to presenting research on distress tolerance, we briefly discuss the inclusionary study selection criteria, and the definitional bases for our utilization of 'risk terminology' in the review.

Study selection criteria

The current review is focused on adults (persons 18 years and older). There were three key factors that led to the decision to focus exclusively on adults for the review. First, the assessment of subjective distress among children and its regulation differs in fundamental ways from that of adults (Garber, 1984; Yule, 1993). Thus, the methods and implications of distress tolerance likely vary considerably across development. Second, reviews of coping with, and tolerance for, distress among youth are available in the literature (e.g., Cicchetti, Ackerman, & Izard, 1995; Thompson & Calkins, 1996). Accordingly, this empirical literature has already been conceptually synthesized and previously reviewed. Finally, the adult literature on distress tolerance is sufficiently large to justify a focused review.

We identified and selected research on distress tolerance for inclusion in this review by performing comprehensive electronic searches on PsychINFO (published between January 1840 and November 2009) and MEDLINE (published between 1966 and November 2009). We searched databases, abstracts, and article titles consisting of the following primary search terms (asterisks indicate that any characters/letters may follow the last character of the term): (1) distress; (2) discomfort; (3) affect*; (4) emot*; (5) pain; (6) phys*; (7) psych*; and (8) task. These primary search terms were each matched with the following secondary search terms: (1) toleran*; (2) intoleran*; and (3) persist*. The use of these primary and secondary search terms resulted in 53 total searches, yielding approximately 721 and 2,007 article hits from PsychINFO and MEDLINE databases, respectively. Review of the title, abstract, and the article body of the articles identified in the literature search revealed that the vast majority were not focused on distress tolerance, and therefore not relevant to the present review.

Risk factor terminology

As an organizational guide to understand existing distress tolerance research, we employ Kraemer and her colleagues' work on risk processes (Kazdin, Kraemer, Kessler, Kupfer, & Offord, 1997; Kraemer et al., 1997; Kraemer, Stice, Kazdin, Offord, & Kupfer, 2001). A common operational definition of risk processes is essential to elucidating the nature of the relations between distress tolerance and psychopathology in research to-date (Kraemer, Lowe, & Kupfer, 2005). Importantly, this terminology is used as a means to better characterize the 'state of knowledge' of the distress tolerance construct.

Briefly, a risk factor is a variable that is related to, and temporally precedes, an unwanted outcome (Kraemer et al., 1997). *Causal* risk factors reflect variables that, when modified in some way, produce systematic change in the dependent variable of interest among persons who did not previously manifest such problems (Kraemer et al., 1997). *Proxy* risk factors are variables that are related to an outcome of interest through the proxy risk factor's relationship with another causal risk factor (Kraemer et al., 2001). Thus, change in a proxy risk factor would not yield corresponding systematic change in an outcome variable, in the absence of a corresponding change in the causal risk factor with which it is related; accordingly, a proxy

risk factor may “mark” risk, but not explain such risk. Both risk and proxy factors are further categorized on the basis of whether or not they are malleable. When a risk factor cannot be changed, it is classified as a *fixed* marker, evidencing relative trait-like stability. Alternatively, when it can be changed, it is classified as a *variable* risk factor (Kraemer, Lowe, & Kupfer, 2005). These terms clarify whether a variable that is related to an outcome can be changed over time; if it can be changed, it can be considered a “risk factor,” and when it cannot, it is better characterized as a “risk marker,” evidencing relative trait-like stability. A risk factor is also distinct from a *maintenance* factor, which is a variable that predicts the persistence of an existing outcome over time among individuals already demonstrating the outcome of interest (Stice, 2002). Notably, however, certain variables may operate as both a risk and maintenance factor.

Theoretical Bases for the Contemporary Study of Distress Tolerance

Conceptual perspective on distress and tolerance

Scholars have conceptualized a wide variety of distress tolerance constructs that differ primarily in their focus of distress (e.g., somatic versus emotional). Likewise, theory and empirical study has been characterized by a large degree of heterogeneity across areas of research. In the present review, we have attempted to be maximally inclusive in our selection of putative distress tolerance constructs by reviewing any construct in which there is an explicit focus on tolerating distress. We believe that this inclusive approach is important. Indeed, across various literatures, experiential distress may be reflected in cognitive, emotional, behavioral, and/or physiological realms. Because distress tolerance constructs have been studied typically in separate lines of research with respect to distinct forms of psychopathology, no single overarching theory has emerged from these lines of work. Without an overarching theoretical framework, various formulations of distress tolerance have emphasized an array of source(s) and forms of experiential distress.

In addition, two broad, conceptually distinct forms of *tolerance* have characterized the distress tolerance literature. Specifically, “distress tolerance” has been referred to as (a) the *perceived* capacity to withstand negative emotional and/or other aversive states (e.g. physical discomfort), and (b) the *behavioral act* of withstanding distressing internal states elicited by some type of stressor. Accordingly, there have been two methodological literatures, with somewhat distinct conceptual bases, on distress tolerance. The self-report measurement literature has largely focused on the perceived capacity to withstand aversive states, whereas the non-self-report (behavioral or biobehavioral) measurement literature has been largely focused on the actual behavioral ability to tolerate aversive states. There are likely to be differences between the perceived tolerance of distress and actual distress tolerance behavior, although empirical study of this central conceptual and methodological issue is largely lacking. In this review, we present and review empirical findings that may be relevant to these key issues.

Preliminary hierarchical structural model

Despite the lack of an established, unified theoretical model of distress tolerance from either a perceived or behavioral perspective, a number of authors have described possible latent structural models that offer initial attempts at conceptually integrating extant work on this construct(s) (Bernstein, Zvolensky, Vujanovic, & Moos, 2009; Schmidt, Mitchell, Keough, & Riccardi, in press). This work is not intended to provide an explanatory account of the ways in which distress tolerance may function, but rather is an initial attempt to depict its structural and conceptual organization. Both of these perspectives suggest that distress tolerance may be hierarchical in nature with a number of related but distinct lower-order facets. For example, it has been postulated that there may be a global hierarchical ‘experiential distress tolerance’

construct and a number of specific lower-order dimensions. Initial work suggests that the lower-order dimensions may be domain specific, with some focused on aversive emotional states and others focused on aversive physical states (Bernstein et al., 2009; Schmidt et al., in press). Additionally, the distress tolerance factors are related to, but distinct from, other variables such as sensitivity to internal states (Bernstein et al., 2009).

Emergent process-model of distress tolerance

Theory-driven process models focused on this construct provide an additional means by which to conceptually integrate and guide distress tolerance research. Trafton and Gifford (in press) have proposed a promising neuro-behavioral process or functional model of distress tolerance. Specifically, Trafton and Gifford propose that distress tolerance: (a) involves behavioral inhibition, or not responding to a negative reinforcement opportunity; (b) reflects one specific type, or example, of control over responding to immediate reward opportunities (relief from distress is negatively reinforcing); and (c) may, therefore, be understood as a propensity to respond to immediate (negative) reinforcement or reward as opposed to pursuing alternative reinforcers that may become accessible when immediate negative reinforcement is inhibited or not pursued. Trafton and Gifford further suggest that neurobiological substrates underlying and modulating reward learning and response may mediate tolerance to distress. Further, they argue that if such a conceptualization is accurate, then, a number of neurobiological processes may underlie and modify the expression of distress tolerance. In addition, a variety of inter-related processes may shape the development, maintenance, and expression of distress tolerance, including assigning value to context-specific opportunities based on experience and cognitions, learning from experienced behavioral consequences, adaptation to the environment at a rate determined by genetics, and executive functions (Trafton & Gifford, in press).

Conceptual links between distress tolerance and risk and resilience

Perspectives on distress tolerance thus far suggest that persons with lower distress tolerance (e.g., perceived and/or behavioral) may be prone to maladaptively respond (e.g., behavioral or affective reactivity, avoidance-oriented coping) to distress and distress-eliciting contexts in the present or future. As a result, persons with lower distress tolerance may attempt to avoid negative emotions and/or related aversive states and will be motivated to pursue negative reinforcement opportunities (i.e., escape/avoidance) when available. Alternatively, persons with high levels of distress tolerance may, theoretically, be more able to 'approach' negative emotions and related aversive states and, when adaptive, may be more able to inhibit pursuit of negative reinforcement opportunities when available. Consequently, distress (in)tolerance may affect a variety of processes involved in many aspects of behavior and affect regulation, including deployment of attention, appraisals of distress, and modulation of responses to distress (Simons & Gaher, 2005). Thus, distress tolerance, as a global factor, may be conceptualized as related to and influential of the evaluation and consequences of exposure to aversive stimuli and related adaptive and maladaptive behavioral responding. This perspective on distress tolerance and related processes reflects the theoretical context for empirical study of the potential relations between distress tolerance and risk and resilience to various forms of psychopathology.

Conceptual and Operational Perspectives on Distress Tolerance

The organization of the present review is conceptually and operationally based upon theory and empirical findings related to (a) the *perceived* capacity to withstand negative emotional and/or other aversive states (i.e., the self-report literature), and to (b) the actual *behavioral act* (s) of withstanding negative emotional and/or other aversive states (i.e., the biobehavioral literature).

Self-Report Measures of the Perceived Capacity to Withstand Negative Emotion and Other Aversive States

Tolerance of ambiguity

Perhaps the earliest conceptualization of a distress tolerance construct is Tolerance of Ambiguity (TOA; Frenkel-Brunswik, 1948, 1951, 1959; Hoffeditz & Guilford, 1935). TOA is operationalized as the way an individual perceives or processes information about a situation or stimulus when faced with a set of complicated, foreign, and vague stimuli (Furnham & Ribchester, 1995). The TOA construct is directly relevant to the study of contemporary distress tolerance work in that it reflects a perceived capacity to tolerate threatening stimuli. Informed largely by traditional personality theory, TOA is theorized to be a stable (trait-like) individual difference variable varying by degree across a single dimension (Budner, 1962). To the extent a person has relatively lower levels of TOA, they are expected to react with greater degrees of emotional distress (e.g., anxiety) and in a more impulsive or dysregulated manner (e.g., reactive cognitions and impulsive behaviors) when faced with an ambiguous situation. Furthermore, it is theorized that these individuals may be more apt to avoid such ambiguous stimuli in the future (Furnham & Ribchester, 1995). In contrast, an individual with relatively higher levels of TOA is theorized to perceive ambiguous stimuli as relatively non-threatening (Furnham & Ribchester, 1995).

The TOA construct has seemingly strong parallels to more contemporary perspectives on information processing biases for emotion-relevant information (MacLeod & Mathews, 1991; McNally, 1996), emphasizing the tendency to respond to ambiguous stimuli as negative and personally threatening (Clark et al., 1997). TOA can be distinguished from interpretive biases for ambiguous information primarily in the sense that this construct is focused on tolerance of ambiguous stimuli, instead of how such information is processed from cognitive or sub-cortical perspectives. That is, there is a direct explanatory emphasis on the individual's ability to withstand the subjective distress that is elicited by perceived ambiguity (Norton, 1975), although these conceptually distinct factors may well be related.

There have been a number of self-report instruments developed to assess TOA from a personality-oriented perspective, often presuming a large volitional and self-awareness component (Budner, 1962; O'Connor, 1952; Rydell & Rosen, 1966). Available TOA measures are listed in Table 1. These instruments include: the Walk's A Scale (O'Connor, 1952; e.g. *"There is more than one right way to do anything."*, *"No one can have feelings of love and hate towards the same person."*), The Scale of Tolerance-Intolerance of Ambiguity (Budner, 1962; e.g. *"There is really no such thing as a problem that can't be solved."*, *"What we are used to is always preferable to what is unfamiliar."*), the Rydell-Rosen Tolerance of Ambiguity Scale (Rydell & Rosen, 1966; e.g. *"A problem has little attraction for me if I don't think it has a solution."*, *"It bothers me when I am unable to follow another person's train of thought."*), Measure of Ambiguity Tolerance Scale – 20-item (MAT-20: Macdonald, 1970; composed of items from the Rydell-Rosen Tolerance of Ambiguity scale (1966) and four additional items), the MAT-50 (Norton, 1975; *"I prefer the certainty of always being in control of myself."* [Philosophy subscale], *"It bothers me when I don't know how strangers react to me."* [Public subscale]), Kirton's Tolerance of Ambiguity Scale – Revision (Kirton, 1981; composed of items from Budner's 1962 and MacDonald's 1970 scales), the Situational Test of Intolerance of Ambiguity (STIA: Bhushan & Amal, 1986; sample items not available), and the Scale of Interpersonal Intolerance of Ambiguity (SIA; Wolfradt & Rademacher, 1999, e.g. *"When a stranger greets me on the street, I'm very confused."*, *"If friends have problems but they don't want to talk about it with me, I feel very insecure."*). Historically, researchers have attempted to improve TOA scales (listed in Table 1) by building from one scale to the next in order to improve the psychometric properties of such tools and refine the TOA construct (see

Furnham & Ribchester, 1995, for a review). Thus, the TOA literature has had a relatively high degree of conceptual interconnectedness in its development (Furnham & Ribchester, 1995). Nevertheless, several TOA scales have been criticized for lacking a clear operational definition and demonstrating relatively poor psychometric properties (see Table 1; Ehlich, 1965).

