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Emotion dysregulation and negative affect: Laboratory and EMA investigations in smokers

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ABSTRACT

Introduction: Difficulties in emotion regulation are associated with addictive behaviors, including smoking. Difficulties in emotion regulation may underlie large, rapid changes in negative affect that can increase likelihood of relapse. We investigated the association between emotion regulation ability and negative affect in smokers assessed both in the laboratory and in the field using Ecological Momentary Assessment.
Methods: Adult community smokers ($N = 44$) carried a personal digital assistant (PDA) for two weeks and were instructed to complete assessments of negative affect multiple times per day. Participants were instructed that they could smoke as much or as little as they liked. The Difficulties in Emotion Regulation Scale (DERS) and the Positive and Negative Affect Schedule (PANAS) were completed at three lab visits.
Results: Participants with higher average DERS scores reported greater negative affect at lab visits. When a participant reported a DERS score at a lab visit higher than their individual average, they also reported higher negative affect at that lab visit. Participants with higher baseline DERS scores reported more labile negative affect during EMA than those with lower baseline DERS scores, and they also reported a higher maximum level of negative affect during EMA.
Discussion and conclusions: Overall, the findings suggest that changes in emotion regulation are associated with negative affect and that emotion regulation ability is related to both the intensity and lability of negative affect. A better understanding of momentary changes in emotion regulation and negative affect may lead to improved interventions for preventing substance use relapse.

1. Introduction

Deficits in emotion regulation are associated with a variety of psychological difficulties, including addictive behaviors such as cocaine abuse, alcohol dependence, and smoking (Fox, Axelrod, Paliwal, Sleeper, & Sinha, 2007; Fox, Hong, & Sinha, 2008; Haaga & Allison, 1994; Magar, Phillips, & Hosie, 2008). For example, a study of patients in treatment for alcohol dependence found that poor emotion regulation was associated with relapse to drinking both during and after treatment. The ability to tolerate negative emotions was the emotion regulation skill most predictive of continued abstinence (Berking et al., 2011).

Affective lability can be defined as the extent to which an individual has frequent fluctuations in emotional valence and intensity (Anestis et al., 2010). Extremely labile or volatile emotions make it difficult to act in accordance with goals (Tice & Bratslavsky, 2000). Likewise, constant, strong, negative emotions can interfere with other objectives, such as desisting from substance use (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004). Emotion regulation includes both the awareness and identification of emotions and the set of strategies and processes people use to redirect their emotions and modify their behaviors to accomplish their goals (Gratz & Roemer, 2004; Koole, 2009; Thompson, 1994). Emotion regulation skills allow an individual to respond more effectively to affect in order to act in accordance with his or her goals. Thus, emotion regulation skills may influence the initial presence or intensity of an emotion, and they may also change the individual's reaction to the emotion and the resulting trajectory of the emotion.

Although emotion regulation is usually conceptualized as a stable construct (Gross, 2015), emotion regulation may also vary over time. Little research has examined within-subject changes in emotion regulation. Overall, it is reasonable to expect that immediate situational factors may influence an individual's ability to regulate emotions at a particular time. For example, one study found that general emotion regulation abilities and situational factors influenced the use of emotion regulation strategies in a stressful situation (Egloff, Schmukle, Burns, & Schwerdtfeger, 2006).

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Ecological momentary assessment (EMA) is a method that may be useful for examining the association between emotion regulation and affect. EMA involves obtaining real-time assessments multiple times per day in the normal environment. The field of emotion dynamics has been proposed, consisting of the study of the trajectories of emotion and related components over time (Kuppens & Verduyn, 2011). Patterns of emotion such as variability, duration, and co-occurrence (i.e., the simultaneous experience of multiple emotions), assessed by EMA have been suggested as ways to investigate emotion regulation (Kuppens & Verduyn, 2011). Most studies have examined the use of specific emotion regulation strategies (e.g., reappraisal) and the effect of their use on symptoms of psychopathology or changes in affect (Heiy & Cheavens, 2014; Kashdan & Steger, 2006; O'Toole, Jensen, Fentz, Zachariae, & Hougaard, 2014). For example, Heiy and Cheavens (2014) examined emotion regulation strategy use and affect three times a day over a 10-day period. They reported associations between use of emotion regulation strategies and changes in positive and negative affect, but not within-subject emotion regulation change (Heiy & Cheavens, 2014). However, little research has examined the association between general emotion regulation ability and negative affect assessed in the field.

