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Mindfulness and rumination as predictors of persistence with a distress tolerance task

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Abstract

Distress tolerance (DT) is a proposed transdiagnostic factor in psychopathology, yet sources of individual differences in DT are largely unknown. The present study examined mindfulness and rumination facets as predictors of persistence on a standardized DT task (mirror tracing). Acting with awareness (a facet of mindfulness) and reflection (a potentially adaptive form of rumination) predicted increased DT. Increased task-induced skin conductance reactivity predicted decreased DT. These results held after controlling for task skill and subjective and heart rate reactivity. Together, these results suggest that teaching skills to promote mindful awareness and reflection hold promise as interventions to enhance DT.

Keywords

Mindfulness; rumination; distress tolerance

1. Introduction

Distress tolerance (DT), or the ability to withstand unpleasant internal states elicited by a stressor, has been linked to several forms of psychopathology (Leyro, Zvolensky, & Bernstein, 2010). DT is operationalized behaviorally as persistence with challenging, unpleasant laboratory tasks. Lower persistence is demonstrated by individuals with major depression (Ellis, Vanderlind, & Beevers, 2013), adolescent self-injurers (Nock & Mendes, 2008), and individuals with borderline personality disorder (Bornovalova et al., 2008). Furthermore, the clinical utility of these tasks has been demonstrated in studies showing that

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lower persistence is associated with substance use relapse (Brown, Lejuez, Kahler, & Strong, 2002) and premature attrition from substance use disorder treatment (Daughters et al., 2005; MacPherson, Stipelman, Duplinsky, Brown, & Lejuez, 2008). Despite the promise of DT as a clinically useful construct, there remains a need for more research to clarify the nomological net of constructs that relate to DT (Leyro et al., 2010). The primary goal of the present study is to examine facets of mindfulness and rumination as two individual differences that may impact DT, as indexed by persistence with the Mirror Tracing Persistence Task Computerized Version (MTPT-C; Strong et al., 2003).

Mindfulness involves attending to one's present internal and external experience in a non-judgmental and accepting manner (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006). Rumination is a response to distress characterized by repetitive focus on symptoms, causes, and consequences of one's distress (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). A recent laboratory study of individuals diagnosed with borderline personality disorder found that those who were randomly assigned to a brief mindfulness exercise following a negative mood induction demonstrated greater DT than those assigned to a rumination procedure (Sauer & Baer, 2012). This study is noteworthy as few published studies have demonstrated that an experimental manipulation impacts DT persistence (Leyro et al., 2010); however, one question raised by this study is the degree to which results were due to salutatory effects of mindfulness, deleterious effect of rumination, or both. As such, an informative complementary approach to experimentally manipulating mindfulness and rumination is to examine individual differences in these constructs as predictors of distress and DT. However, direct comparisons of individual differences in mindfulness and rumination as predictors of behavioral DT have yet to be reported.

Both mindfulness and rumination are multi-dimensional constructs. An initial mindfulness questionnaire—the Mindful Attention and Awareness Scale (MAAS: Brown & Ryan, 2003)—captures a single dimension: present-focused attention and awareness in daily activities. A subsequent factor-analysis derived measure, the Five Facet Mindfulness Questionnaire (FFMQ: Baer et al., 2006), captures this construct in the "acting with awareness" subscale, and also includes subscales to assess nonjudgmental acceptance of experiences and non-reactivity to internal experiences. Similarly, a factor analysis study revealed two factors in the widely-used self-report measure of rumination, the Response Styles Questionnaire (RSQ, Nolen-Hoeksema & Morrow, 1991); one factor called brooding emphasizes passively focusing on symptoms of distress, whereas reflection emphasizes active efforts to gain insights into one's problems (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Both factors of rumination are typically correlated with depression in cross-sectional analyses with brooding showing stronger associations (Nolen-Hoeksema et al., 2008). Brooding is also associated with increased depression prospectively, whereas reflection predicts decreased depression over time (Treynor et al., 2003). Thus, reflection may be a more adaptive form of rumination. Through the use of multi-dimensional measures of mindfulness and rumination, the present study allows for greater specificity in understanding which elements of each constructs are most relevant for DT, which in turn may help guide more targeted clinical interventions.