Of the existing TOA instruments, the MAT-50, a multidimensional construct pertaining to tolerance for ambiguity across life domains (e.g., philosophy, interpersonal communication, public image, job-related, problem-solving, social, habit, and art forms; Norton, 1975), has been the most commonly employed in the field. It was tested seven times on a total sample of 1,496 undergraduates (127 to 274 participants per test) in order to develop high reliability with a resultant internal consistency of .88 (Norton, 1975). In addition, it evidences high test-retest reliability ($r = .86$). Tests of validity demonstrate significant correlations with rigidity of attitudes regarding personal habits ($r = .57$) (Meresko, Rubin, Shontz, & Marrow, 1954), Budner's (1962) measure of TOA ($r = -.40$), and rigidity ($r = .38$; Rehfisch, 1958).

Presumably because the TOA literature has not been informed by the study of psychopathology (cf. personality theory), there is limited study of the construct in relation to variables related to psychological symptoms and disorders. As a result, it is unclear how TOA is shaped by psychological vulnerabilities (e.g., family history of psychiatric illness) or psychopathology. In one early study in which a battery of tests were administered to a group of control and neurotic participants in order to examine varying responses to a range of ambiguous situations, Hamilton (1957) found that participants classified as neurotic avoided ambiguity more than control participants. Within those classified as neurotic, those specified as "conversion hysterics" and "obsessionals" were even less tolerant of ambiguous situations than anxious patients (Hamilton, 1957). In a sample of 197 university students, Buhr and Dugas (2006) similarly reported TOA was significantly, but modestly, related to trait worry among university students. Overall, whereas some work has found modest associations between TOA and certain psychological symptoms, the literature on this particular construct and psychopathology is highly limited.

Intolerance of uncertainty

Intolerance of uncertainty (IU) is operationalized as individual differences in the tendency to react in an intolerable fashion (emotionally, cognitively, or behaviorally) to uncertain situations and events (Buhr & Dugas, 2002; Dugas, Buhr, & Ladouceur, 2004). IU has historically been theorized to be relatively stable and therefore akin to a trait-like (Dugas, Gagnon, Ladouceur, & Freeston, 1998). The IU construct is important to the present review and distress tolerance work more generally, as it reflects a perceived capacity to be intolerant of distressing life situations and events.

IU has been studied most systematically and extensively in regard to generalized anxiety disorder (GAD), worry more generally, and to a lesser extent, obsessive-compulsive and panic psychopathology (Dugas, Gosselin, & Ladouceur, 2001; Hedayati, Dugas, Buhr, & Francis, 2003; Tolin, Abramowitz, Brigidi, & Foa, 2003). The IU construct, indeed, has been largely informed by cognitive-behavioral perspectives of GAD (Borkovec & Roemer, 1995; Craske 1999; Davey, 1994). This GAD work has indicated both theoretically and empirically that worry often involves the prediction of potential future negative outcomes and that such a prediction may permit a greater sense of perceived control or predictability over these outcomes (Borkovec & Roemer, 1995); such a process, for example, may conceivably foster greater preparatory time to problem-solve or avoid the expected outcome(s) (Stöber, 1998). As day-to-day life experiences often involve uncertain events and outcomes, individual variation in the ability to tolerate uncertainty may be a central construct for understanding the degree to which persons may worry about, and experience emotional distress (e.g., elevated state anxiety) in response to, such stimuli (Dugas, Schwartz, & Francis, 2004). Although the IU construct

may share some conceptual similarity to TOA, it is distinct from TOA insofar as IU is expressly focused on tolerance for uncertain, future-oriented, rather than ambiguous, “here and now,” life events (Grenier, Barrette, & Ladouceur, 2005). A basic distinction is that uncertain life events are not necessarily ambiguous (e.g., the relative success of a relationship could involve uncertain outcomes, but neither the relationship nor outcomes are ambiguous per se; Greco & Roger, 2001).

Historically, IU has been studied through self-report inventories primarily among adult clinical and nonclinical populations. The original scale, entitled the Intolerance of Uncertainty Scale (IUS) was developed in the French language by Freeston, Rhéaume, Letarte, Dugas, and Ladouceur (1994) with the subsequent successful development of an English-language version (Buhr & Dugas, 2002). There have been a variety of factor solutions reported for the IU scales with most indicating four- or five-factor solutions (see Table 1; Buhr & Dugas, 2002; Freeston et al., 1994; Norton, 2005), possibly due to methodological differences between studies (e.g., sample selection techniques, factor analytic approaches; Norton, 2005). Notably, Buhr and Dugas’ (2002) 27-item English-language version of the IUS scale replicated the original four subscales of the Freeston et al.’s (1994) French-language version: (1) Uncertainty Leads to Inability to Act subscale (e.g. “*When it’s time to act uncertainty paralyzes me.*”; 10 items); (2) Uncertainty is Stressful and Upsetting subscale (e.g. “*My mind can’t relax if I don’t know what will happen tomorrow.*”; 12 items); (3) Unexpected Events are Negative and Should be Avoided subscale (e.g. “*I should be able to organize everything in advance - reverse scored.*”; 7 items); (4) Being Uncertain About the Future is Unfair subscale (e.g. “*Unlike me, others seem to know where they are going with their lives.*”; 5 items). However, the English language version suggested that six items load onto more than one IUS subscale.

Because of the varied factor structures reported in past work, in conjunction with the high inter-item correlations, researchers have argued for a more refined IU scale (Carleton, Norton, & Asmundson, 2007). In response, Carleton and colleagues (2007) recently developed a 12-item IU measure entitled the Intolerance of Uncertainty Scale (IUS-12). The factors of the IUS-12 are entitled (a) Prospective Anxiety (e.g., “*Uncertainty keeps me from having a full life*”); and (b) Inhibitory Anxiety (e.g., “*Unforeseen events upset me greatly*”). Initial work on the IUS-12 indicated acceptable degrees of internal consistency for each of the two moderately correlated factors (Carleton et al., 2007).

Sexton and Dugas (2009) re-examined the validity of the original English-language 27-item IUS. Using both exploratory and confirmatory factor analysis, Sexton and Dugas examined the full-scale factor structure of the 27-item IUS among a non-clinical sample of 2,451 individuals. Both exploratory and confirmatory factor analyses revealed a well-fitted model comprised of two distinct, internally valid, and highly correlated, factors: (a) the Uncertainty has Negative Behavioral and Self-Referent Implications subscale ($\alpha = .92$; e.g. “*When it’s time to act, uncertainty paralyzes me.*”; 15 items); and (b) the Uncertainty is Unfair and Spoils Everything subscale ($\alpha = .90$; e.g. “*I always want to know what the future has in store for me.*”; 12 items) (Sexton & Dugas, 2009). Because the factors were so highly correlated, a single-factor solution also was evaluated; however, the two-factor model revealed superior model fit. Finally, tests of validity indicated that relative to Factor 2, Factor 1 was significantly more strongly related to the presence of GAD, trait anxiety, anxiety symptoms, and depressive symptoms; however, both factors were equally correlated with generalized worry (Sexton & Dugas, 2009).

Empirical evidence indicates that IU is related to greater concurrent degrees of anxiety symptoms, and that this construct maintains unique explanatory value (i.e., incremental validity) relative to related constructs with respect to anxiety symptoms. For example, cross-sectional work indicates a strong predictive relationship between IU and trait anxiety in non-

clinical college samples (Berenbaum, Bredmeier, & Thompson, 2008 [$n = 239$]; Buhr & Dugas, 2002 [$n = 276$]; Dugas, Freeston, & Ladouceur, 1997). Other work on college students ($n = 105$) has implicated IU as a partial mediator of the relationship between neuroticism and trait worry (de Bruin, Rassin, & Muris, 2007). Moreover, in tests comparing clinical and non-clinical samples, cross-sectional investigation of the relations between IU and anxiety disorders document that IU scores robustly discriminate between individuals with and without GAD (82–91% correctly classified) (Dugas, Gagnon, Ladouceur, & Freeston, 1998).

In an examination of 106 participants classified as meeting criteria for primary GAD, secondary GAD, another anxiety disorder, or a non-clinical control group, Ladouceur et al. (1999) found that the clinical participants evidenced significantly higher scores than control participants on IU. In addition, those with GAD scored significantly higher than those with other anxiety disorders on IU (Ladouceur et al., 1999). Further, in a sample of 62 patients with OCD, Steketee, Frost, and Cohen (1998) found that IU predicted an additional 18.1% variance in severity of OCD symptoms above and beyond variance accounted for by depression, anxiety sensitivity, and worry. Similarly, in a sample of 55 patients with OCD, Tolin, Abramowitz, Brigidi, and Foa (2003) found that IU was significantly correlated with severity of OCD obsessions, compulsions, and overall OCD severity. However, in a large sample of 505 individuals, Holaway and colleagues (2006) found no evidence of a stronger association between worry or GAD symptoms and IU in comparison to the relationship between OCD symptoms and IU. In addition, although individuals diagnosed with either OCD and GAD evidenced significantly higher levels of IU than controls, there was no significant difference in IU scores between these two clinical groups. However, those diagnosed with both GAD and OCD evidenced significantly higher levels of IU as compared to those with just one anxiety disorder diagnosis and non-anxious controls (Holaway, Heimberg, & Coles, 2006).

Ladouceur and colleagues (2000) found that individuals who underwent experimental manipulations aimed at increasing intolerance (i.e., decreasing tolerance) evidenced significantly greater increases in worry relative to those who underwent a manipulation aimed at decreasing intolerance (i.e., increasing tolerance) (Ladouceur, Gosselin, & Dugas, 2000). However, some research has indicated that the association between IU and worry may vary based on the *level* of uncertainty. For example, deBruin and colleagues (2006) manipulated high and low levels of uncertainty in a lab task, utilizing impossible to complete word association tasks in which half of the participants were instructed that they would “probably do very well” (high uncertainty) but the other half were instructed that “it would be perfectly normal if they didn’t answer all the questions correctly” (low uncertainty). They found that differences in IU were related to task-related worry in the low uncertainty situation, but not in the high uncertainty situation (de Bruin, Rassin, & Muris, 2006). Research indicates that a significant change in IU over the course of CBT for GAD is highly related to positive treatment gains that have been both maintained and improved upon, prospectively, at 6-month, and 1- and 2-year follow-ups (Dugas & Ladouceur, 2000; Dugas et al., 2003; Ladouceur, Dugas et al., 2000).

Overall, extant work on IU suggests that it is a risk marker for worry and GAD symptoms, and possibly for some other anxiety conditions (e.g., obsessive-compulsive disorder). Although the IU construct is relatively stable, potentially warranting risk marker status, it is malleable and prospectively related to change in worry and clinical status for GAD. Thus, IU also may serve as a risk factor for certain forms of anxiety and their disorders. Yet, one central overarching limitation of this empirical work is that it is not fully clear how IU relates to core distress tolerance processes. For example, people who achieve high scores on IU measures might be concerned about uncertainty because of concerns about emotional consequences (e.g., uncertainty elicits distress) or, alternatively, because of doubts about their ability to effectively cope and problem-solve with concrete external contingencies as opposed to experiencing

distress per se. Therefore, one important area of future IU research should focus on testing the putative linkages between IU and other distress tolerance constructs.

Discomfort intolerance

Discomfort intolerance has been defined as individual differences in the capacity to withstand uncomfortable physical sensations (Schmidt & Lerew, 1998; Schmidt, Richey, Cromer, & Buckner, 2007; Schmidt, Richey, & Fitzpatrick, 2006). In contrast to constructs that are delimited to specific internal stimuli such as pain (Feldner et al., 2006; Geisser, Robinson, & Pickren, 1992), discomfort intolerance has been conceptualized as relating to interoceptive (bodily) sensations that are uncomfortable, though not necessarily painful, to the individual more generally. Discomfort intolerance is theorized to be a relatively stable (trait-like) construct (Schmidt et al., 2006).