EMA has also been used to examine the association between negative affect and smoking behavior (Shiffman, Stone, & Hufford, 2008). EMA research has revealed that large, rapid increases in negative affect (e.g. more than one standard deviation in about 5 h) may precede some smoking temptations and lapses (Shiffman, Paty, Gnys, Kassel, & Hickcox, 1996; Shiffman & Waters, 2004). Other data suggest a link between emotion regulation and smoking behavior. For example, maladaptive regulation strategies such as suppression have consistently been associated with early smoking initiation, greater smoking urges, and higher rates of cessation relapse (Haaga & Allison, 1994; Magar et al., 2008). Further, individuals instructed to reappraise their emotions about smoking showed less negative affect, reduced craving for cigarettes, and diminished attentional biases to smoking-related cues than individuals who were instructed to suppress or accept their smoking-related emotions (Szasz, Szentagotai, & Hofmann, 2012). Thus, smoking is an appropriate domain to study emotion regulation because there is a large EMA literature in this population (Shiffman et al., 2008), because affect and affective lability is associated with smoking behavior (Baker et al., 2004), and because emotion regulation has been associated with smoking behavior outcomes (Szasz et al., 2012).

In sum, little research has investigated within-subject changes in emotion regulation, or the relationship of general emotion regulation (vs. specific strategies) to momentary ratings of negative affect. This study utilized repeated laboratory assessments and EMA to investigate the relationship between emotion regulation and negative affect in smokers not attempting to quit. It was hypothesized that difficulties in emotion regulation would be associated with higher and more labile negative affect in smokers. In addition, it was expected that within-subject changes in difficulties in emotion regulation would be observed from assessment to assessment, and that such changes would themselves be associated with negative affect.

2. Methods

2.1. Participants

Participants were adult, community-based smokers in the greater Washington, D.C. metropolitan area recruited using advertisements seeking smokers interested in meditation. Advertisements were displayed on local mass transit, a free local newspaper, Craigslist.com, and on flyers throughout the community. Participants were eligible if they were a current smoker, aged 18 to 65, and had been smoking at least 10 cigarettes a day for the past two years. Exclusion criteria were current participation in smoking cessation treatment or the current use of tobacco products other than cigarettes including e-cigarettes. Self-reported smoking was biochemically verified, and participants were also excluded if their expired breath carbon monoxide (CO) was lower than 10 ppm.

The current study was a secondary analysis of data collected for a study examining mindfulness meditation training (Ruscio, Muench, Brede, & Waters, 2016), conducted at the Uniformed Services University of the Health Sciences (USUHS) in Bethesda, Maryland. The USUHS Institutional Review Board approved all study procedures. Data were collected between June 2012 and September 2012.

2.2. Procedures

Participants were first screened via telephone. Eligible participants were invited to attend the initial laboratory visit (visit 1), which began with informed consent procedures, followed by assessment of expired CO in breath. If individuals were ineligible (based on CO level) or declined to participate, they were offered self-help materials and references to local smoking cessation programs. If eligible individuals agreed to participate, they were randomly assigned to either a Brief Mindfulness Practice (BMP) or Control training condition (see Ruscio et al., 2016, for further detail). The parent study examined the effect of BMP on affect, craving, and smoking. Participants were told that they could smoke "as much or as little as they like" during the study including the days of laboratory visits.

Participants then completed a number of self-report assessments, including assessments of emotion regulation and negative affect (described below). Finally, research staff trained participants on the use of a personal digital assistant (PDA; HP iPAQ Pocket PC model 1940/1945; Microsoft Windows Mobile 6.5 OS). Programming was completed by Terminal C, a Houston-based company, using C#.NET.