Individual differences in mindfulness have been associated with persistence with difficult laboratory tasks. In a laboratory study with both clinically-anxious and non-anxious participants (Arch & Craske, 2010), persistence with a CO_2 challenge task was predicted by higher mindful attention and awareness, as measured by the MAAS. In a college student sample (Evans, Baer, & Segerstrom, 2009), persistence with a difficult anagrams task was predicted by two facets of FFMQ, non-judgment and non-reactivity to internal experiences. Acting with awareness showed a small, marginally significant association with persistence (r = .15) similar in magnitude to non-judgment (r = .17, p<.05) and non-reactivity (r = .21, p<.

05). We did not examine or observe and describe FFMQ scales in the present study as Evans et al. (2010) found they were virtually uncorrelated with persistence.

Research to date has yet to directly examine the association of trait rumination and DT; however, experimentally-induced rumination produces impaired goal-directed behavior and problem-solving generally (Nolen-Hoeksema et al., 2008). Brooding and reflection may have divergent effects on persistence in the face of stress. Specifically, reflection is positively associated with self-reported active coping styles; whereas brooding is correlated with coping through goal disengagement (Burwell & Shirk, 2007; Marroquín, Fontes, Scilletta, & Miranda, 2010). The present study tested whether these rumination facets predicted persistence with a laboratory stressor in a manner consistent with findings on self-reported coping styles in daily life.

As an exploratory aim, we also examined whether stress-induced physiological arousal influences DT persistence. DT tasks produce increases in skin conductance levels (SCL) (Ellis et al., 2013; Lejuez et al., 2003; Nock & Mendes, 2008). Prior studies typically report such increases as a validity check (i.e., to show that the task is arousing) or a dependent variable. For instance, adolescents who self-injure show greater SCL reactivity during a DT task (Nock & Mendes, 2008); whereas, individuals with major depression show a blunted SCL response (Ellis et al., 2013). However, the association between sympathetic arousal and task persistence has received little attention to date. Furthermore, heart rate (HR) response to DT tasks is less clear. HR has been shown to have a less robust increase than SCL to DT tasks (Lejuez et al., 2003) and may actually decrease when performing the MTPT-C (Ellis et al., 2013).

We hypothesized that higher levels of the mindfulness facets of acting with awareness, non-judgment, and non-reactivity would predict greater DT persistence (Arch & Craske, 2010; Evans et al., 2009). We also predicted that brooding would negatively correlate with persistence whereas reflection would correlate positively with persistence (Burwell & Shirk, 2007; Marroquín et al., 2010). In addition, we performed follow-up analyses controlling for two potentially confounding factors that may also impact task persistence: task skill and task-induced stress reactivity assessed with subjective and objective (SCL and HR) measures.

2. Methods

2.1. Sample

One-hundred female undergraduates attending a woman's college participated in a single laboratory session in exchange for course credit. Due to technical problems, psychophysiological data were not recorded for three participants and task skill data were not recorded for one. Analyses were performed on the remaining sample [N = 96, Age *M* = 20.50 (4.14); 76.0% White, 11.5% Asian/Pacific Islander, 4.2% Black/African-American, 7.3% circled multiple ethnicities or "Other"; 92.7% non-Hispanic, 6.3% Hispanic, 1.0% left this item blank].

2.2 Measures

Three facets of mindfulness were assessed with the FFMQ (Baer et al., 2006): 1) acting with awareness (8 items, α = .87) measures the tendency to act in a conscious, deliberate, non-automatic manner and to concentrate on present moment experiences, 2) non-judging (8 items α = .92) measures the tendency to accept one's thoughts/feelings without judging them as good or bad, and 3) non-reactivity (7 items, α = .76) assesses the tendency to allow thoughts/feelings to enter and pass through awareness without reacting to or becoming absorbed by them. Items are rated on a scale of 1 ("never or very rarely true") to 5 ("very often or always true"). All three scales uniquely predict psychopathology symptoms (Baer et al., 2006).