The core idea driving discomfort intolerance work is that persons less able to tolerate aversive physical sensations may be less able to withstand such stimuli, and therefore, motivated to escape or avoid situations (e.g., public settings) or activities (e.g., exercise) that may trigger them (Schmidt & Lerew, 1998). If such individuals high in discomfort intolerance consistently were unable to withstand physical stress and discomfort associated with fear and anxiety, and by extension were to escape or avoid it, they may place themselves at greater risk for maladaptive anxiety-relevant learning. For example, approach rather than avoidant behavior may result in a greater ability to tolerate physical stress (e.g., bodily sensations); specifically, certain people may become habituated to unwanted and feared sensations and/or develop a perceived sense of self-efficacy to experience and manage these otherwise unwanted states. This type of perspective is consistent with integrative theoretical models and intervention strategies that attempt to modify anxiety and other problematic emotional states by changing one's maladaptive (typically avoidant or change-oriented) responses to aversive interoceptive (e.g., bodily sensations) and exteroceptive (e.g., stressful life occurrences) events (Hayes & Shenk, 2004; Orsillo, Roemer, & Barlow, 2003; Ramel et al., 2004).

In order to empirically study the putative relation(s) between discomfort intolerance and the onset and maintenance of panic and related anxiety disorders, Schmidt and colleagues (2006) developed the Discomfort Intolerance Scale (DIS). The DIS is a five-item self-report instrument that measures the degree to which a person tolerates uncomfortable physical sensations. Its factor structure has been analyzed using principal axis factoring among four samples comprised of individuals with panic disorder, clinical controls, and non-clinical community members ($n = 1700$). The final factor analytic solution among the clinical sample indicated that the DIS comprises a global higher-order discomfort intolerance factor ($\alpha = .70$) and two sub-factors entitled Intolerance of Discomfort Intolerance ($\alpha = .78$; 55.8% variance explained) (e.g. "*I can tolerate a great deal of physical discomfort.*" – reverse scored), and Discomfort Avoidance ($\alpha = .92$; 23.8% variance explained) (e.g. "*I take extreme measures to avoid feeling physically uncomfortable.*") (Schmidt et al., 2006). This solution was also observed among the non-clinical sample. The DIS demonstrated good test-retest stability over 12 weeks among a sub-set of the clinical sample (Schmidt et al., 2006). Overall, extant work suggestst that the DIS demonstrates high levels of internal consistency (Schmidt et al., 2006; see Table 1).

Discomfort intolerance has been examined in a variety of adult clinical and non-clinical samples in relation to anxiety and other negative emotional symptoms. For example, Schmidt and colleagues (2006) found higher DIS scores among clinical samples, particularly persons with panic disorder, compared to persons without a clinical disorder. They also discovered that discomfort intolerance, indexed by the DIS, is moderately associated, both concurrently and prospectively, with measures of anxiety but less strongly associated with measures of depression (Schmidt et al., 2006). In laboratory research, DIS has sometimes, but not

uniformly, been related to elevated negative emotional responding. For example, Schmidt and Cook (1999) found that among 22 adults meeting criteria for panic disorder, discomfort intolerance was not predictive of self-reported ratings of anxiety or pain, or physiological responsiveness following a procedure where participants were asked to hold a chemical cold-compress to their throat for up to 120 seconds (Schmidt & Cook, 1999). Schmidt and Trakowski (1999) examined discomfort intolerance in terms of its association with change in self-reported anxiety using a carbon-dioxide (CO₂) enriched air paradigm among clinical ($n = 45$) and non-clinical ($n = 45$) participants. Here, they found that whereas discomfort intolerance was not predictive of greater fear response in the clinical group, high relative to low scores were associated with significantly greater fear responding in the non-clinical group.

Two other studies have similarly found that discomfort intolerance, measured by the DIS, is related to small increases in anxiety symptoms using biological challenge paradigms among non-clinical participants (Bonn-Miller, Zvolensky, & Bernstein, 2009; Schmidt et al., 2007). Specifically, in an examination of 216 young adults who participated in a biological challenge procedure, Bonn-Miller et al. (2009) found that the intolerance subscale of the DIS was significantly incrementally predictive of post-challenge ratings of anxiety focused on bodily sensations, physical panic symptoms, and behavioral avoidance above and beyond anxiety sensitivity, negative affectivity, and emotional acceptance. Similarly, among a group of 44 non-clinical community participants, Schmidt and colleagues (2007) found that discomfort intolerance significantly and incrementally predicts ratings of anxiety and agoraphobic cognitions following a biological challenge procedure, above and beyond trait anxiety and anxiety sensitivity. These data collectively suggest discomfort intolerance is related to anxious and fearful responding to bodily sensations among non-clinical but not necessarily clinical samples of anxiety disordered groups. Multiple possibilities may account for these findings, including pre-elevated levels of anxiety among the clinical groups. Such a restricted range may limit the possibility of identifying vulnerability processes in a manner similar to those observed among non-clinical samples.

Although the majority of research on discomfort intolerance has focused on anxiety in response to somatic cues and stress, an emergent line of study is focused on somatic discomfort and behavioral responding to it. One paradigm in this domain has been to employ voluntary hyperventilation; breathing at a paced rate exceeding metabolic demand (e.g., breathing a full breath every two second for 3-min period of time while sitting in a chair). For example, discomfort intolerance has been found to significantly predict the duration of voluntary hyperventilation time relative to other factors of theoretical interest (e.g., anxiety sensitivity; Marshall et al., 2008). Specifically, lesser levels of discomfort intolerance are related to greater levels of anxiety in response to voluntary hyperventilation. Although work in this area is only emerging, initial findings suggest a potential link between discomfort intolerance on the one hand and interpretation of and reaction to somatic discomfort on the other. Additional investigators have begun to extend the examination of discomfort intolerance to the area of substance use. For example, among a non-clinical sample of 265 undergraduates, Buckner and colleagues (2007) found that discomfort intolerance concurrently moderated the association between depression and marijuana use problems such that depressed individuals high in discomfort intolerance were most vulnerable to marijuana use problems (Buckner, Keough, & Schmidt, 2007). DIS scores also concurrently correlate with motives to use tobacco for habitual, addictive and negative affect reduction reasons, but not other types of motives (e.g., sensory satisfaction; Leyro, Zvolensky, Vujanovic, & Bernstein, 2008).

Overall, work on discomfort intolerance using the DIS suggests that this construct is concurrently and prospectively related to anxiety focused on bodily sensations, especially among non-clinical samples. The size of the observed effects has, however, tended to be small to moderate. Such work, although limited in overall scope, suggests that discomfort intolerance

may be a risk marker or factor candidate for certain anxiety symptoms and disorders. However, larger-scale prospective studies are needed to more comprehensively explore this issue.

Distress tolerance (for negative emotional states)

Simons and Gaher (2005) conceptualize distress tolerance as an individual's ability to withstand negative emotion states (Simons & Gaher, 2005).¹ Simons and Gaher (2005) suggested that affective distress tolerance is multidimensional in nature: involving an individuals' anticipation of and experience with negative emotions, including (a) ability to tolerate; (b) assessment of the emotional situation as acceptable; (c) how the individual regulates her/his emotion; and (d) how much attention is absorbed by the negative emotion and how much it interferes with functioning.

To measure distress tolerance from this perspective, Simons and Gaher (2005) developed the Distress Tolerance Scale (DTS). The DTS is a 15-item self-report measure that examines one's perceived ability to tolerate emotional distress including questions related to tolerance, appraisal, absorption, and regulation. Initial exploratory and confirmatory factor analyses of the DTS by Simons and colleagues (2005) among large college-aged samples (Study 1: 642 students; Study 2: 823 students) supported a four-factor model composed of four subscales: tolerance ($\alpha = .72$) (e.g. "I can't handle feeling distressed or upset."), appraisal ($\alpha = .82$) (e.g. "Being distressed or upset is always a major ordeal for me."), absorption ($\alpha = .78$) (e.g. "When I'm distressed or upset, I cannot help but concentrate on how bad the distress actually feels."), and regulation ($\alpha = .70$) (e.g. "I'll do anything to stop feeling distressed or upset.") with good test-retest reliability (intra-class $r = .63$). A single higher-order distress tolerance factor emerged from the four related factors (see Table 1 for summary).

These initial examinations also indicated that the DTS was, as theorized *a priori*, negatively associated with measures of affective distress (negative affectivity) and dysregulation (lability), while positively associated with mood acceptance, and mood typicality, and negatively related to alcohol and marijuana coping use motives (motivation to use substances to reduce negative mood) (Simons & Gaher, 2005; Study 1, $n = 642$). In addition, based on the single higher order factor, measured as the mean of the four identified subscale scores ($\alpha = .82$), men reported significantly greater levels of distress tolerance than women after controlling for negative affectivity (Simons & Gaher, 2005; Study 1, $n = 642$). Further, the DTS was associated with levels of alcohol use-related problems (but not alcohol use frequency) among active male users, after controlling for negative affectivity and alcohol problems at baseline and use frequency at 6-month follow-up (Simons & Gaher, 2005; Study 2, $n = 543$). Specifically, the regulation factor of the DTS was most associated with alcohol-related problems, but again, only among men (Simons & Gaher, 2005; Study 1, $n = 543$). Consistent with the trait-like perspective of distress tolerance, the DTS appears to be relatively stable over a 6-month time period (Simons & Gaher, 2005).

Recently, the DTS has been studied among a number of populations to explore its associations with psychological symptoms and disorders, although the overall empirical data base is relatively small. Utilizing this scale, in an investigation among 118 HIV-positive patients, O'Leirigh and colleagues (2007) found that DTS scores moderated the associations between number of life events rated negatively over the previous 6 months and depressive symptoms,

¹Distress tolerance is the general label most frequently given to the body of work reviewed in the current paper (Zvolensky & Otto, 2007). It is important to recognize that Simons and Gaher (2005) use this same term to reflect a specific type of distress tolerance, as described in this review. Thus, distress tolerance has been employed to represent (a) a global area of work and (b) a specific type of tolerance. In this section of the paper, we use the term distress tolerance to refer to the Simons and Gaher (2005) conceptualization. From this point forward, however, we note specifically when we are referring to the Simons and Gaher (2005) perspective of a specific construct. In all other instances, it should be presumed we are referring to the putative higher-order distress tolerance concept.

use of substances in a coping-oriented manner, alcohol use, and cocaine use in the past month, and number of reported reasons for missing HIV medication dosages (O’Cleirigh, Ironson, & Smits, 2007). Specifically, lower levels of distress tolerance under conditions of higher degrees of life stress were related to greater endorsement of the aforementioned outcomes. Other work has been cross-sectional in nature, and focused on exploring distress tolerance in terms of eating and substance use symptoms and problems. For example, among $n = 200$ undergraduates, Anestis and colleagues (2007) found an interaction between distress tolerance and impulsivity in the prediction of bulimic symptoms, such that individuals low in distress tolerance and high in impulsivity were most likely to report high bulimic symptoms when experiencing negative affect (Anestis, Selby, Fink, & Joiner, 2007). In addition, distress tolerance significantly mediated the association between anxiety sensitivity and bulimia severity among a large sample of undergraduates (Anestis et al., 2007). In another investigation among 265 undergraduate students, Buckner and colleagues (2007) found that DTS scores concurrently mediated the relationship between depressive symptoms and both marijuana and alcohol use problems. More recently, Zvolensky and colleagues (2009) found that DTS scores concurrently related to coping motives but not other motives and to marijuana use among adult marijuana users ($n = 135$); these effects were evident above and beyond current marijuana use frequency (past 30 days), daily cigarette smoking rate, average volume of alcohol used over the past year, negative affectivity, and other marijuana use motives.

Overall, existing work using the DTS suggests that distress tolerance is concurrently related to a variety of psychological symptoms, and one study has observed prospective relations to poor HIV-related outcomes over a 6-month time period. Across investigations, the effects tend to be observed incrementally above and beyond a variety of relevant factors. Although limited, these data highlight the potential role of distress tolerance as a relatively stable, trait-like putative risk marker for psychopathological symptoms. No data regarding the malleability of distress tolerance, as indexed by the DTS, are available, limiting inferences that may be made regarding its potential to function as a risk factor. Future prospective work is needed to build upon the promising findings on distress tolerance from the DTS measurement perspective.