2.3. EMA procedures

After visit 1, participants carried the PDA with them throughout each day. The PDAs were programmed to alert participants to complete an assessment at four randomly selected times per day (termed "random assessments"; RAs). As reported elsewhere (Ruscio et al., 2016), participants completed a mean of 66.4% of presented RAs (Median Compliance = 75.5%). Participants were also instructed to practice meditating once a day at a time of their choosing by listening to a Brief Mindfulness Practice and then to complete an assessment as soon as possible after the end of the recording. Controls listened to sham-meditation tracks on their PDA, and the instructions did not promote mindfulness (Ruscio et al., 2016). Controls were also instructed to complete an assessment as soon as possible after the end of the recording. BMP and Control participants completed an average of 32.8 ($SD = 14.9$) and 25.8 ($SD = 17.7$) RAs, $F(1, 35) = 1.70$, $p = 0.20$, and 24.0 ($SD = 25.4$) and 17.8 ($SD = 10.6$) post-training assessments, $F(1, 35) = 0.88$, $p = 0.36$., respectively.

After one week, participants returned to the laboratory for a second visit, followed by a second week of PDA assessments and mindfulness/control practice. They returned to the laboratory for a third and final visit, where they were debriefed and given referrals to smoking cessation programs. At the second and third laboratory visits, participants again completed an assessment of expired breath CO, as well as assessments for emotion regulation and negative affect (described below). Participants received compensation up to $215 for completing lab visits, mindfulness/control practices, and random assessments.

2.4. Laboratory assessments

The following assessments were administered at all laboratory visits.

2.4.1. Positive and negative affect schedule (20-items)

The Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988) consists of 10 negative affect items and 10 positive affect items. Participants rated how much they felt each affect item "in the past week" on a five-point Likert scale ranging from 1 ("very slightly or not at all") to 5 ("extremely"). Negative affect and positive affect scores can range from 10 to 50. Both subscales have demonstrated good internal reliability, with Cronbach's alpha ranging from 0.86–0.90 for positive affect and 0.84–0.87 for negative affect (Watson et al., 1988). The current study focuses on negative affect (PANAS-NA), because of the documented associations with smoking behavior (Baker et al., 2004; Shiffman & Waters, 2004).

2.4.2. Difficulties in emotion regulation scale

The Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) assessed participants' emotion regulation abilities. Emotion dysregulation, as assessed by the DERS, is related to impulsivity (Schreiber, Grant, & Odlaug, 2012), and includes impulsivity as a subscale (Gratz & Roemer, 2004), but is distinct in that it also assesses nonacceptance of emotional responses, difficulty engaging in goal-directed behavior, lack of emotional awareness, limited access to emotion regulation strategies, and lack of emotional clarity. The DERS is a 36-item self-report questionnaire on which participants use a five-point Likert scale ranging from 1 ("almost never") to 5 ("almost always") to indicate the extent to which they experience each item. An example item is "When I'm upset, I become out of control". Total DERS scores can range from 36 to 180, with higher scores indicating more difficulties regulating emotion. Cronbach's alpha in the current study for the total DERS score was 0.93 at lab visit 1, 0.93 at lab visit 2, and 0.90 and lab visit 3. The interclass correlation coefficient (ICC) for the DERS scores across the three laboratory assessments was 0.73 ($p < 0.001$). DERS scores at baseline ($M = 77.61$, $SD = 21.80$) were comparable to other data reported in large samples (e.g., Ritschel, Tone, Schoemann, & Lim, 2015).

2.5. EMA assessments

2.5.1. Positive and negative affect schedule (10-items)

A 10-item short form of the Positive and Negative Affect Schedule assessed affect in the field (Mackinnon et al., 1999). The short form uses five positive and five negative items (Scared, Nervous, Afraid, Upset, Distressed).

Participants rated each affect item "at this moment". Negative affect and positive affect scores can range from 5 to 25. Cronbach's alpha in the current study was 0.92 for positive affect and 0.90 for negative affect during EMA. Again, only negative affect was examined.

