Health Psychology

ISSN: 0278-6133

2021, Vol. 40, No. 9, 578–586
https://doi.org/10.1037/hea0001105

Awareness, Affect, and Craving During Smoking Cessation: An Experience Sampling Study

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Objective: Mindfulness has received attention in smoking cessation research, yet the mechanisms by which mindfulness may promote smoking cessation are not well understood. Mindfulness training may help individuals increase awareness and respond skillfully to processes that contribute to smoking, such as affective states and craving. This study used experience sampling (ES) to test how awareness was related to craving, positive and negative affect and smoking, in the moment, among smokers in treatment for smoking cessation. ***Method:*** Participants (N = 228) were part of a clinical trial evaluating Craving to Quit, a smartphone app for mindfulness training for smoking cessation, compared to an app delivering only ES. All participants were asked to complete 22 days of ES, with up to 6 ES surveys per day, measuring awareness, craving, positive and negative affect and smoking. Data were analyzed using multilevel linear modeling. ***Results:*** Both at the within and between-person level, higher awareness was associated with higher positive affect, lower craving and lower negative affect. Lower within-person craving was associated with lower smoking. Within-person awareness, positive and negative affect were not significantly associated with smoking. At the between-person level, higher awareness and higher positive affect, and lower negative affect and lower craving were associated with lower smoking. ***Conclusions:*** Awareness of current experience was related to key psychological variables linked to behavior change in smoking cessation, namely positive and negative affect and craving, among smokers trying to quit. Future studies should test whether learning to increase awareness, such as through mindfulness training, may benefit smokers in treatment.

Keywords: mindfulness, craving, smoking, affect, ecological momentary assessment

Supplemental materials: https://doi.org/10.1037/hea0001105.supp

Cigarette smoking is the leading preventable cause of death and disease in the United States (National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health, 2014), and quitting smoking is one of the most important behavior change steps most smokers can take to improve their life expectancy and health-related quality of life (U.S. Department of Health and Human Services, 2020). Yet the majority of adult smokers are unable to successfully quit, despite repeated attempts. There are approximately 37 million smokers (15% of the population) in the United States (Jamal et al., 2018), and despite 55% of smokers making a quit attempt in the past year, nine of ten are unable to quit successfully (Babb, 2017). In order to improve interventions and aid smokers in quitting, it is critical to identify the behavior change mechanisms that underlie successful outcomes.

This article was published Online First September 27, 2021.

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The trial was registered at ClinicalTrials.gov, identifier: NCT02134509.

Margaret Sala, Corey R. Roos, and Kathleen A. Garrison conceptualized the study aims for the current analysis and curated the data. Margaret Sala conducted formal data analysis. Margaret Sala, Corey R. Roos, and Kathleen A. Garrison wrote the original draft of the manuscript. Kathleen A. Garrison and Judson A. Brewer contributed to the parent clinical trial. Kathleen A. Garrison led the parent clinical trial. All authors reviewed and edited the manuscript.

This study was supported by grants from the American Heart Association [14CRP18200010] and the National Institute on Drug Abuse Grant [K12DA00167]. The views presented in the article are not necessarily those of the funding agencies who did not have input into the content of the article outside of funding the proposed research.

Judson A. Brewer is the founder of MindSciences, the company that developed the mindfulness app used in this study. He owns stock in, serves as a non-compensated scientist for the company and has previously served on the board of directors. This financial interest has been disclosed to and is being managed by Brown University, in accordance with its Conflict of Interest and Conflict of Commitment policies. All other authors report no biomedical financial interests or potential conflicts of interest.

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A psychological factor that has received an increasing amount of attention in the smoking cessation literature is mindfulness. Mindfulness has been defined as bringing awareness to one's current experience and maintaining an attitude of curiosity and acceptance to one's experience (Bishop et al., 2004). Meta-analyses report promising initial evidence regarding the efficacy of mindfulness-based interventions (MBI) for smoking cessation (Goldberg et al., 2020; Maglione et al., 2017; Oikonomou et al., 2017). However, there is limited evidence on the specific mechanisms by which mindfulness might reduce smoking behavior. Clarifying mechanisms of behavior change can inform theoretical models and improve interventions (Nielsen et al., 2018). With MBIs for smoking cessation, a better understanding of mechanisms might allow for the identification of psychological and behavioral treatment targets, as well as proximal or intermediary processes that enable early detection of benefit from an MBI.