Frustration tolerance

A final, promising self-report measure of distress tolerance is Harrington’s Frustration-Discomfort Scale (FDS; Harrington, 2005a). Development of this scale was informed by rational-emotive behavior therapy (REBT) and the associated belief system composed of intolerance of frustration and discomfort. The scale consists of 28 items and was developed and evaluated among a sample of 333 clinical and 79 non-clinical participants. Initial work suggests that the FDS is multi-dimensional, consisting of four sub-scales comprising seven items each; all exhibit good internal consistency (Discomfort Intolerance, Entitlement, Emotional Intolerance, and Achievement/Frustration). However, examination of the scale items suggests that only two of these sub-scales are directly relevant to the current review: (1) Factor I: Emotional Intolerance ($\alpha = 0.87$) – beliefs regarding uncertainty, controllability, and aversiveness of emotion (e.g., “*I can’t bear disturbing feelings.*”, “*I must be free of disturbing feelings as quickly as possible; I can’t bear if they continue.*”); and (2) Factor III: Discomfort Intolerance ($\alpha = 0.88$) – demands that life should be easy, comfortable, and free of hassle (e.g., “*I can’t stand having to persist at unpleasant tasks.*”, “*I can’t stand doing tasks when I’m not in the mood.*”) (Harrington, 2005a). It also is noteworthy that psychometric analysis supported a four-factor multidimensional model and did not indicate a higher-order or global frustration tolerance factor.

Work by Harrington documents a number of concurrent associations between the FDS Discomfort Intolerance and Emotional Intolerance factors and a variety of self-control and affective variables. For example, among a non-clinical college-aged sample ($n = 86$), FDS

Discomfort Intolerance sub-scale scores were correlated with procrastination problems ($r = .34, p < .001$) (Harrington, 2005b). Among an outpatient adult clinical sample ($n = 242$; 32% anxiety, 23% depression), FDS Emotional Intolerance sub-scale scores were uniquely related to medication reliance ($r = .39, p < .001$) and self-harm ($r = .24, p < .001$) after controlling for negative affect (Harrington, 2005c). Harrington (2006) additionally examined the predictive validity of FDS Discomfort Intolerance and Emotional Intolerance sub-scale scores with respect to a variety of affective processes among an adult sample of 254 referred clinical patients (Harrington, 2006). After controlling for sex, self-esteem, and negative affect, as well as scores on the other FDS sub-scales, FDS Emotional Intolerance sub-scale scores were significantly related to anxiety while FDS Discomfort Intolerance sub-scale scores were significantly related to depression (Harrington, 2006). In addition, in a large sample of students ($n = 2,114$), Ko and colleagues (2008) found that greater FDS Discomfort Intolerance sub-scale scores were related to greater levels of internet addiction among males and females).

Overall, research utilizing the FDS indicates that the Discomfort Intolerance and Emotional Intolerance sub-scales may be related to self-control as well as affective vulnerabilities. Yet further psychometric evaluation and study using the FDS is necessary prior to drawing more firm conclusions. To date, there are no empirical data on the relative degree of malleability of frustration intolerance dimensions, or how these constructs relate to psychopathology over time. Accordingly, it is not presently possible to comprehensively discern how, or in what ways, frustration tolerance may be systematically related to psychopathological symptoms or disorders.

Distress Tolerance Perspectives: Biobehavioral Measures of Withstanding Negative Emotional and Other Aversive States

There have been a number of approaches used to measure the duration of time an individual can withstand exposure to a specific type of aversive stimulus or task that elicit various forms of distress. These assessment approaches are listed in Table 2. They are conceptually directly relevant to the study of distress tolerance in that they reflect the behavioral capacity to tolerate a specific form(s) of elicited distress. They have been studied explicitly as biobehavioral indices of distress tolerance across a variety of literatures.

Physical tolerance tasks

One line of work focused on tolerance for physical distress is termed thermal stress tolerance. The empirical investigation of thermal environmental affects on humans has been explored since the 18th Century (Blagden, 1775a, 1775b). This work has had implications for various domains of applied work, including industrial productivity as well as physical, psychomotor, and cognitive activities (e.g. Goldman, 2001). Research within this area has addressed how individuals tolerate stressful thermal conditions (Hancock, Ross, & Szalma, 2007) and is oriented toward tolerance of acute physical distress elicited by specific (thermal) stimuli. There has been little described about the relative stability over time of this type of thermal stress tolerance. However, this body of work implicitly operates from the perspective that thermal stress tolerance is relatively stable, even though it may vary as a function of learning (e.g., practice of thermal stress exposure may increase the ability to withstand thermal stress) and other factors (e.g., current stress level; Hancock et al., 2007).

Thermal tolerance has primarily been induced through partial body exposures or water immersion (e.g., cold pressor; Hines & Brown, 1932). The cold pressor task (CPT), for example, involves continual application of an aversive, but safe (i.e., no permanent tissue damage), cold stimulus. Most procedures involve the immersion of an individual's hand at least up to the wrist in ice water, typically 1°C (33°F), with instructions to keep one's hand

still (e.g., Burns, Bruehl, & Caceres, 2004; Hines & Brown, 1932; Neufeld & Thomas, 1977; Willoughby, Hailey, Mulkana, & Rowe, 2002). Pain *threshold* is determined by measuring the time taken for the participant to indicate that s/he feels “pain” (e.g., Burns et al., 2004; Hines & Brown, 1932; Willoughby et al., 2002) or “discomfort” (Neufeld & Thomas, 1977). *Tolerance* is determined by the time it takes for an individual to report that the pain or discomfort is no longer tolerable and/or terminates the procedure by removing her/his hand (e.g. Burns et al., 2004; Hines & Brown, 1932). *Endurance* is measured as tolerance minus threshold (Neufeld & Thomas, 1977). If the participant has not demonstrated intolerance within 5 minutes the procedure is typically terminated in order to prevent possible harm (Hackett & Horan, 1980; Neufeld & Thomas, 1977; Willoughby et al., 2002). Some procedures prompt participants to rate their level of discomfort periodically throughout the procedure on a rating scale (e.g. Hackett & Horan, 1980; Willoughby et al., 2002). For purposes of the present review, the tolerance variable and the endurance variable are most relevant to distress tolerance processes.

Thermal stress has additionally been induced experimentally through whole body air temperature exposures (see Hancock et al., 2007; Pilcher, Nadler, & Busch, 2002, for reviews). Whole body methods of examining cold thermal stress (temperatures typically less than 65° F [18.33° C]) (e.g., Sharma & Panwar, 1987; Thomas, Ahlers, House, & Schrot, 1989; van Orden, Benoit, & Osga, 1996) are less common than methodologies used to induce heat thermal stress (temperatures of at least 70° F; e.g. Hocking, Silberstein, Lau, Stough, & Roberts, 2001; Hygge & Knez, 2001; Razmjou, 1996; Razmjou & Kjellberg, 1992), but both have been used to examine psychomotor, perceptual, and mental capacity functioning (Hancock et al., 2007). These procedures typically include exposure to cold (less than 65° F) or hot (greater than 70° F) temperatures over an extended period of time. Temperatures of 90° F or above and 50° F or below are most reliably and strongly related to detrimental cognitive-related task performance (Pilcher et al., 2002).

Radiant heat stimulation also has been used in various procedures to induce cutaneous, or skin surface pain, and to measure related tolerance and threshold ratings. Most methods include the application of light-bulb heat to a darkened area of the forehead (Kane, et al., 1971; Wolff & Jarvik, 1963), wrist (Procacci, 1979; Orbach et al., 1996), or finger of the dominant hand (Rhudy & Meagher, 2003). Participants are asked to indicate when a feeling of warmth changes to a feeling of pain or induces notable bodily sensations (Kane et al., 1971; Rudy & Meagher, 2003); this task has been typically referred to as a measure of thermal heat tolerance (Wolff & Jarvik, 1963). To the extent that the measurement is focused expressly on the detection of body temperature changes, however, it may possibly be more akin to an index of sensitivity to thermal heat.

Overall, regardless of the type of thermal stress (i.e., cold versus heat exposure), findings tend to show a similar pattern. Furthermore, tolerance for pain induced by these tasks is shorter after exposure to a pre-task emotional stressor. For example, Zelman et al. (1991) found that pain tolerance was significantly reduced after negative mood was induced compared to no mood induction (Zelman, Howland, Nichols & Cleeland, 1991). Others have found similar results (Jones, Spindler, Jorgensen, & Zachariae, 2002; Schmidt & Cook, 1999; Uman, Stewart, Watt, & Johnson, 2006; Willoughby et al., 2002). These data suggest that negative mood is related to poorer tolerance to acute pain induced via thermal stimulation. Thus, research suggests a possible interconnection between the degree to which a person may be sensitive to (and tolerant of) pain and the degree of her/his negative emotional distress.

Distress tolerance has also been examined with respect to tasks that elicit symptoms of physiological arousal and anxiety, typically called biological challenge tasks. These are

procedures used to manipulate individual oxygen and carbon-dioxide (CO₂) levels in order to induce physiological activity associated with anxious arousal (Zvolensky & Eifert, 2000).

Breath-holding is typically measured with the functional residual capacity estimate of breath-holding duration. In this procedure, participants breathe normally for 30 seconds, completely exhale on the experimenter's instruction, and then, inhale and hold their breath for as long as possible; this procedure is then repeated after a 60 second rest period. The longer duration for the two trials is typically employed as the index of maximum breath-holding duration and index of distress tolerance (Hajek, 1991; Hajek et al., 1987; Zvolensky, Feldner, Eifert & Brown, 2001).

The CO₂ challenge task developed by Brown and colleagues (2005) lasts 15-minutes and includes two 20% CO₂ presentations set to occur at 7 minutes and 12 minutes (Brown et al., 2005). The first presentation lasts 25 seconds, while the participant determines the length of the final presentation. That is, once the final presentation has begun, participants can press a button to terminate the CO₂-enriched air delivery. The duration of time (latency) to press the button (task termination) is the behavioral measure of distress tolerance. Unbeknownst to participants, if the participant does not terminate the CO₂-enriched air delivery within 60 seconds, the task automatically terminates. This same type of distress tolerance format also has been adapted using a voluntary hyperventilation procedure rather than CO₂-enriched air delivery (Marshall et al., 2008).

Work utilizing experimental manipulation of oxygen and CO₂ levels and behavioral responses to these biological challenge tasks as indices of distress tolerance has been applied to addiction and substance abuse research. These studies have yielded some evidence that daily smokers with a lower breath-holding duration have a lower ability to abstain following a quit attempt (Brown, Lejuez, Kahler, & Strong, 2002; Brown et al., 2009; Hajek et al., 1987), although these findings have not been replicated consistently, possibly owing to methodological differences between studies (Zvolensky et al., 2001). It is important to note that Brown and colleagues (2002) found that women were significantly more likely to terminate a CO₂ challenge procedure than men. This finding points to potentially important sex differences in distress tolerance that may have implications for quit success (Brown et al., 2002). Similarly, initial data suggest that persistence on a CO₂ challenge may be associated with early lapse to smoking (Brown et al., 2009). Specifically, in an examination of 81 smokers, Brown et al. (2009) found that pre-quit distress tolerance levels, as indexed by breath-holding duration and persistence on a CO₂ challenge procedure, predicted risk for early lapse to smoking following self-guided (unaided) quit attempt. These two effects were each incremental, over and above levels of nicotine dependence, education, and history of major depressive disorder.

Next, Abrantes and colleagues (2008) found that compared to smokers in a "high persistence group" (i.e., high persistence on breath holding and CO₂, $n = 23$), smokers in a "low persistence" group (i.e., low persistence on breath holding and CO₂, $n = 21$) were more likely to (a) lapse to smoking on quit day; (b) demonstrate higher levels of negative affect and greater urges to smoke on quit day; and (c) show elevated negative affect on quit day. There were relatively few differences observed between the "low persistence group" and the "average persistence group" (high persistence on either breath-holding or CO₂, $n = 37$). In other work, MacPherson and colleagues (2008) found that physical distress tolerance, as indexed by breath-holding duration and latency to terminate a cold pressor procedure, was lower among men ($n = 81$) who dropped out of a (behavioral activation) smoking cessation treatment for depressed smokers prior to quit-day relative to men who engaged in treatment; this effect was observed above and beyond anxiety sensitivity and current depressive symptoms. This finding was not observed among women (MacPherson, Stipelman, Duplinsky, Brown, & Lejuez, 2008).

A similar association has been observed for other addictive problems. For example, in a comparison of 16 gamblers with a history of at least one sustained period of abstinence and 16 gamblers with no history of successful abstinence attempts greater than 2 weeks (immediate relapsers), there was a marginally lower breath-holding duration among those with an immediate relapse history (Daughters, Lejuez, Strong et al., 2005). With regard to hyperventilation, in a sample of 95 daily cigarette smokers, Marshall et al. (2008) found that smokers who experienced a panic attack during a hyperventilation procedure evidenced lower levels of distress tolerance based upon latency to termination of a second hyperventilation procedure.