2.6. General analytic strategy

Linear mixed models (LMMs) using PROC MIXED (continuous outcomes) and SAS PROC GLIMMIX (dichotomous outcomes) were used for analysis of laboratory (108 visits) and EMA data (1874 assessments). LMMs take into account the dependence between participant observations and allow for different numbers of observations across participants. For all models we used a random (subject-specific) intercept. Treatment condition (Brief Mindfulness Practice vs. Control) was included as a covariate in all analyses (lab and EMA data), because treatment condition had a significant effect on PANAS-NA assessed using EMA (Ruscio et al., 2016). Parameter estimates (*PE*) and standard errors (*SE*) are reported for all models. Because there was evidence that PANAS-NA was not normally distributed (lab and field), we also report bias-corrected and accelerated 95% CIs, derived from bootstrapping, to bolster the conclusions derived from the parametric tests; results are interpreted if these 95% CIs do not overlap with 0.

For laboratory data, the primary independent variables were a Mean DERS score and a Deviation DERS score. The Mean DERS score was computed by aggregating over all available visits for each subject (i.e., a subject-level variable). The Deviation DERS score (a visit-level variable) was computed for each visit and was the difference between the DERS score at each visit and the (subject-specific) Mean DERS score. The Mean DERS and Deviation DERS scores were entered together. As described below, a significant effect for the Mean DERS score would indicate a between-subjects association, and a significant effect for the Deviation DERS score would indicate a within-subject association (Hedeker, Mermelstein, Berbaum, & Campbell, 2009). For analysis of laboratory data, visit number (1–3) was also included in all models as a covariate.

For EMA data, consistent with Ruscio et al. (2016), day was entered as a continuous variable in all models (slopes were allowed to vary), and we used an autoregressive model of order 1 for the residuals within subjects. Assessment type was included as a covariate (3 levels: "valid" meditation assessment (MA; < 60 s after completing mindfulness/control practice), "invalid" MA (> 60 s after practice), and random assessment. Baseline DERS (continuous variable) was used as a predictor variable to examine associations between DERS and negative affect during EMA.

To analyze variability in negative affect, to facilitate communication of key findings, participants were divided into DERS groups (high vs. low) using a median split on the baseline DERS score. However, all significant findings reported were robust if baseline DERS was treated as a continuous variable. Low DERS participants ($n = 18$) had a DERS score of 70 or below ($M = 59.22$, $SD = 7.18$), and high-DERS participants ($n = 19$) had a score of 71 or greater ($M = 96.21$, $SD = 17.77$). The two DERS groups did not differ significantly on age, sex, race, or years of education (Table 1). Reported cigarettes smoked per day did not differ between groups (Table 1); inclusion of this variable as a covariate did not change any of the findings. Nine (50.00%) of the low and 11 (57.89%) of the high DERS participants were assigned to the Brief Mindfulness group, χ^2 (1) = 0.23, $p = 0.63$.

We also examined DERS Group differences on participants' highest level of negative affect reported during the study ("max" assessments), as well as the assessments immediately preceding ("pre" assessment) or following ("post" assessment) max assessments. If a participant had multiple assessments with the same maximum value, the average of the corresponding pre- assessments was used for the pre- value, and likewise for the post- value. For analysis of pre-, max, and post- data, we used ANOVA (SAS PROC GLM), with DERS Group (low vs. high) as the independent variable. There was no significant difference between groups on number of EMA assessments completed, number of max assessments reported, day of max assessment, time of day of max assessment, or time between assessments (Table 1).

In a further analysis of lability, each EMA assessment (except each participant's first) was coded as "changed" if the negative affect score at time (t1) was different (lower or higher) than the negative affect score at the previous assessment (t0) or "no change" if the negative affect at t1 was the same as at t0. An LMM examined if DERS group was associated with change (changed/no change) in negative affect. Additional LMMs examined if the absolute magnitude of change in negative affect and MSSD (Mean Squared Successive Difference), a measure of affective instability recommended by Jahng, Wood, and Trull (2008), differed between groups.

Alpha was set to 0.05, and all tests were 2-tailed.

3. Results

Overall, 44 participants completed DERS and PANAS assessments at visit 1. Analyses on lab data used data from 108 laboratory visits. Of the 44 participants, 37 completed at least one EMA assessment. Analyses on EMA data used data from these 37 participants who completed a total of 1874 EMA assessments.

Table 1
Summary Statistics for Low (n = 18) and High (n = 19) DERS Groups.