Mindfulness effects on health outcomes have been explained in part by (1) enhancing awareness of one's experiences by attention monitoring, and (2) modifying one's relation to one's experience through acceptance (Lindsay & Creswell, 2017). Other models have focused on attention-awareness as central to mindfulness (Brown & Ryan, 2003; Kabat-Zinn, 1994), highlighting potential benefits of training awareness itself (Chambers et al., 2009). Mindfulness as a dispositional trait has been described to be comprised of five facets: *acting with awareness, observing, describing, nonjudgment* and *nonreactivity* (Baer et al., 2006). These facets are found to be differentially related to substance use, with evidence that awareness factors (*describing, acting with awareness*) are negatively related to substance use (e.g., Fernandez et al., 2010), and that *acting with awareness* is one of the facets more frequently related to substance (including tobacco) use by meta-analysis (Karyadi et al., 2014). Therefore, the current study sought to better understand the role of *awareness*, defined as paying attention to present moment experience, in the treatment of smoking cessation, related to craving, smoking, and affect.

A few studies have evaluated mindfulness, craving, smoking and affect in the context of smoking cessation treatment using either the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) or the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006), thereby providing some evidence on the possible role of awareness. For example, in several smoking cessation studies (MBI and non-MBI), higher MAAS scores were indirectly related to better outcomes (in particular, lower lapse rates in early abstinence) by reducing negative affect (Heppner et al., 2016) or stress (Cambron et al., 2020; Spears et al., 2019). Likewise, higher ratings of positive emotions (happy, relaxed) and lower ratings of negative emotions (bored, sad, angry) mediated the association between MAAS scores and early abstinence (Spears et al., 2019). For the FFMQ, higher *acting with awareness* was associated with lower affective symptoms more generally in a large meta-analysis (Carpenter et al., 2019). In the few studies which have examined the FFMQ subscales (i.e., facets) and smoking, *acting with awareness* was associated with lower smoking behavior (Roberts & Danoff-Burg, 2010), although only *nonjudgment* has been found to predict long-term smoking cessation (Spears et al., 2015). Together, these data suggest a potential role for awareness in impacting smoking behavior, possibly by modifying negative and positive affective states and craving. For example, awareness may help individuals to recognize affective states and cravings to smoke when they arise, enabling them to work mindfully with these experiences rather than to react by smoking.

However, these studies measuring awareness, as well as most studies on mindfulness more generally, have utilized retrospective self-report measures of trait mindfulness (e.g., MAAS, FFMQ), and focused on between-subjects effects. To fully understand mechanisms of behavior change for smoking, it is critical to also examine how awareness relates to smoking, affect and craving in real time and within-subjects. One way to measure momentary experience is using ecological momentary assessment or experience sampling (ES), the repeated sampling of one's current experience and behaviors in real time (Shiffman et al., 2008; Trull & Ebner-Priemer, 2014). Advantages of ES include reduced recall bias versus retrospective reports, and the ability to test both between- and within-person processes (Bolger & Laurenceau, 2013).

Several recent studies have used ES to measure different aspects of mindfulness in the moment, although few studies have used ES to measure awareness (Goldberg et al., 2020; Landmann et al., 2020; Moore et al., 2016; Rupp et al., 2020). A recent ES study tested three facets of mindfulness (from the FFMQ) as predictors of positive and negative affect, finding that *present moment experience* and *nonjudgmental acceptance*, but not *acting with awareness*, predicted positive and negative affect (Blanke et al., 2018). An earlier study found that a composite state mindfulness variable adapted from the MAAS for ES predicted both positive and negative affect (Brown & Ryan, 2003). Only one smoking-related study has used ES to measure mindfulness (Ruscio, Muench, Brede, & Waters, 2016). This pilot study compared the effects of a brief-MBI versus sham meditation on smoking, craving and affect. Mindfulness was measured using the MAAS and the 13-item Toronto Mindfulness Scale (TMS; Lau et al., 2006), which has two subscales: curiosity and decentering (Ruscio, Muench, Brede, MacIntyre, et al., 2016). The TMS was additionally delivered by ES. They found that brief-MBI versus control was associated with increases over time on the TMS as measured by ES but not on the TMS or MAAS measured in the laboratory. Relationships between ES measures of mindfulness with smoking, craving and affect were not tested.