Investigators have additionally begun to explore the context-dependent expression of distress tolerance, as indexed by breath-holding, within the context of substance use and its disorders. Among 43 adult daily smokers, Bernstein, Trafton, Ilgen, and Zvolensky (2008) found that breath-holding duration was significantly shorter during an experimental session that immediately followed a 12-hour smoking deprivation period (internal contextual shift via nicotine deprivation) than during a smoking-as-usual session. This effect was observed above and beyond changes in level of self-reported stress between sessions 1 and 2. Furthermore, among these daily smokers, levels of psychiatric symptoms were significantly negatively correlated with breath-holding duration during the smoking deprivation, but not the smoking-as-usual session (Bernstein et al., 2008). These findings are consistent with theory suggesting that for individuals with a pre-existing psychological diathesis (i.e., psychiatric symptoms), smoking deprivation as an 'internal context' shift may activate a vulnerability process that decreases capacity to tolerate distress. Alternatively, in the absence of this stressor or change in context, these psychiatrically vulnerable daily smokers may express differing levels of distress tolerance.

Various potential mechanisms of action may help account for these observed associations between smoking deprivation and distress tolerance. First, smoking deprivation could increase physiological and interoceptive perturbations (e.g., nicotine withdrawal symptoms), and thereby, decrease availability of resources to tolerate distress. Secondly, smoking deprivation could limit smokers' access to a well-learned coping strategy; specifically, smoking to reduce negative affect and perceived distress. Without the use of smoking as a means to cope, a maladaptive strategy that nonetheless provides immediate perceived relief, smokers may be unable to temper their distress and over time experience a decreased capacity to tolerate distress. This perspective is broadly consistent with limited resource models of self-regulation (Muraven & Baumeister, 2000). Finally, smoking deprivation also could, neurobiologically and behaviorally, predispose an individual to be increasingly sensitive to distress and disinhibited in their pursuit of negative reinforcement cues (i.e., motivated to escape distress) (Trafton & Gifford, in press).

The existing data collectively suggest that breath-holding duration, and perhaps persistence on CO₂ challenge, may possibly be related to duration of abstinence for smoking, and other addictive problems (e.g., gambling; Daughters, Lejuez, Strong et al., 2005). It also appears that more affective reactivity (panic symptoms) in response to bodily stress may be related to lesser ability to tolerate exposure to the same type of stress in the future (Marshall et al., 2008). Furthermore, initial data suggest that distress tolerance, as indexed by breath-holding and potentially other related indices of the construct, may possibly be characterized by a context-sensitive/dependent expression as opposed to a more context-insensitive or rigid trait-like expression (Bernstein et al., 2008). Additionally, initial data indicate that psychiatric symptoms and distress tolerance, as indexed by breath-holding duration, may be more strongly associated under certain contextual conditions (Bernstein et al., 2008).

Breath-holding duration, conceptualized as an index for tolerance of suffocation sensations, also has been explored as a marker of vulnerability for anxiety disorders (Asmundson & Stein, 1994). Although some work has found evidence that breath-holding duration is related to panic psychopathology to a greater extent than some other anxiety states or conditions (e.g., social phobia; Asmundson & Stein, 1994), other work has not found evidence of such specificity (e.g., Eifert, Zvolensky, Sorrell, Hopko, & Lejuez, 1999; McNally & Eke, 1996; Van der Does, 1997).

Overall, lesser tolerance to tasks that induce abrupt anxious arousal sensations suggests that such indices may mark a greater vulnerability to incur problems abstaining from substance use among active users, especially early in the quit attempts (when bodily sensations and interoceptive distress are generally most evident). For methodological reasons, it is unclear whether such indices of distress tolerance represent a risk factor per se or are better understood as a fixed marker. Work in the anxiety domain suggests that there is little empirical evidence that breath holding duration is related to specific types of anxiety disorders, such as panic psychopathology, characterized by interoceptive fears. In all areas of study, prospective research would be a useful next step addition to better explicate how, and in what ways, tolerance to aversive internal sensations relates to psychopathological disorders.

Cognitive-based tolerance tasks

Tolerance measures also have been focused on the ability to complete difficult or frustrating tasks that require cognitive or related psychological resources. These types of measures have been conceptualized and employed as indices of cognitive tolerance for psychological frustration (Lejuez, Kahler, & Brown, 2003). The Paced Auditory Serial Addition Test (PASAT), Mirror-tracing, and Anagram Persistence tasks are perhaps the most well-known and used measures.

The PASAT is a visual and/or auditory serial addition task originally developed by Gronwall and Sampson (1974). Administration involves visually or aurally presenting individuals with a series of single-digit numbers where the individual continually sums the two most recently presented digits (Tombaugh, 2006). The individual must correctly respond prior to the presentation of the next digit in order to receive a correct response score. Each set typically consists of 60 trials, or opportunities to correctly respond, and each trial consists of a set inter-stimulus interval (ISI), which is the amount of time between digit presentations. Many researchers have employed several ISIs across several trials, and may choose certain trial lengths based on the population being investigated and the potential of ISIs to detect group differences (Tombaugh, 2006). Scoring consists of the total number of correct responses for each trial, where a composite score is the total number of correct responses summed across all trials (Tombaugh, 2006). Alternatively, performance may be assessed as the average response time for a correct response where the total trial length (duration of the ISI multiplied by 60) is divided by the number of correct responses (Gronwall, 1977). In addition, scoring has been assessed by the percent of correct scores, response latency, and sum of errors (omission, incorrect responses, and late responses; Tombaugh, 2006). Gronwall and Sampson (1974) originally conceptualized the PASAT as an index of information processing, however, subsequent work has suggested that it measures multiple cognitive functions such as attention, working memory, and ability to perform under time constraints (e.g. Madigan, DeLuca, Diamond, Tramontano, & Averill, 2000).

Although the PASAT has been used primarily as an index of sustained attention and concentration, researchers have noted the difficulty of the PASAT and its elicited perceived stress, negative affect, unwillingness to engage in the task, as well as propensity toward early termination, of the task among participants (Tombaugh, 2006). For example, Holdwick and Wingenfeld (1999) investigated mood state change among 80 college students and found that

self-reported negative affect, as measured by the Multiple Affect Adjective Checklist (MAAC; Zuckerman, Lubin, & Rinck, 1983), significantly increased as a result of PASAT administration among those with positive or neutral mood, whereas the mood of those already sad and anxious remained the same. In addition, among a sample of 20 participants, Deary and colleagues (1994) observed a significant increase in state anxiety as assessed by the Spielberger State Anxiety Questionnaire (Spielberger, Gorsuch, & Lushene, 1970), during PASAT administration.

Lejuez and colleagues (2003) proposed a modified computerized version of the PASAT consisting of three corresponding levels: Level 1 - low difficulty, 3 minutes; Level 2 - medium difficulty, 5 minutes; and Level 3 - high difficulty, 10 minutes; PASAT-C). There are two formats, one in which participants select their response by using the computer mouse and one in which participants provide their response verbally (e.g., Daughters, Lejuez, Kahler, Strong & Brown, 2005). During administration of the PASAT-C, Level 1 transitions to Level 2 (Lejuez et al., 2003), which is followed by a 2-minute rest period before participants are prompted to complete Level 3 (Lejuez et al., 2003). Participants are provided negative feedback with each error and told that at some point during Level 3 that they will be given the option to terminate the procedure but that their reward is contingent on their level of performance (Lejuez et al., 2003). Participants are then told that they will be awarded 1 point for each correct response, where incorrect scores or failure to respond will not impact their score. Unbeknownst to the participant, the task automatically terminates within 7–10 minutes (Daughters, Lejuez, Bornovalova et al., 2005; Daughters, Lejuez, Kahler et al., 2005; Lejuez et al., 2003). Prior to the task as well as after Level 2, levels of dysphoria including self-reported anxiety are obtained using a four-item scale that assesses difficulty concentrating, irritability, and frustration, to ensure that levels of psychological stress increase significantly as a result of the task (relative to baseline levels) (Brown et al., 2002). This dysphoria scale has demonstrated moderate internal reliability ($\alpha = .69$) (Daughters, Lejuez, Bornovalova, et al., 2005). In addition, Lejuez and colleagues (2003) have found evidence for the PASAT-C increasing physiological arousal, most strongly evidenced in skin conductance changes, but also in heart rate response. Psychological distress tolerance using the PASAT-C is indexed as time in seconds until task termination of level 3 (Lejuez et al., 2003).

The mirror-tracing task is another cognitive tolerance task involving a high degree of motor control. This methodology requires participants to trace the outline of a geometric figure, often a star, while viewing it through a mirror, or as though they are viewing the object through a mirror (Matthews & Stoney, 1988; Quinn, Brandon, & Copeland, 1996). Because of the mirror-tracing perspective, participants must move the tracer along the object (e.g., the star) in the opposite direction from where they intend for it to go. Each time the tracer falls off the outline of the star, an irritating auditory sound is omitted (Matthews & Stoney, 1988). Performance on this task is determined as the percent of time during the trial that the tracer is off the figure (Matthews & Stoney, 1988). Research indicates that engagement in this task results in a substantial increase in blood pressure, heart rate, and self-reported stress and frustration (Krantz, Manuck, & Wing, 1986; Matthews & Stoney, 1988, Tutoo, 1971).

In research utilizing mirror-tracing as a measure of distress tolerance, participants are typically given two practice trials consisting of simple line images that serve to help them to orient themselves to the task (Daughters, Lejuez, Bornovalova et al., 2005; Daughters, Lejuez, Kahler et al., 2005; Quinn et al., 1996). These lines are followed by one or more complex drawings that are extremely difficult, or practically impossible, to trace with accuracy (Daughters, Lejuez, Bornovalova et al., 2005; Daughters, Lejuez, Kahler et al., 2005; Quinn et al., 1996). To facilitate use of mirror-tracing in this area of research, Strong et al. (2003) developed the computerized mirror-tracing persistence task where participants trace figures using the computer mouse (MTPC-C; Strong et al., 2003). Prior to the task, participants are encouraged

to try their best, and in some cases, told that their level of performance will influence their monetary compensation (Daughters, Lejuez, Bornovalova et al., 2005; Daughters, Lejuez, Kahler et al., 2005; Strong et al. 2003). During the task, participants are not permitted to proceed until they have completed the trial figures but are given the option of discontinuing the final complex figure at any time (Daughters, Lejuez, Bornovalova et al., 2005; Daughters, Lejuez, Kahler et al., 2005; Quinn et al., 1996). Similar to the PASAT, after 5 minutes presentation of the object terminates. When using the task as a measure of distress tolerance, tolerance is measured as the average time spent on tasks that the individual was unable to complete (Daughters, Lejuez, Bornovalova et al., 2005; Daughters, Lejuez, Kahler et al., 2005; Quinn et al., 1996). Brandon and colleagues (2003) found that the mirror-tracing demonstrated good internal consistency among a sample of daily smokers ($\alpha = .92$).

The anagram persistence task (APT) (Eisenberger & Leonard, 1980) has also been employed to induce frustration and study distress tolerance. The APT presents participants with anagrams, which may range in levels of difficulty (Mayzner & Tresselt, 1966). Participants are told by the experimenter that each anagram stimulus contains letters that can be rearranged to form a word. Participants are then asked to either indicate to the experimenter (e.g., by raising hand or verbally; Postman & Solomon, 1950) that they have reached a solution in order to receive a point or to move on to the next anagram stimulus in the event that they cannot solve the word (Eisenberger & Leonard, 1980). It is noteworthy that points are assigned as a means to track the number of anagrams accurately solved and not as a reward. Participants are typically given a distinct amount of time in order to solve the anagram (e.g., 3 minutes; Brandon et al., 2003) and are directed to move on to the next card if they do not respond within the time allotted (Eisenberger & Leonard, 1980).

For procedures in which the APT is used as a measure of persistence or tolerance, the average time spent on difficult or uncompleted anagrams before giving up and proceeding to the next anagram stimulus is used as the individual's score (e.g., Quinn et al., 1996). Brandon and colleagues (2003) found that the APT demonstrated good reliability ratings across 6 trials among a sample of smokers ($\alpha = .85$).