	Whole sample (n = 37)	Low DERS (n = 18)	High DERS (n = 19)	t/χ^2	p
Demographic & smoking data					
Age	44.81 (12.55)	47.98 (9.80)	41.87 (12.28)	2.71	0.11
Sex (%)				0.23	0.63
Male	47.7	50.0	42.1		
Female	52.3	50.0	57.9		
Race (%)*				0.97	0.62
White	68.2	66.7	63.2		
Black	29.5	33.3	31.6		
Other	2.3	0.0	5.3		
Years of education	13.55 (2.62)	14.50 (2.20)	13.50 (3.00)	1.15	0.26
Baseline cigarettes per day	16.11 (7.36)	15.61 (7.11)	16.56 (7.87)	−0.38	0.71
EMA data					
Compliance on RAs (%)	66.36 (22.90)	68.17 (26.76)	64.64 (19.14)	0.46	0.65
Number of assessments	50.65 (26.32)	47.3 (20.2)	53.8 (31.3)	−0.76	0.23
Number of trainings	9.49 (5.16)	9.67 (5.60)	9.32 (4.84)	0.20	0.84
Number of max assessments	1.81 (1.33)	1.94 (1.31)	1.68 (1.38)	0.59	0.56
Day of max assessment	7.72 (5.14)	6.06 (4.21)	7.32 (6.09)	−0.73	0.47
Time of day for max assessment	14:57 (4:52)	15:54 (4:28)	14:03 (5:11)	1.16	0.25
Time between assessments (hr)					
Pre to max	8.16 (8.09)	6.93 (5.29)	9.47 (10.28)	−0.91	0.37
Max to post	9.16 (12.27)	10.75 (15.07)	7.58 (8.80)	0.77	0.45

Note: Data shown are for participants who completed at least one EMA assessment. Data are broken down by high (DERS ≤ 70) and low (DERS ≥ 71) DERS at baseline (see text for details). Number of Trainings refers to Brief Mindfulness or Control trainings completed over 2-week period. Day of Max Assessment refers to the study day (1–15) on which the Max assessment occurred. For continuous variables, none of the findings change if a Mann-Whitney U test were used. *Use of Fisher's exact test yields a p value of 1.0.

3.1. Analysis of lab data

The mean PANAS-NA (lab) across 108 visits was 18.22 (SD = 7.79). A LMM revealed a significant effect of Mean DERS on PANAS-NA at lab visits, PE = 0.17, SE = 0.05, 95% CIs = 0.11, 0.21, F (1, 61) = 10.90, p = 0.001, indicating that participants who reported generally higher DERS scores also reported generally higher negative affect at lab visits (i.e., a between-subjects association). A LMM also revealed a significant effect of Deviation DERS on PANAS-NA at laboratory visits, PE = 0.15, SE = 0.05, 95% CIs = 0.06, 0.27, F (1, 61) = 9.31, p = 0.003, (see Fig. 1). When a participant reported a higher DERS score than his or her average at a given visit, he or she also reported greater negative affect at that visit (i.e., a within-subject association).

3.2. Analysis of EMA data

The average negative affect across 1874 EMA assessments was 7.37 (SD = 3.91). A LMM revealed a significant effect of baseline DERS score on negative affect, PE = 0.065, SE = 0.016, F (1, 1798) = 16.95, p < 0.001, indicating that higher DERS individuals (vs. lower DERS) reported higher overall negative affect during EMA.

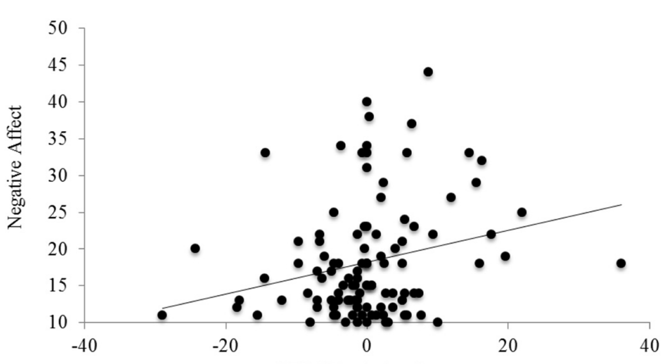

Fig. 1. Scatterplot of the association between Deviation DERS and PANAS-NA (10–50 scale) across 108 lab visits. Positive Deviation DERS scores indicate higher scores than a participant's average. Negative Deviation DERS scores indicate lower scores than a participant's average.