To better understand how awareness is related to craving, positive and negative affect, and smoking, as measured by ES, the current study used available data from a clinical trial evaluating a smartphone app for mindfulness training for smoking cessation—Craving to Quit (Garrison et al., 2018; Garrison et al., 2015). Craving to Quit included ES of key variables and was compared to an app delivering only ES. The primary outcomes have already been reported (Garrison et al., 2018), including that mindfulness as measured using the FFMQ increased comparably between groups. Therefore, for the current analyses, groups were collapsed, and no intervention effects were tested. Using ES data, we tested the hypotheses that higher awareness would be associated with higher positive affect and lower negative affect, craving, and smoking, both within- and between-subjects. Additionally, we tested the hypothesis that higher positive affect and lower negative affect and craving would be related to lower smoking.

Method

Participants

Participants were part of a parent randomized clinical trial (NCT02134509) evaluating Craving to Quit, a smartphone app

for mindfulness training for smoking cessation. In the parent trial, Craving to Quit, which included ES, was compared to an app delivering ES only (Garrison et al., 2015, 2018). All study procedures were approved by the Yale Institutional Review Board, and all participants provided online informed consent. Eligibility criteria included: (a) age 18 to 65; (b) smoking ≥ 5 cigarettes per day; (c) smoking for ≥ 9 months of the past year; (d) own a smartphone; and (e) motivated to quit smoking, defined as scoring ≥ 8/10 on the Contemplation Ladder (Biener & Abrams, 1991) and ≥ 4/5 on the Action Item of Readiness to Change (Rollnick et al., 1992). Recruitment used Google ads (46%), word of mouth/other (23%), Facebook posts (14%), smokefree.gov (11%), Twitter (2%), Reddit ads (2%), and clinicaltrials.gov (1%).

The sample analyzed in the parent trial included 325 participants (Garrison et al., 2018). However, for this study focused on ES, we only included participants who completed at least 33% or 7 days of ES surveys (Figure S1), as this type of threshold is standard in ES studies, and most substance use ES studies include at least a week of ES data (see Jones et al., 2019). Participants in the current study (N = 228) reported significantly lower baseline cigarettes per day (CPD) as compared to participants in the primary sample (t = 3.60, $p < .001$); therefore, all analyses control for baseline cigarettes per day. The samples did not differ significantly on any other demographic variable presented in Table 1 ($ps > .09$).

Procedure

Participants in the parent trial were randomized to receive either the Craving to Quit app with ES; or a comparator app delivering ES only; for 22 days; and set a quit smoking day at 21 days. Craving to Quit included training modules (5–15 minutes/day) teaching mindfulness skills; three standard meditation practices: body scan, loving kindness and breath awareness; an informal practice to work mindfully with cravings, RAIN: Recognize, Accept, Investigate, and Note what cravings feel like as they arise and pass away; and other features. The app included ES to measure smoking, craving, and other factors (see below), with ES items adapted from the Day Reconstruction Method—a method that assesses how people use their time and how they experience the settings and activities of their lives (Kahneman et al., 2004)—and from prior ES studies (Berkman et al., 2011). Participants set daily start/end times, each day was divided into six intervals, and participants were notified by the app to complete an ES survey once randomly within each interval. Although participants were notified to complete an ES survey six times per day, they were only sent a reminder text message if their response rate dropped below three ES surveys per day. The comparator was a smartphone app with the same look and feel as Craving to Quit, but delivering only ES, with all other study procedures matched to the active group. Both groups completed online surveys at baseline, end of treatment, three and six months via Yale Qualtrics Survey Software (optimized for mobile), measuring smoking, craving, mindfulness and other factors. Participants were compensated up to $116 for the study, which included $.50 per ES survey, up to six per day for 22 days.