Extant work utilizing cognitive tests of distress tolerance has centered on addictions research. For example, Daughters and colleagues (2005) found that individuals' PASAT termination was related to the duration of the most recent drug/alcohol cessation attempt among 89 individuals in an inner-city residential drug treatment facility (Daughters, Lejuez, Kahler et al., 2005). Also, among 122 individuals entering a residential substance abuse treatment, shorter PASAT duration predicted greater risk of early treatment dropout (< 30 days) (Daughters, Lejuez, Bornovalova et al., 2005). Aforementioned research on pathological gamblers also has indicated that those with a delayed relapse history are less likely to terminate a PASAT task than those with an immediate relapse history (Daughters, Lejuez, Strong et al., 2005).

With regard to mirror-tracing and APT, researchers have found that non-smokers ($n = 57$) are more likely to persist on both mirror-tracing than smokers ($n = 52$) after controlling for demographic variables, vocabulary scores, negative affect, and problems associated with other substance abuse (Quinn et al., 1996). Furthermore, performance on these tasks is related to both problematic alcohol use (mirror-tracing) and substance abuse history (mirror-tracing and APT) (Quinn et al., 1996). In an examination of 144 smokers, mirror-tracing was found to be significantly related to sustained abstinence at 12-months following a smoking cessation attempt, whereas APT performance was not (Brandon et al., 2003). Also, shorter duration on the mirror-tracing task predicted early residential substance use program treatment dropout (< 30 days) (Daughters, Lejuez, Bornovalova et al., 2005). In an examination of affective processes linked to pre-smoking cessation treatment attrition among 53 smokers, MacPherson

and colleagues (2008) also found that persistence on the PASAT was lower among women who dropped out of the behavioral activation oriented group before beginning treatment, relative to men and women who completed at least one session; the effect was observed above and beyond anxiety sensitivity and current depressive symptoms. A similar effect was not observed, however, for persistence on the mirror-tracing task. In contrast to findings for physical distress tolerance reported above, Brown and colleagues (2009) found that among 81 smokers planning to make an unaided self-quit attempt, pre-quit distress tolerance levels, as indexed by persistence on the PASAT, were not prospectively associated with risk for early lapse to smoking following a self-guided quit attempt above and beyond levels of nicotine dependence, education, and history of major depressive disorder.

Research using cognitive distress tolerance tasks is growing, usefully drawing from well-established methodologies from basic cognitive science and related fields. There is some empirical indication that the behavioral capacity to engage in and not terminate these tasks (i.e., to inhibit pursuit of negative reinforcement opportunities), despite the high degrees of psychological frustration and fatigue such tasks elicit, is similarly related to the ability to maintain substance use abstinence despite physical discomfort and despite the availability of negative reinforcement opportunities associated with lapse/relapse (Brandon et al., 2003). It is unclear, however, whether other factors better account for such effects. Thus, it is presently unclear whether tolerance to such cognitive tasks may be a possible risk marker or risk factor.

Limitations of Extant Distress Tolerance Research

Global limitations

The overall body of research and evidence evaluating the theoretical and clinical importance of the distress tolerance construct(s) and its related facets for vulnerability to psychopathology is broad and growing but nonetheless limited. In this section, we outline formative gaps in empirical knowledge that may shape theoretical, methodological, and clinical advances related to distress tolerance.

Gap 1: Construct validity

Although the various biobehavioral and self-report measures reflect a strength of this literature – from the perspective that they are intended to provide a multi-measure and multi-method approach to distress tolerance research – it is not clear how these self- and non-self-report measures relate to one another or to the intended overarching construct(s) of distress tolerance. In one such recent attempt to understand these associations, McHugh and colleagues (in press) examined shared variance among a variety of self-report and behavioral indices of distress tolerance. Results suggested that the self-report measures were highly correlated, as were the behavioral measures; however, behavioral and self-report measures did not exhibit significant associations with one another (McHugh et al., in press).

This scientific limitation, along with preliminary research efforts, highlights the importance of more systematic study to develop and evaluate multi-methodological measurement of a common distress tolerance construct, or specific facet(s) of this construct for the purpose of more rigorously measuring individual differences in the variable(s). This gap in the literature is central to offering more internally valid investigation of the linkages between distress tolerance and psychopathology.

In addition, the construct validity of certain biobehavioral tasks as measures of distress tolerance, such as the cognitive frustration tasks (e.g., anagram, PASAT, mirror-tracing), remains largely unclear. For example, indices of persistence (i.e., propensity to maintain a behavior related to reward contingencies; Cloninger, Przybeck, & Švrakic, 1991) may be related to willingness and ability to tolerate unwanted or distressing states elicited by these

tasks (e.g., frustration), specifically *in order to seek reward*. Standard contingencies in studies that use biobehavioral methods of measuring distress tolerance—specifically those that utilize cognitive-frustration tasks—often include positive reinforcement. Here, reward is typically contingent on successful task performance (e.g., accurate mirror-tracing is rewarded). Consequently, performance and persistence/tolerance on these tasks may be partially confounded. Namely, persistence on these tasks may be a result of greater distress tolerance *per se*, as theoretically intended, but also a byproduct of the fact that performance (e.g., solving anagrams accurately) may improve as a function of reward received for accurate performance and the time that a participant is willing to persist on that task. An alternative perspective is that these biobehavioral tasks do index distress tolerance insofar as these tasks may reflect individual differences in motivation to seek negative reinforcement (via task termination) relative to motivation to seek other delayed (positive) reinforcement opportunities (i.e., task performance rewards). This issue also pertains to other literatures such as approach-avoidance motivation research (e.g., Trafton & Gifford, *in press*). This overall construct validity issue highlights a fundamental gap in the extant distress tolerance literature. Indeed, how we measure distress tolerance will continue to directly inform the theoretical meaning of the construct, and vice-versa.

A related limitation of extant work using self-report and biobehavioral methods to operationalize distress tolerance involves a seldom recognized construct-method confound, an apparent “accident” of the distress tolerance research literature. Specifically, self-report measures of distress tolerance differ from biobehavioral measures of distress tolerance not only methodologically; moreover, they index (by design) *perceived* capacity to tolerate various forms of distress. In contrast, biobehavioral measures of distress tolerance not only differ from self-report measures methodologically; moreover, they index (by design) *behavioral* acts of withstanding distress. Thus, our inferences and understanding based on extant research of the associations between distress tolerance and various forms of psychopathology, may, in part, be the result of the fact that our methods are confounded by the measurement of specific and distinct facets of the distress tolerance construct(s). Empirical study to date has not expressly attempted to disentangle this potential method-construct confound in extant distress tolerance measurement. In future work, a new self-report measure regarding a person’s behavioral acts of withstanding distress should be contrasted with other self-report measures of perceived capacity to tolerate distress *and* with biobehavioral measures of behavioral acts of withstanding distress in regard to psychopathology. Similarly, a new biobehavioral measure of perceived tolerance of distress (e.g., rating one’s perceived tolerance in a standardized real-time experimental task) should be contrasted with other biobehavioral measures of behavioral acts of withstanding distress *and* self-report measures of perceived capacity to tolerate distress in regard to psychopathology.

Such research may help advance our knowledge of distress tolerance and its linkages to psychopathology in a number of ways. This type of research may help to explicate whether perceived capacity to tolerate and behavioral acts of tolerance are clinically important in similar ways and whether these conceptual facets of distress tolerance are unique or common elements of vulnerability to psychopathology. As another example, such work may help to elucidate whether and how these conceptual facets of distress tolerance shape one another and how psychopathology may differentially or commonly affect each conceptual and operational facet of distress tolerance. Such future work may be central to strengthening theoretical and methodological aspects of the distress tolerance literature and the distress tolerance-psychopathology literature.

Gap 2: Distress tolerance and its nomological net

A second, formative gap in the distress tolerance literature involves theory and empirical tests of the linkages between the distress tolerance construct(s)/measures and conceptually overlapping and putatively related risk and protective factors and processes. Such work is necessary to advance understanding of the nature of distress tolerance construct(s), related processes, and vulnerability to psychopathology.

Along this line, future research may usefully involve study of the following constructs in relation to distress tolerance and psychopathology vulnerability: experiential avoidance (Hayes et al., 1999), emotional suppression (Richards & Gross, 2000), and avoidant (Folkman & Lazarus, 1986) or disengagement-related coping (Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001), emotion (dys)regulation (Kashdan & Steger, 2006), anxiety sensitivity (Bernstein et al., 2007; McNally, 2002; Taylor, 1999), and personality-based perspectives on persistence (Barkley, 1997; Cloninger et al., 1991). We now present the major conceptual distinctions and similarities between these constructs and distress tolerance, in an effort to guide future empirical work on distress tolerance and its putative nomological network. See Table 4.

Experiential avoidance subsumes a large constellation of responses functionally aimed at altering the form or frequency of aversive internal experiences (e.g., negative thoughts, bodily sensations) and the contexts that occasion them (Hayes, Wilson, Gifford, Follette, & Strosahl, 1996). It is possible that distress tolerance is a specific type of experiential avoidant process (Hayes et al., 1999), although direct empirical work testing this hypothesis is lacking. Likewise, emotional suppression is generally defined as effortful inhibition of *ongoing* emotional experiences (Gross, 1998), whereas distress tolerance may or may not actually involve the suppression of an elicited affective state. Thus, although distress tolerance and emotional suppression both involve inhibitory processes, they are not conceptually identical constructs. Similarly, avoidant and disengagement coping generally reflect conscious, voluntary attempts to manage internal or external stressors that an individual perceives as exceeding her/his personal resources (Compas et al., 2001; Folkman & Lazarus, 1986). Thus, unlike distress tolerance, such coping is a behavioral strategy and cognitive skill set that influences *how* one responds to unwanted stimuli, including distress. Distress tolerance may theoretically 'drive' a variety of forms of avoidance, such as avoidant or disengagement coping or experiential avoidance such as suppression, and perhaps vice-versa; but it is not conceptually one in the same as these (related) processes.

Emotional dysregulation involves multiple difficulties in emotional functioning and control (Cole, Michel, & Teti, 1994; Mennin, 2004; Mennin, Heimberg, Turk, & Fresco, 2002; Salovey, Mayer, Goldman, Turvey, & Palfai, 1995). Contemporary perspectives denote that emotional dysregulation reflects (a) difficulties in the self-regulation of affective states and (b) difficulties in self-control over affect-driven behaviors (Carver, Lawrence, & Scheier, 1996; Gross, 1998). To this end, Mennin and colleagues (2005) have developed an emotional dysregulation model that has shown much promise. In brief, the model posits that emotion dysregulation and disruption is reflected in heightened emotional intensity, poor understanding of emotional states, negative reactivity to one's emotional states (fearing the consequences of emotions), and maladaptive management of emotional responses (Mennin, Heimberg, Turk, & Fresco, 2005). Thus, from this perspective, tolerance of distress is a perhaps narrower construct than emotion dysregulation per se. For example, distress tolerance may theoretically be conceptualized as a lower-order component of a higher-order emotional dysregulation construct. To the best of our knowledge, there has not been work that empirically documents that distress tolerance is, in fact, an aspect (component) of emotional dysregulation, although certain models of psychopathology allude to this possibility (e.g., Linehan, 1993).

Distress tolerance also may be related to anxiety sensitivity. Anxiety sensitivity is the fear of anxiety and arousal-related sensations and their consequences, and specifically, the tendency to interpret such changes in physiology in a catastrophic manner (Reiss, Peterson, Gursky, & McNally, 1986). We note that distress tolerance is not conceptually equivalent to anxiety sensitivity. For example, distress tolerance is not related principally to the expectation of negative consequences of anxiety and other interoceptive sensations, central to the anxiety sensitivity construct. Also, concurrent study of distress tolerance and anxiety sensitivity has documented differential predictive effects with respect to emotional and drug use behavior (Bonn-Miller et al., 2009; Zvolensky et al., 2009). These data empirically document that these two constructs, although related, appear to be indexing distinct processes.

The construct of persistence has been operationalized as an individual trait-like dimension of temperament related to propensity to maintain a behavior related to reward contingencies (Barkley, 1997; Cloninger, 1991). Models of personality often suggest persistence is a sub-trait of a higher-order reward dependence construct (e.g., Cloninger, 1991; Cloninger, Švrakic, & Przybeck, 1993). Similar perspectives have been offered in the context of learned industriousness theory (Eisenberger, Kuhlman, & Cotterell, 1992). Individuals at the higher end of this trait tend to persist on tasks despite frustration and fatigue and to increase their task-specific responding when a reward is anticipated (Kose, 2003). From this perspective, persistence may be expected to relate to distress tolerance in the sense that persistence could involve features of distress tolerance (e.g., a propensity to persist may involve a perceived and/or actual to tolerate distressing states). However, these constructs also may be distinct insofar as persistence typically focuses on reward achievement (Cloninger et al., 1991), whereas distress tolerance typically does not.