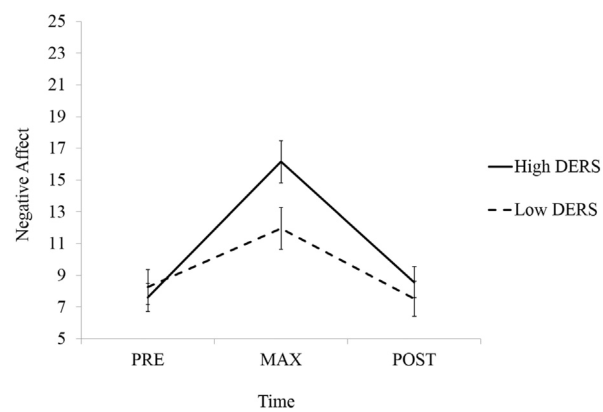

Fig. 2. Mean negative affect (5–25 scale) at pre-, max assessment, and post- time points (see text for details) for the high DERS group (n = 19) (unbroken line) and low DERS group (n = 18) (dotted line). Error bars are ± 1SE.

A 2 × 3 repeated measures ANOVA with 1 between-subjects factor (DERS; 2 levels) and 1 within-subjects factor, Time (3 levels; pre, max, post) revealed a DERS group x Time interaction, F (1.536, 47.615) = 7.81, p = 0.003 (Fig. 2). There were no significant DERS Group differences at pre, PE = −0.39, SE = 1.43, 95% CIs = −3.34, 2.17, F (1, 32) = 0.07, p = 0.79, or post assessments, PE = 1.13, SE = 1.50, 95% CIs = −1.94, 3.82, F (1, 33) = 0.57, p = 0.46. However, the high DERS group reported significantly higher negative affect at max assessments (vs. low DERS), PE = 4.42, SE = 1.85, 95% CIs = 0.35, 7.97, F (1, 34) = 5.71, p = 0.02. There was a significant effect of DERS Group on "jumps" from pre to max assessments (i.e., max minus pre difference scores), PE = 5.33, SE = 1.33, 95% CIs = 2.27, 8.49, F (1, 32) = 16.06, p = 0.0003, but not "drops" from max to post assessments (i.e., max minus post differences scores), PE = 2.89, SE = 1.42, 95% CIs = −0.60, 6.11, F (1, 33) = 4.14, p = 0.05.

Low and High DERS groups exhibited a "change" in negative affect on 40.17% and 57.43% EMA assessments respectively. A LMM revealed an effect of DERS Group on change/no change, PE = 0.82, SE = 0.42, F (1, 1797) = 3.90, p = 0.04; OR = 2.28, 95% CI = 1.01, 5.17. Being in the high DERS group (vs. low DERS) more than doubled the odds of a change in negative affect from the previous assessment, suggesting greater overall lability in negative affect. Next, a LMM examined if the absolute magnitude of change in negative affect differed between groups. The dependent variable was the absolute value of the magnitude of the change in negative affect at each EMA assessment (except the first). The average magnitude of change was 1.27 (SD = 2.32) and 2.18 (SD = 3.36) for the low DERS and high DERS groups respectively. Again, there was a significant effect of DERS Group, PE = 1.16, SE = 0.43, F (1, 1761) = 7.15, p = 0.008. Finally, a LMM examined if the MSSD (Mean Squared Successive Difference), a measure of affective instability recommended by Jahng et al. (2008), differed between groups. Once again, there was a significant effect of DERS Group, PE = 11.86, SE = 4.36, F (1, 1761) = 7.41, p = 0.007.

4. Discussion

This study investigated the association between difficulty in emotion regulation and negative affect assessed in the lab and field in a sample of smokers. The main findings were as follows. First, in the lab, both between- and within- subject associations between DERS and negative affect were observed. Second, DERS scores at baseline were associated with overall negative affect in the field, with higher peak levels of negative affect, and with more labile negative affect.