Two facets of rumination were measured with the RSQ (Nolen-Hoeksema & Morrow, 1991; Treynor et al., 2003). Brooding (5 items, α =.74) taps passive rumination on negative mood and personal shortcomings whereas reflection (5 items, α = .71) describes active efforts to understand one's negative feelings. Items are rated on a scale of 1 ("almost never") to 4 ("almost always").

Distress tolerance (DT) was assessed with the Mirror Tracing Persistence Task Computerized Version (MTPT-C; Strong et al., 2003). The task requires participants to move a red dot with a computer mouse along the lines of three different geometric shapes presented on a computer monitor. The dot moves in the opposite direction of physical movement, simulating tracing the image in a mirror. All participants used their left hand to avoid interference in psychophysiological recordings taken from the right hand and arm. Each error—moving the red dot off the shape or a hesitation in movement of 2 seconds or more—was accompanied by a loud buzzer sound and resulted in having to return to the beginning of the shape. Participants first completed two relatively simple shapes (a line, L-shape) with a 60 second time limit. Next, a 30 second latency period occurred during which participants viewed a message on the screen indicating the final shape will be difficult. Participants then were asked to trace a difficult star shape. Participants were told that they could discontinue the task by pressing any key on the keyboard. They were instructed to use their maximum effort to attain the highest score they could and discontinuing early would affect this overall score. Consistent with prior studies assessing the association of task persistence with psychopathology (Ellis, Fischer, & Beevers, 2010; Nock & Mendes, 2008) and mindfulness (Arch & Craske, 2010; Evans et al., 2009), no monetary incentive for persistence was provided. All participants who did not terminate after 5 minutes were stopped by the experimenter and told that they could continue to the next portion of the study. DT was assessed by persistence, defined as the time (seconds) spent until discontinuing the third shape. Skill was assessed by two behavioral measures: a) total time spent on shapes 1 and 2 and b) number of errors on shape 3 divided by number of seconds spent on this shape (cf. Bornovalova et al., 2008). A log10 transformation was applied to the error/second variable to correct a non-normal distribution. Because the two skill measures were moderately correlated (r = .30, p = .003), a composite skill score was created by standardizing and summing the two variables. To aid interpretation, this score was reversed such that higher scores reflect greater skill.

The construct validity of MTPT-C as a behavioral DT task is supported by the consistent finding (e.g., Bornovalova, Gratz, Daughters, Hunt, & Lejuez, 2012) that it is correlated with scores on the Paced Auditory Serial Addition Task (PASAT; Lejuez et al., 2003), another widely-used behavioral DT measure. We selected MTPT-C for the present study with a college student sample in light of prior evidence that it may be more sensitive than the PASAT to individual differences among samples with relatively less severe psychopathology (Ellis et al., 2010). We also decided to focus only on a behavioral DT measure given that self-reported DT appears to be an empirically-distinct construct (McHugh et al., 2011).

Negative affect (NA) was assessed before and after the MTPT-C with the Positive and Negative Affect Scale (PANAS: Watson, Clark, & Tellegen, 1988). NA items assess subjective distress, anger, contempt, guilt, shame, fear, and nervousness. Possible scores on the PANAS range from 10 – 50 and items are rated on a scale of 1 ("very slightly or not at all") to 5 ("extremely"). A change in NA scores was calculated (post-task score minus pre-task score) as an index of subjective reactivity to the MTPT-C. The PANAS demonstrated acceptable internal consistency at both pre-task ($\alpha = .71$) and post-task ($\alpha = .81$).