Overall, explicating the nomological net of distress tolerance will facilitate a clearer understanding of its shared and/or unique role(s) in the development and maintenance of psychopathology. For example, potentially promising steps for future research may involve cross-sectional, experimental, and controlled prospective studies for functional uniqueness, overlap, and relations between distress tolerance and the variety of factors and processes that are theorized as structurally and functionally distinct, at least partially, from distress tolerance. It may be particularly useful to evaluate the nature of the associations between distress tolerance and its theoretically related factors with respect to one another and with respect to the development and maintenance of psychopathology. Such study may involve tests evaluating its incremental validity, as well as tests of potential mediating and moderating mechanisms underlying vulnerability to psychopathology within which distress tolerance may operate. In terms of structural study, factor analytic and other emerging latent structural variable modeling methods may be particularly promising tools for explicating the latent structural topography of distress tolerance and its nomological network.

Gap 3: Context and flexibility in the application of distress tolerance

There is a need to consider the role of flexibility and context-sensitivity in distress tolerance processes. Although the current review has largely focused on psychopathological correlates of limited or low levels of distress tolerance, low distress tolerance may not be necessarily maladaptive in certain contexts; similarly, high distress tolerance may not necessarily be adaptive in other contexts. For example, to the extent that individuals maintain a rigid perspective that they cannot tolerate aversive emotional experiences like sadness, they may employ maladaptive escape/avoidance coping strategies (e.g., cognitive/affective suppression) that may thereby paradoxically promote greater negative mood states such as depressive symptoms (Wegner, 1994). In contrast, to the extent a person is exposed to life circumstances that result in extreme and prolonged distress, inflexible *high* levels of distress tolerance may result in undue, prolonged suffering, whereas context-sensitive avoidance of such distress may

alternatively lead to adaptive behavior and outcomes valued by the person. Thus, mixed findings with respect to low levels of distress tolerance and psychopathology vulnerability would be expectable.

Scholars have recently suggested that greater scientific and clinical attention should be focused on overly high levels of distress tolerance (Lynch & Mizon, in press). Here, the perceived ability to tolerate distress, or actual behavioral tolerance of distress, can refer to situations in which an individual tolerates (perceived or objective) high levels of distress despite the fact that such tolerance may be maladaptive. For example, an individual may tolerate protracted mistreatment from a loved one out of fear of personal abandonment. In this instance, high levels of distress tolerance may facilitate ongoing interpersonal maltreatment and related suffering. Indeed, research might fruitfully explore the possibility that contextually inappropriate or inflexible tolerance of distress may be linked to vulnerability, such that overly low *or* high levels of tolerance are maladaptive in a context and lead to unwanted outcomes. Lynch and Mizon (in press) proposed testing quadratic functions between distress tolerance and psychopathology vulnerability, as one statistical means by which to explore these novel conceptual ideas.

Specific future directions to advance understanding and knowledge of distress tolerance in relation to psychopathology

In addition to the broad, formative gaps in the existing literature on distress tolerance and psychopathology highlighted above, there are a variety of relatively narrower domains of knowledge in need of future empirical study.

Specific versus common risk marker and factor?

The degree to which distress tolerance is related to specific or to multiple forms of psychopathology is an important area of research. Such knowledge is central to guiding intervention and preventive intervention strategies focused on distress tolerance and related processes. It is possible that whereas certain facets of distress tolerance may have common or trans-diagnostic relevance, others may be more narrowly involved in vulnerability for specific disorders. For example, intolerance of uncertainty may have greater explanatory specificity with respect to certain forms of psychopathology (e.g., GAD), whereas other operational measures of perceived distress tolerance of negative affective states may, broadly speaking, be trans-diagnostically related to multiple forms of psychopathology. In addition, it may be useful for investigators to examine associations between distress tolerance variables and psychopathology symptoms, as well as categorically operationalized psychological disorders (e.g., Axis I and II disorders). Such ongoing work may help to further clarify the nature and distinctions between specific distress tolerance variables and various facets of psychopathology.

A second key limitation involves what may be understood as the conceptual circularity of distress tolerance and psychopathology, negating a foundational premise of the contention that distress tolerance precedes psychopathology. Many distress tolerance scales explicitly ask individuals to rate their degree of discomfort/(in)tolerance to various aversive (distressing) states. It is not necessarily surprising that people with high levels of distress, such as those who suffer from elevated psychopathological symptoms or disorders, may endorse those items, as they are presumably suffering from more intense aversive states. In contrast, it may be argued that some individuals who are exposed to extensive, distressing experiences and stressful situations may increasingly habituate to such experiences and thereby become increasingly tolerant of such states over time (e.g., Lynch & Mizon, in press). In addition, we also know from biobehavioral investigations of distress tolerance that individuals demonstrate a range of levels of tolerance to standardized distress-eliciting behavioral tasks (e.g., cold-pressor

exposure). These biobehavioral indices of distress tolerance may thereby lead us to conclude that individual differences in tolerance are not a simple function of degree of experienced distress.

Expression of distress tolerance?

Currently, we know little about the means by which individuals express tolerance or intolerance to unwanted or distressing affective states or the automatic or effortful strategies they may use to respond to tolerance/intolerance. For example, individuals who are highly *intolerant* versus highly *tolerant* of certain distressing affective states may exhibit differential behavioral responses to distress. The highly intolerant individual may engage in cognitive or affective suppression, avoidant coping, and the like, whereas the highly tolerant individual may be more apt to utilize acceptance, approach-oriented coping, or other more adaptive regulatory strategies. To better understand the nature of distress tolerance, it is important that we study these basic processes between individuals (i.e., differences in expression of and response strategies to distress in/tolerance across people) and within individuals (i.e., the variety of means of expression of and response strategies to distress in/tolerance a given person may utilize).

Trait-like risk marker or context-sensitive risk factor?

There is limited theory and data regarding a fundamental, but implicit assumption, underlying much of the extant study of distress tolerance: its often presumed trait-like stability over time and across contexts. The vast majority of research on distress tolerance has employed cross-sectional methodological designs. There is emerging, albeit limited, work that has expressly evaluated the degree to which distress tolerance may be a malleable risk factor characterized by a context-sensitive/dependent expression as opposed to a context-insensitive risk marker with a more rigid trait-like expression (e.g., Bernstein et al., 2008). Future research may focus on understanding this fundamental aspect of the nature of this construct(s).

Developmental origins?

Another gap in theory and study of distress tolerance involves the factors related to its development and maintenance. Few factors, beyond psychopathology or mood, have been explored in relation to the development or change of distress tolerance, such as learning history, genetic or biological factors, and environmental stressors or traumatic stress. As one example, work has only begun to explore whether and under what conditions psychiatric symptoms may influence expression of distress tolerance (e.g., Bernstein et al., 2008). For individuals with a pre-existing diathesis (i.e., greater psychiatric symptoms), smoking deprivation (a personally relevant stressor) may decrease their capacity to tolerate distress; but in the absence of this stressor, levels of psychiatric symptoms may not necessarily be as strongly associated with levels of distress tolerance (Bernstein et al., 2008). Furthermore, few studies have explored the temporal impact of change in distress tolerance on psychopathology or changes in psychopathology on distress tolerance.

Although there are numerous factors that could influence distress tolerance, one useful starting point, in terms of theory, would be to direct scientific attention on individual differences in the tendency to experience positive and negative mood states (Watson, 2000). Individual differences in emotionality are directly relevant to the study of distress tolerance in that they may influence the development and maintenance of distress tolerance (e.g., the more frequent or intense emotional experience would require more frequent or greater degree of utilization of distress tolerance skills and resources). A number of possibilities may occur in the context of a predisposition for negative affectivity in relation to distress tolerance. For example, one possibility is that a person may become sensitized to various affectively distressing events and grow intolerant of them, or may be increasingly motivated to avoid/escape such subjective

states. Alternatively, an individual may become habituated to such states and over time learn to be more tolerant of such distress. A variety of related factors may interact with this negative affective predisposition to influence distress tolerance; such factors would include learning history or perceived/behavioral capacity to tolerate and/or cope adaptively with distress.

Latent structure?

The field has thus far operated from the perspective that of distress tolerance construct(s) are dimensional. Yet, the latent structural nature of distress tolerance and its putative facets has yet to be tested beyond factor analytic modeling of specific measures; and no latent structural study, to the best of our knowledge, has used biobehavioral measures of distress tolerance as manifest indices of the putative latent distress tolerance construct. Furthermore, latent structural study has not yet been conducted to evaluate a broad-based model of distress tolerance that may incorporate the various first-order factors or putative dimensions of the higher-order construct, including the possibility of a discontinuous models of distress tolerance. In addition, examination of latent structure across a variety of samples could help clarify the nature of this construct and its utility in a variety of populations. In short, a focused program of latent structural study of distress tolerance may be important to advances in conceptual and measurement of distress tolerance.

Therapeutic mechanism?

There is limited study of the malleability of distress tolerance in the context of intervention programs. Strikingly, as the vast majority of empirical work has not used clinical (diagnosable samples), direct treatment implications are necessarily limited. This lack of investigation is all the more striking given that so many treatment programs incorporate distress tolerance in their therapeutic approaches (e.g., Linehan, 1993). Indeed, this gap in the empirical literature is noteworthy given the direct focus of the theoretical basis of a number of widely-disseminated, efficacious clinical interventions on distress tolerance (e.g., Barlow et al., 2004; Brown et al., 2008; Linehan, 1993). One notable exception in this domain has been work by Dugas, Ladouceur, and colleagues (2000; 2003; 2000), who have found that change in IU is related to positive treatment outcome in Generalized Anxiety Disorder (Dugas & Ladouceur, 2000; Dugas et al., 2003; Ladouceur et al., 2000). This work indicates that this facet of distress tolerance is malleable and causally related to therapeutic change for at least one form of anxiety psychopathology. In another study, Miller, Wyman, Huppert, Glassman, and Rathus (2000) found that perceived helpfulness of distress tolerance skills were positively associated with improvements in interpersonal problems among a sample of suicidal adolescents. Outside of these (limited) empirical findings, there is a need for direct study of the role(s) of distress tolerance in mechanisms of clinical change. Here, it would be useful to empirically examine whether changes in distress tolerance precede and/or mediate changes in psychopathology and related problems from pre- to post-treatment. Such study would provide insight into the utility of distress tolerance in the prevention and treatment of psychopathology. Research in this area is necessary to test whether distress tolerance may be a causal risk factor in regard to a specific/multiple form(s) of psychopathology.

Summary

Distress tolerance has increasingly been viewed as important to developing new insights about the development and maintenance of adult psychopathology as well as its prevention and treatment (Zvolensky et al., in press; Zvolensky & Otto, 2007). The current paper reviewed extant empirical evidence on distress tolerance and the study of adult psychopathology. Inspection of the scientific literature indicates that there are a number of promising ways to conceptualize and measure distress tolerance and that some of these factors are related to a variety of psychopathological symptoms and disorders. Yet a number of basic questions remain

regarding the nature of the construct, its associations with other risk and protective processes, as well as its putative role(s) in supplying either vulnerability for or resilience in the face of psychopathology.