Table 1
Demographic Information, Smoking Characteristics, and Key Variables

Demographics	Mean (*SD*) or *n* (%)
Female gender	172 (75.4%)
Age	41.48 (12.48)
Race/ethnicity	
White	184 (80.7%)
African-American	22 (9.6%)
Hispanic/Latino	8 (3.5%)
Asian	3 (1.3%)
Native American	3 (1.3%)
Multiracial	5 (2.2%)
Unknown	3 (1.3%)
Income	
<$25,000	64 (28.1%)
$25−50,000	58 (25.4%)
$50−75,000	45 (19.7%)
$75−100,000	20 (8.8%)
>$100,000	41 (18%)
Education	
Less than high school	5 (2.2%)
High school	27 (11.8%)
Partial college	104 (45.6%)
College or more	92 (40.4%)
Smoking characteristic	
Age of smoking onset	17 (5.2)
Number of quit attempts	13.6 (74.3)
Number of additional smokers in home	.68 (.94)
Cigarettes/day at baseline	15.13 (7.16)
ES variables (across surveys)	
Awareness	.49 (.28)
Craving	−.07 (.66)
Positive affect	.03 (.43)
Negative affect	−.27 (.42)

Note. n = 228. ES = experience sampling.

Measures

At baseline, smoking was measured as cigarettes per day, craving was measured using the Craving Experiences Questionnaire (May et al., 2014), and mindfulness was measured using the FFMQ. The following ES items were utilized for the current analyses, each collected using a visual analog scale with text anchors, scaled from −1 to 1 for analysis.

Awareness

Awareness was measured as: *When you started this check-in, how aware were you of what you were doing?* (*Not at all* to *Very much*). In order to evaluate the construct validity of this single item measure of awareness, we tested its association with the *acting with awareness* subscale of the baseline FFMQ. The *acting with awareness* subscale of the FFMQ is closely related to our ES measure of awareness conceptually and includes items such as "I rush through activities without being really attentive to them" and "I find it difficult to stay focused on what's happening in the present moment." Aggregate scores on the ES measure of awareness had a significant, small-medium size correlation with the *acting with awareness* subscale (r = .25, $p < .001$). This correlation is consistent with small-medium size associations between trait and state constructs in other ES studies (e.g., Sala et al., 2019).

Craving

Craving was measured as: *When you started this check in, how much were you craving a cigarette?* (*Not at all* to *Very much*). Aggregate scores on the ES measure of craving had a significant, small size correlation with the baseline CEQ ($r = .15$, $p = .015$).

Affect

Affect was measured by asking participants to rate how much they were feeling eight emotions from *Not at all* to *Extremely,* by responding to the question: *When you started this check-in, how much were you feeling these emotions?* Positive affect included: *relaxed, joyful, content,* and *excited.* Negative affect included: *anxious, tired, sad,* and *irritable.* Internal consistency was good (positive affect $\alpha = .79$, negative affect $\alpha = .71$).

Smoking Behavior

Participants reported how many cigarettes they had smoked by updating a cigarette tracker. They were asked: *The tracker says you have smoked # cigarettes today. Adjust your tracker below if needed.* Each day, the cigarette tracker would start at zero and be updated by the participant at each ES survey. The tracker would reset to zero each day at midnight. For the analysis, smoking was calculated as the number of reported cigarettes at a given ES survey minus the number of reported cigarettes at the previous ES survey. Average ES smoking had a significant, medium-large size correlation with CPD at both baseline ($r = .49$, $p < .001$) and 6 months follow-up ($r = .61$, $p < .001$).

Statistical Analyses

SPSS Version 21.0 was used to analyze data using multilevel linear modeling (MLM), which is robust to missing data. In the current data, ES surveys (Level 1) were nested within individuals (Level 2). Intraclass correlation coefficients (ICCs) were computed for each ES item to measure the degree of dependence in the data, or strength of the nesting effect. Subtracting the ICC from 1 provides the proportion of variance due to within-person differences. Therefore, lower ICCs suggest higher variance due to within-person variance.