Physiology data were obtained using a Biopac MP150 system and processed with Acqknowledge v3.9 software (Biopac Systems Inc., Santa Barbara, CA). Heart rate (HR) was measured by recording electrocardiographic activity (ECG) with a Biopac ECG100C amplifier and data were band pass filtered between 0.5 and 35Hz before analysis. Skin conductance levels (SCL), converted to microsemens (μS), were obtained using the Biopac GSR100C amplifier. Ag-AgCl electrodes with isotonic gel were placed on the palmar sides of the participant's right-hand (middle phalanges of middle and ring fingers). Amplification utilized a constant voltage approach to measure absolute conductance. Signals were sampled at 1000 Hz and submitted to a 0.05-Hz highpass filter before being analyzed. Mean HR and SCL levels were calculated for the 7 minute resting baseline period and the three task phases (first two shapes, the 30-second latency period, final shape). Separate reactivity scores (task score – baseline score) were calculated for each phase; however, because these reactivity scores were strongly intercorrelated (HR $\alpha = .78$; SCL $\alpha = .99$), we instead used for analyses total task reactivity scores for HR and SCL.

2.3 Procedure

Participants provided informed consent, completed questionnaires, were fitted with electrodes, seated in a comfortable chair in front of a laptop computer, and instructed to rest for a 7-minute period during which baseline HR and SCL were assessed. The experimenter was seated 112″ behind the participant to monitor task progress and manually time stamp the physiological data at the beginning and end of resting baseline period and MTPT-C task phases. After the resting period, participants completed the pre-task PANAS, the MTPT-C, and the post-task PANAS. After debriefing, participants were assigned course credit. All procedures received IRB approval prior to data collection.

2.4 Analysis plan

Paired samples t-tests were performed to examine whether HR, SCL, and NA increased from pre- to post-task as a manipulation check to confirm that the MTPT-C was distressing. Next, we examined zero-order correlations between DT, mindfulness and rumination facets, and covariates (task skill, subjective and physiological stress reactivity). Finally, we performed hierarchical multiple regression analyses to test whether effects of rumination and mindfulness facets on DT remained significant after controlling for covariates. Cohen's (1988) guidelines were used for interpreting effect size of R^2 in multiple regression analyses with both a single independent variable (.01 = small, .06 = medium, and .14 = large) and multiple independent variables (.02–.12 = small, .13–.25 = medium, .26 and greater = large).

3. Results

During the MTPT-C, skin conductance increased significantly ($M_{baseline} = 2.42$ (2.77), $M_{task} = 4.90$ (3.76), $t(95) = -12.83$, $p < .001$); however, the change in heart rate was not statistically significant ($M_{baseline} = 75.77$ (10.07), $M_{task} = 76.49$ (10.15), $t(95) = -1.62$, $p = .11$]. Following the MTPT-C, significant increases were observed in negative affect ($M_{baseline} = 12.48$ (3.02), $M_{task} = 15.30$ (4.88), $t(95) = -6.13$, $p < .001$). Descriptive statistics and correlations between variables appear in Table 1.

Zero-order correlations revealed that acting with awareness and reflection were significantly associated with greater DT. As for covariates, increased physiological arousal, indicated by skin conductance (ΔSCL), was associated with less DT. No other self-report or physiological measures were significantly associated with DT; however, greater heart rate reactivity was significantly correlated with lower skill. Of note, brooding, non-judgment and non-reactivity were associated with increased subjective reactivity. Specifically, brooding (but not reflection) was correlated with a greater increase in negative affect post-task; whereas non-judgment and non-reactivity (but not acting with awareness) were correlated with less increase in negative affect.

Hierarchical multiple regression revealed incremental effects of mindfulness and rumination facets above and beyond task skill and stress reactivity (Table 2). Skill was entered in step 1 and accounted for 1% of the variance in persistence (small effect). All three stress reactivity measures were entered in step 2 and accounted for an additional 6% of the variance (small effect). Mindfulness and rumination facets were entered in step 3 and accounted for 14% of additional variance in persistence (medium effect). In the final model, acting with awareness, reflection, and ΔSCL remained significant unique predictors of DT.