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Table 1

Self-Report Measures of Distress Tolerance

Distress Tolerance Construct	Format	Items	Internal Consistency
Tolerance of Ambiguity (TOA)			
1. Walk's A Scale (O'Connor, 1952)	6-point Likert-type scale ranging from "agree" to "disagree"	8	$\alpha = 0.08 - 0.10$ (Ehlrich, 1965)
2. The Scale of Tolerance-Intolerance of Ambiguity (Budner, 1962)	Forced choice: True/False OR 6-point Likert-type scale ranging from "strongly agree" to "strongly disagree"	16	$\alpha = 0.49 - .59$ (Furnham, 1995)
3. Rydell-Rosen Tolerance of Ambiguity Scale (AT-16; Rydell & Rosen, 1966) from the Self-Other Test, Forms B and C	Forced Choice: True/False	16	No evidence of internal reliability (Furnham & Ribchester, 1995)
4. Measure of Ambiguity Tolerance Scale (MAT-20; Rydell-Rosen, 1966 items plus four additional items) (MacDonald, 1970)	Forced Choice: True/False	20	$\alpha = 0.63 - 0.75$ (Macdonald (1970); Haslam, Rothschild, & Ernst, 2002)
5. MAT-50 (Norton, 1975)	7-point Likert-type scale	61	$\alpha = 0.88$
6. Tolerance of Ambiguity Scale - Revision to Budner (1962) and MacDonald (1970) measures (Kirton, 1981)	Forced Choice: True/False	18 (7 items from Budner and 11 items from MacDonald, 1970)	Budner items (1962), $\alpha = 0.65$ MacDonald (1970) items $\alpha = 0.71$
7. Situational Test of Intolerance of Ambiguity (STIA; Bhushan & Amal, 1986) – Based on Sample from India	4-point Likert-type scale ranging from "always" to "never" true for me	40	Not reported
Intolerance of Uncertainty (IU)			
1. Intolerance of Uncertainty Scale (IUS – French Version) (Freeston et al., 1994)	5-point Likert scale ranging from "not at all" to "entirely" characteristic of me	27	$\alpha = 0.91$
2. IUS - English Version (Buhr & Dugas, 2002)	5-point Likert scale ranging from "not at all" to "entirely" characteristic of me	27	$\alpha = 0.94$
3. IUS-short version (IUS-12; Carleton, Norton, & Asmundson, 2006)	5-point Likert scale ranging from "not at all" to "entirely" characteristic of me	12	$\alpha = 0.91$
Discomfort Intolerance			
1. Discomfort Intolerance (Schmidt, Richey, & Fitzpatrick, 2006)	6-point Likert-type scale ranging from "not at all like me" to "extremely much like me"	5	$\alpha = 0.70$
Distress Tolerance			
1. Distress Tolerance (Simons & Gaher, 2005)	5-point Likert scale ranging from "strongly agree" to "strongly Disagree"	15	$\alpha = 0.82$
2. Discomfort Intolerance and Emotional Intolerance scales (Frustration-Discomfort Scale; Harrington, 2005a)	5-point Likert scale ranging from "absent" to "very strong"	28	Discomfort Intolerance, $\alpha = 0.88$ Emotional Intolerance, $\alpha = 0.87$

Table 2

Behavioral Indices of Distress Tolerance (Non Self-Report Methods)

Physical-based Tolerance Tasks	Description/Methodology
<i>Thermal Stress Tolerance</i>	
1. Cold pressor task (CPT)	- Individuals are instructed to submerge entire hand in ice water and report when they begin to feel discomfort as a <i>threshold</i> rating, remove hand when pain becomes intolerable as a <i>tolerance</i> rating. <i>Endurance</i> is additionally measured by subtracting the obtained threshold rating from the tolerance rating (e.g. Burns et al., 2004; Hines & Brown, 1932; Neufeld & Thomas, 1977).
2. Full Body Cold- and Heat-induced Thermal Stressor	- Exposure to cold (less than 65° F) or hot (greater than 70° F) temperatures over an extended period of time. Research indicates that hot temperatures of 90° F or above and cold temperatures of 50° F or below are most strongly related to detrimental cognitive-related task performance (Pilcher et al., 2002).
3. Radiant Heat Stimulation	- Typically involve heat applied through light bulb to a darkened area of skin in order to induce pain and discomfort (Kane, Nutter, & Weckowicz, 1971; Rhudy & Meagher, 2003; and Wolff & Jarvik, 1963).
<i>Physical Capacity Tolerance Tasks</i>	
1. Breath-holding Challenge	- Duration, measured in seconds, a participant is able to hold their breath (Daughters, et al., 2005; Hajek, 1991; Hajek et al., 1987); Zvolensky et al., 2001).
2. Carbon Dioxide Challenge	- Procedure in which individuals are asked to breath in 20% carbon dioxide-enriched air. Time to termination is used as a measure of tolerance of physical discomfort (e.g. Brown et al., 2002).
3. Hyperventilation	- Latency in seconds until termination of a breathing exercise in which participants are directed to breathe at a rate of 30 breaths-per-minute (e.g. Marshall et al., 2008). Time to termination of the procedure is used as the index of tolerance of physical distress.
<i>Cognitive-based Tolerance Tasks</i>	
1. Paced Auditory Serial Addition Test (PASAT)	- Computerized auditory serial addition task used as a method of stress induction. This task involves 3 levels corresponding with 3.0s, 1.5s., and 1.0s inter-stimulus intervals (ISIs). Dysphoria levels including anxiety, difficulty concentrating and irritability on a 4-point scale are obtained at baseline, and post-level 2 administration in order to determine that the task was adequately stressful. Psychological distress tolerance is indexed as the time in seconds until task termination during level (Lejuez et al., 2003).
2. Mirror-Tracing	- Motor and cognitive distress tolerance task where participants are prompted to trace difficult geometric shapes while viewing the object, or as though viewing the object, through a mirror (Matthews & Stoney, 1988). Recent versions are fully computerized and the participant must move the tracer using a computer mouse in the opposite direction they intend for it to go (Strong et al., 2003). Tolerance is measured as the average time spent on tracing the difficult tasks before self-selecting to terminate (Strong et al., 2003).
3. Anagram Persistence Task (APT)	Participants are presented with a series of difficult anagrams and are asked to solve them or move on if they feel they are unsolvable. Participants are typically prompted to move on to the next if they fail to solve the anagram within an allotted period of time. Persistence is assessed as the average amount of time participants spend on the difficult or unsolvable anagrams. (Brandon et al., 2003; Eisenberger & Leonard, 1980; Quinn et al., 1996; Postman & Solomon, 1950)

Table 3

Summary of Findings in accordance with Kraemer Framework

Distress Tolerance Construct	Association	Prospective?	Malleable?
Self-Report Indices of Distress Tolerance			
<i>Tolerance of Ambiguity</i>			
TIA (Budner, 1962)	Anxiety/Worry (Hamilton, 1957; Buhr & Dugas, 2006)	No	No evidence
<i>Intolerance of Uncertainty</i>			
Obsessive Compulsive Beliefs Questionnaire (OCBQ; Steketee 1998 [OCD (Steketee 1998)	No	No evidence
Obsessive Compulsive Beliefs Questionnaire (OCBQ; Steketee 1998)	Anxiety (Steketee 1998)	No	No evidence
Intolerance of Uncertainty Scale	Anxiety (Berenbaum et al., 2008; Buhr & Dugas, 2002; Dugas et al., 1997)	No	No evidence
Intolerance of Uncertainty Scale (27-item)	GAD (Dugas et al., 2001; 2004; 1998; Holaway et al., 2006; Ladouceur et al., 1999)	Yes (Dugas & Ladouceur, 2000; Dugas et al., 2003; Ladouceur et al., 2000)	Yes (Dugas & Ladouceur, 2000; Dugas et al., 2003; Ladouceur et al., 2000)
Intolerance of Uncertainty Scale (27-item)	OCD (Dugas et al., 2001; Holaway et al., 2006; Tolin et al., 2003)	No	No evidence
Intolerance of Uncertainty Scale-12	Anxiety Sensitivity (Dugas et al., 2001)	No	No evidence
Intolerance of Uncertainty Scale-12	Meta worry/neuroticism (de Bruin et al., 2007)	No	No evidence
<i>Discomfort Intolerance Scale</i>			
	Anxiety/Anxiety Sxs among non-clinical sample (Bonn-Miller et al., 2009; Schmidt et al., 2006; 2007; Schmidt & Trakowski, 1999)	Yes (Bonn-Miller et al., 2009; Schmidt et al., 2007; Schmidt & Trakowski, 1999)	No evidence
	Depression/Depressive Sxs (Schmidt et al., 2006)	No	No evidence
	Panic (Schmidt et al., 2006)	No	No evidence
	Clinical Psychopathology	No	No evidence
	Substance use/Lower substance use Problems (Buckner et al., 2007)	No	No evidence
	Task Persistence (Marshall et al., 2008)	Yes (Marshall et al., 2008)	No evidence
	Smoking Motives (Leyro et al., 2008)	No	No evidence
<i>Distress Tolerance Scale</i>			
	Depression/Depressive Sxs (O' Cleirigh et al., 2007; Simons & Gaher, 2005)	No	No evidence
	Substance Use Motives (O' Cleirigh et al., 2007; Simons & Gaher, 2005; Zvolensky et al., 2009)	No	No evidence
	Substance Use Problems (Buckner et al., 2007; Simons & Gaher, 2005)	No	No evidence
	Eating Disorder Sxs (Anestis et al., 2007)	No	No evidence

Distress Tolerance Construct	Association	Prospective?	Malleable?
<i>Frustration-Discomfort Scale</i>			
	Anger (Harrington, 2006)	No	No evidence
	Anxiety Sxs (Harrington, 2006)	No	No evidence
	Depressive Sxs (Harrington, 2006)	No	No evidence
	Self-harm (Harrington, 2005b)	No	No evidence
<u>Behavioral Indices</u>			
<i>Physical-based Tolerance</i>			
<i>Cold Pressor</i>	Negative Mood (Jones et al., 2002; Schmidt & Cook, 1999; Uman et al., 2006; Willoughby et al., 2002; Zelman et al., 1991)	Mixed (MacPherson et al., 2008; Zelman et al., 1991)	Yes
	Addiction Abstinence (MacPherson et al., 2008)	Yes (MacPherson et al., 2008)	No Evidence
<i>Breath-holding Duration</i>	Addiction Abstinence (Bonn-Miller et al., 2008; Brown et al., 2002; Brown et al., 2009; Daughters, Lejuez, Strong et al., 2005; Hajek, 1987; MacPherson et al., 2008; West, 1989)	Mixed (Brown et al., 2002; Brown et al., 2009; Hajek, 1987; MacPherson et al., 2008; West, 1989)	Yes (Brown et al., 2002; Brown et al., 2009)
	Psychiatric Symptoms (Bonn-Miller et al., 2008)	No	No evidence
<i>Carbon-Dioxide Challenge</i>	Smoking Abstinence (Abrantes et al., 2008; Brown et al., 2002; 2009)	No	No evidence
	Depressive Sxs (Abrantes et al., 2008)	(Abrantes et al., 2008)	No evidence
	Panic Sxs (Asmundston & Stein, 1994)	Yes (Asmundston & Stein, 2004)	No evidence
<i>Hyperventilation</i>	Panic Sxs (Marshall et al., 2008)	Yes (Marshall et al., 2008)	No evidence
<u>Cognitive-based Tolerance Tasks</u>			
<i>Mirror-Tracing</i>	Substance Abstinence (Brandon et al., 2003)	Yes (Brandon et al., 2003)	No evidence
	Smoking Status (Quinn et al., 1996)	No	No evidence
	Problematic Alcohol Use (Quinn et al., 1996)	No	No evidence
<i>PASAT</i>	Addiction/Substance Abstinence (Daughters, Lejuez, Bornovolova et al., 2005; Daughters, Lejuez, Kahler et al., 2005; Daughters, Lejuez, Strong et al., 2005)	Mixed (Brown et al., 2009; Daughters, Lejuez, Bornovolova et al., 2005; Daughters, Lejuez, Kahler et al., 2005; Daughters, Lejuez, Strong et al., 2005; MacPherson et al., 2008)	No evidence
<i>APT</i>	Smoking Status (Quinn et al., 1996)	No	No evidence
	Problematic Alcohol Use (Quinn et al., 1996)	No	No evidence

Note: In accordance with Kraemer framework: Association = cross-sectional examination of DT as a “predictor,” indicating a correlational link with the criterion variable of interest; Prospective = DT as a predictor, indicating a correlational link with a criterion variable, such that it temporally

proceeds the dependent variable of interest; Malleable = DT as a predictor, whereby as a *causal risk factor*, its modification produces a change in the criterion variable of interest; Sxs = Symptom.

Table 4

Theoretically-Relevant Variables related to Distress Tolerance

Variable	Definition
Experiential Avoidance	Propensity to escape aversive internal experiences (e.g. negative emotional and somatic states) (Hayes et al., 1996).
Emotional Suppression	Inhibition of ongoing affective experience(s) (Gross, 1998).
Avoidant or Disengagement Coping	Behavioral and/or cognitive strategy employed to remit an individual's response to unwanted internal and external stressors perceived as exceeding personal psychological-based resources (Compas et al., 2001; Folkman & Lazarus, 1986).
Emotion Regulation	Difficulty in: (1) regulation of affective state; and (2) self-control over affect-driven behavior(s) (Kashdan & Steger, 2006).
Anxiety Sensitivity	Fear of anxiety and arousal-related sensations and physical, emotional and social consequences (McNally, 2002; Taylor, 1999).
Personality-based Persistence	Dimension of temperament related to propensity to continually disengage in an emotionally or physically distressing task linked to reward contingency (Barkley, 1997; Cloninger et al., 1991).