We employed an autoregressive (AR1) autocorrelation given the dependence within the nested data. Models were run using full-information maximum likelihood estimation. We conducted random intercept and fixed predictor models for all MLM analyses in order to permit model convergence. All models controlled for intervention condition (Craving to Quit vs. ES only), time from start of treatment, and baseline cigarettes per day.

Because the smoking variable was skewed, a generalized linear mixed model (GLMM) was used based on a negative binomial distribution with log link for the analyses with smoking as the outcome variable (Atkins & Gallop, 2007). A one-survey lag was used to test for temporal precedence, with smoking at time t being predicted by affect, mindfulness and craving at time ($t-1$, controlling for smoking at time $t-1$. We lagged the analyses because, whereas participants rated their current awareness, affect and craving at each ES survey, for smoking, they updated a daily cigarette tracker, and therefore, reported smoking was considered to occur between the current and previous ES survey. Only one-survey lags were included; that is, if data were missing, those surveys were not included, rather than including two+ survey lags. Additionally, lags across days were included.

We disaggregated all time varying predictors (TVPs) into the participant's average level across all ES surveys (TVP_{mean}; the between-person component) and deviations from the mean at each survey (TVP_{dev}; the within-person component; $TVP_{dev} = TVP_{raw} - TVP_{mean}$). Therefore, between-person variables reflect the degree to which an individual's average level of a variable across ES surveys differs from the total sample, and within-person variables reflect the degree to which an individual's momentary value of a variable differs from that individuals' average level across ES surveys. We computed effect sizes by transforming the *t* statistic into a Cohen's *d* effect size (Wilson, n.d.).

Results

Descriptive Statistics and Preliminary Analyses

Demographics and target variables are described in Table 1. Over the 22-day treatment, participants completed on average 48% of ES surveys. They completed on average 63.4 ES surveys (active = 64.2, comparator = 62.2), on 17.3 days of treatment (active = 17.4, comparator = 17.2; week 1 = 6.6, week 2 = 5.6, week 3 = 5.05). Participants reported smoking an average of 1.32 cigarettes between ES surveys (*SD* = 2.40, *Range* = .00–40.00). Awareness was not significantly associated with treatment group ($b = .00$, $SE = .00$, 95% CI = [−.00, .00], $p = .58$), and increased over time in both treatment groups ($b = .01$, $SE = .01$, 95% CI = [.00, .02], $p = .02$). ICCs (i.e., the proportion of between person variability) were: .44 for negative affect, .38 for awareness, .35 for positive affect, and .29 for craving. Intercorrelations among predictor variables are reported in Table 2.

Awareness and Craving

Within-person, higher awareness was significantly associated with lower craving ($p = .02$), indicating that higher awareness on a given ES survey, relative to an individual's average awareness across ES surveys, was related to lower craving. Between-person, higher awareness was significantly associated with lower craving ($p < .001$), indicating that individuals who reported higher awareness were more likely to report lower craving across ES surveys (see Table 3).

Awareness and Affect

Within-person, higher awareness was significantly associated with higher positive affect and lower negative affect ($ps < .001$). That is, higher awareness on a given ES survey, relative to an individual's average awareness across ES surveys, was related to higher positive affect and lower negative affect. Between-person, higher awareness was associated with higher positive affect and lower negative affect ($ps < .001$). These findings indicate that individuals who reported being more aware of their current experience were more likely to report higher positive affect and lower negative affect across ES surveys (see Table 3).

Table 2
Bivariate Correlations Among Predictor Variables

Predictor variable	Awareness	Craving	Positive affect	Negative affect
Awareness	—	−.18**	.31**	−.32**
Craving	—	—	−.32**	.40**
Positive affect	—	—	—	−.49*

* $p < .05$. ** $p < .01$.