As predicted, mean DERS scores across visits were robustly associated with negative affect across visits, demonstrating that individuals with poor overall emotion regulation abilities reported higher negative affect. The intraclass correlation coefficient for the DERS was 0.73, suggesting that scores are fairly consistent across three weekly assessments. These findings support a conceptualization of emotion regulation as primarily a trait measure (Linehan, 1993; Thompson, 1994).

More important, the significant relationship between deviation DERS score and negative affect indicates that within-subject changes in emotion regulation abilities are themselves related to negative affect. Therefore, within-subject changes are meaningful, rather than, for example, merely reflecting measurement error. These findings bolster the rationale for assessing changes in emotion regulation. Future studies should include a true state measure of emotion regulation such as the S-DERS (Lavender, Tull, DiLillo, Messman-Moore, & Gratz, 2015), which assesses emotion regulation abilities in the moment.

The EMA data supported the lab data by showing that higher DERS at baseline is associated with higher negative affect in the field. Field data also suggest that individuals with higher DERS had higher peak levels of negative affect, which is arguably of greatest clinical relevance. Most importantly, across multiple analyses, there was converging evidence that - compared to low DERS participants - high DERS participants showed more labile negative affect. For example, high DERS participants (vs. low DERS) exhibited greater jumps in negative affect to the maximum rating. Given that large increases in negative affect over the timescale of a few hours precede relapses to smoking (Shiffman et al., 1996; Shiffman & Waters, 2004), this suggests a mechanism by which high DERS scores can precipitate relapses to smoking. That is, poor emotion regulation can increase risk of rapid increases in negative affect that in turn can increase risk of relapse.

These findings have theoretical and clinical significance. Theoretically, they link emotion regulation difficulties to real-world patterns of negative affect. Clinically, these findings are significant because large, rapid increases in negative affect precede some smoking lapses (Shiffman & Waters, 2004). Therefore, reducing the frequency of large changes in negative affect or increasing the ability to tolerate such changes could reduce the risk of smoking or relapse in people with higher DERS scores. More generally, a better understanding of state emotion regulation can improve the delivery of interventions using mobile devices for addictive behaviors that focus on emotion regulation.

The primary strength of this study is that the use of EMA methodology yielded new and fine-grained information about the relationship between emotion regulation and affect. The study had several limitations. First, this was a secondary data analysis and the parent study included an intervention. The presence of the intervention may limit the generalizability of the findings. For example, it is not certain that the current findings would be obtained in smokers in more naturalistic circumstances. Second, the data are correlational. It is not possible to infer that baseline emotion regulation causes the patterns of negative affect observed in the field. Third, the study relied exclusively on self-report measures. Future studies could use psychophysiological measures as well as more tightly spaced EMA assessments to provide an even more comprehensive assessment of negative affect. Fourth, the study did not provide information on the cognitive processes underlying emotion regulation. Fifth, there was appreciable variability in the number of EMA assessments completed (see also Ruscio et al., 2016), perhaps due to study burden. Sixth, the study did not use a true state emotion regulation measure, such as the S-DERS (Lavender et al., 2015), which precluded examination of the association between state emotion regulation and negative affect in the field. Seventh, repeated assessment during EMA may reduce reports of negative affect (McCarthy, Minami, Yeh, & Bold, 2015; but see Shiffman, 2015). Last, the use of a relatively small sample of smokers not attempting to quit precluded an examination of the associations between emotion regulation and craving or relapse, and the influence of important moderator variables such as gender (Pang & Leventhal, 2013). Future studies using larger samples of smokers attempting to quit can examine these associations as well their mediation by negative affect.

5. Conclusions

This study is the first to use EMA to examine the association between emotion regulation and negative affect in smokers. The data suggest the presence of state- and trait-like aspects of emotion regulation and that emotion regulation ability is related to the both the intensity and lability of negative affect. A better understanding of momentary changes in emotion regulation and negative affect may lead to improved interventions for preventing relapse to smoking as well as other addictive substances.

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Declaration of interests

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper.

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