4. Discussion

The goal of the present study was to further clarify the relationships between mindfulness and rumination facets with distress tolerance (DT) behavior, a risk factor that has been linked to a range of psychological disorders. In partial support of our hypotheses, we found that one facet of mindfulness (acting with awareness) and rumination (reflection) predicted higher levels of persistence with a distressing mirror tracing task (MTPT-C). Hierarchical regression analyses offered further support that these associations were not explained by task skill or task-induced stress reactivity. The three variables that did not predict persistence (non-judgment, non-reactivity, and brooding) were associated with subjective emotional reactivity whereas acting with awareness and reflection were not.

These divergent associations and the lack of correlation between task persistence and subjective reactivity suggests they are distinct aspects of DT impacted by distinct processes. Acting with awareness and reflection share an element of effortful, intentional strategic cognition and behavior. Acting with awareness items largely reflect the absence of mind-wandering during daily activities. Reflection includes purposeful responses to negative affect (e.g., writing down thoughts to analyze them). It is noteworthy that both acting with awareness (Weinstein, Brown, & Ryan, 2009) and reflection (Burwell & Shirk, 2007; Marroquín et al., 2010) have been linked to use of active coping with problems. Self-regulation processes such as attentional control may underlie both acting with awareness and reflection, play an important role in DT in the laboratory, and account for the previously-documented associations of DT with sustained engagement with wellness goals (e.g., substance abstinence, treatment participation). In contrast, brooding and low non-judgment/non-reactivity may reflect less cognitive, more affective processes that increase negative affect under stress but do not directly influence goal persistence, at least in non-clinical populations.

Behavioral measures of DT are beginning to be used in intervention research. One recent study of individuals with substance use disorders found that a brief DT skills training intervention increased behavioral DT relative to control conditions (Bornovalova et al., 2012). This intervention included training in three skill areas: acceptance, healthy distractions, and interpersonal effectiveness. The present study suggests that mindfulness attention training (e.g., Segal et al., 2001) and strategies to help individuals shift from unproductive to more productive forms of rumination (e.g., Watkins et al., 2012) may hold further promise as additional skills to promote DT. Nonetheless, it is important to note that persistence while distressed in and of itself is not necessarily an optimal clinical goal but rather the use of effective DT skills in the pursuit of adaptive goals. In fact, higher behavioral DT may actually increase the risk of suicidal behavior among individuals with borderline personality disorder (Anestis, Gratz, Bagge, & Tull, 2012).

A manipulation check revealed that the MTPT-C was effective in increasing subjective distress ratings and skin conductance levels (ΔSCL) consistent with prior research (Ellis et al., 2013; Lejuez et al., 2003; Nock & Mendes, 2008). The association between ΔSCL and task persistence observed in the present study is noteworthy in that it is the first to our knowledge to demonstrate an association between objective physiological arousal and behavioral DT. It is important to note that neither task skill nor subjective distress were significantly associated with task persistence, a finding that replicates prior research and which speaks to the validity of persistence as a meaningful dependent variable that does not simply reflect level of participant skill or task-induced dysphoria (Bornovalova et al., 2008). Heart rate (HR) did not increase significantly during the DT task; however this null finding is consistent with previous research that shows SCL reactivity is more robust than HR to DT tasks (Lejuez et al., 2003). The significant negative association between task skill and HR reactivity in the present sample suggests that greater HR increase was evident in those who had more difficulty performing the task.

Taken together, the pattern of psychophysiological findings in the present and prior research suggests that ΔSCL holds considerable promise as a marker of sympathetic arousal in DT studies of both healthy and clinical populations. In contrast, interpreting HR reactivity may be less-straightforward. Increases in HR attributable to task stress may be obscured by HR decelerations associated with focused attention demanded by the task (Ellis et al., 2013). An additional complicating factor is that primarily active stressors (e.g., public speaking) tend to increases in HR via systolic reactions whereas passive stressors (e.g., viewing distressing film clips) can produce HR decreases consistent with a diastolic reaction (Schneiderman & McCabe, 1989). The MTPT-C contains features of both active and passive stressors in that participants are asked to perform an active problem-solving task with aversive error feedback; however, there are also elements that are consistent with a passive stressor in that the task is essentially unsolvable and aversive stimuli are also presented in the absence of active behavior (e.g., after a two second hesitation). Even when presented without an explicit termination option, mirror tracing has been found to produce more modest HR increases than other active stressors (Hurwitz et al., 1993).

A central strength of the present study is the integration of self-report, behavioral, and psychophysiological assessments in clarifying the nomological net of DT. However, more research is needed to determine the role of other potentially-relevant traits (e.g., conscientiousness, competitiveness) in DT. The present study’s female-only sample introduces potential limitations. Although previous research has typically not found gender differences in persistence with cognitive-based DT tasks (e.g., Bornovalova et al., 2008; Brown et al., 2002); gender has been shown to moderate the association of task persistence with personality traits (Tull et al., 2010) and treatment attrition (MacPherson et al., 2008). In both cases, hypothesized effects were evident only in female participants. As such, it would be important to see if the present findings extend to men. Also, in light of our use of a student sample, replication in clinical and community populations is crucial.

In summary, results suggest that mindful awareness and reflection facilitate behavioral persistence in the face of performance-related stress and associated arousal of negative affect and physiology. Results also support the value of treating both mindfulness and rumination as multidimensional constructs in the study of DT. Improving our understanding of the nature of DT is important for two reasons. First, enhancing DT through psychotherapy can help clients learn to endure distressing experiences without automatically resorting to habitual, destructive behaviors such as substance misuse and self-injury to escape unpleasant emotions and thoughts. Second, given that distress intolerance predicts premature treatment attrition, early attention to factors that may undermine DT may help prevent at-risk individuals from dropping out of treatment before obtaining benefits.

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Highlights

- Low distress tolerance (DT) has been linked to a range of psychological disorders
- Individual differences associated with DT have received limited research
- Higher mindful awareness and reflection predicted greater DT in this study
- Interventions that teach mindful awareness and reflection skills may enhance DT

Table 1

Descriptive statistics and correlations

	1.	2.	3.	4.	5.	6	7	8	9	10
1. Distress tolerance		.23*	.03	.11	−.02	.27**	.09	−.01	−.24 *	−.10
2. Acting with awareness			.39***	.20*	−.37***	−.05	.04	−.11	.05	−.04
3. Non-judgment				.27**	−.50***	−.35***	.09	−.22*	.13	.01
4. Non-reactivity					−.28**	.00	.11	−.28**	−.01	−.12
5. Brooding						.22*	−..09	.27**	−.04	.12
6. Reflection							−.02	−.01	−.08	.02
7. Skill								.03	.07	−.22 *
8. Δ Negative affect									.19†	..25*
9. Δ Skin conductance										.29**
10. Δ Heart rate										
M	150.13	26.13	26.22	20.44	12.24	11.83	.05	2.82	2.48	0.72
SD	102.86	5.58	6.69	3.87	3.46	3.29	1.61	4.51	1.89	4.33

† $p<.10$,

* $p < .05$,

** $p<.01$,

*** $p<.001$

Table 2

Hierarchical multiple regression predicting distress tolerance

	Step 1 $\Delta R^2 = .01$ β	**Step 2** $\Delta R^2 = .06$ β	**Step 3** $\Delta R^2 = .14^*$ β
(Step 1)			
Skill	0.09	0.11	0.08
(Step 2)			
Δ Negative affect		0.04	0.10
Δ Skin conductance		−0.24*	−0.25*
Δ Heart rate		−0.01	−0.02
(Step 3)			
Act with awareness			0.23*
Non-judgment			0.08
Non-reactivity			0.06
Brooding			0.04
Reflection			0.28*

* $p < .05$