Smoking Behavior

Table 4 displays results from lagged models testing how variables at time t−1 were associated with smoking (number of cigarettes smoked) at time t. For awareness, within-person, awareness at time t−1 was not significantly associated with smoking at time t ($p = .66$). Between-person, higher awareness was significantly associated with lower smoking ($p < .001$), indicating that individuals who reported higher awareness also reported lower smoking across ES surveys. For craving, both within- and between-person, higher craving was significantly associated with higher smoking ($ps < .001$). For affect, within-person, positive ($p = .99$) and negative ($p = .90$) affect at time $t-1$ were not significantly associated with smoking at time t. Between-person, higher positive affect was significantly associated with lower smoking ($p < .001$), and higher negative affect was significantly associated with higher smoking ($p < .001$; see Table 4).

Sensitivity Analyses

All models were computed with all available data from all participants in the sample used in primary analyses for the parent trial (n = 325), and this yielded the same pattern of results with regard to significance and directionality as the current analyses (n = 228). Additionally, no differences were found between the included and excluded samples on ES average awareness, craving, negative or positive affect; baseline *acting with awareness* (from the FFMQ) or craving (from the CEQ); or change in CPD from baseline to 6 months ($ps > .13$). Sensitivity analyses were also conducted excluding participants who smoked a large number of cigarettes per day at baseline (≥30 CPD, $n = 4$) and results were the same with regard to significance and directionality as the current analyses. For further posthoc exploratory analyses, see online supplemental materials.

Discussion

This study is the first to use ES to test how awareness is associated with craving, affect and smoking, in the moment, in the daily lives of individuals who smoke. Findings indicate that higher awareness was associated with lower craving, higher positive affect and lower negative affect, within- and between-person, with sizable effects. Lower craving was associated with lower rates of smoking within- and between-person, with small-medium size effects. Finally, higher awareness and positive affect, and lower negative affect and craving, were each associated with lower smoking, between-person, with small-size effects. Findings highlight that awareness is associated with several key psychological factors linked to behavior change in smoking cessation, including positive and negative affect and craving.

This is the first study, to our knowledge, to demonstrate that higher awareness was related to lower craving to smoke in the moment. This finding is noteworthy because craving is a main symptom that smokers seek to alleviate during treatment (Ferguson & Shiffman, 2009). This finding is consistent with an earlier study using ES in which a brief-MBI was associated with reduced momentary craving (Ruscio, Muench, Brede, & Waters, 2016). It is possible that higher awareness of present moment experience may help smokers to bring attention to cravings that arise, and to maintain awareness on their experiences (emotions, sensations, etc.) rather than "getting caught up in" cravings (Brewer et al., 2013; Elwafi et al., 2013).

Next, findings indicate that craving was positively associated with smoking in the moment. This finding is consistent with a systematic review reporting craving as a strong proximal predictor of smoking behavior in ES data (Serre et al., 2015), and with studies showing that craving is a key contributor to smoking relapse (e.g., Allen et al., 2008).

Table 3
Awareness as a Predictor of Craving and Affect

Relationship tested	*b*	*SE*	95% CI	*d*	*p*
Awareness as a predictor of craving					
Between-person	−.19	.18	[−.35, −.03]	−.31	.02
Within-person	−.11	.01	[−.14, −.09]	−.15	<.001
Awareness as a predictor of positive affect					
Between-person	.25	.06	[.14, .37]	.59	<.001
Within-person	.16	.01	[.14, .17]	.36	<.001
Awareness as a predictor of negative affect					
Between-person	−.33	.06	[−.45, −.21]	−.71	<.001
Within-person	−.13	.01	[−.14, −.12]	−.32	<.001

Note. Covariates included treatment group, time, and baseline cigarettes per day.

Table 4
Summary of Lagged Models Testing Predictors of Smoking

Predictor	*b*	*SE*	95% CI	*d*	*p*
Awareness					
Between-person	−.29	.05	[−.39, −.18]	−.10	<.001
Within-person	.02	.04	[−.05, .08]	−.01	.66
Craving					
Between-person	.90	.04	[.82, .98]	.41	<.001
Within-person	.13	.02	[.08, .17]	.11	<.001
Positive affect					
Between-person	−.54	.06	[−.65, −.43]	−.18	<.001
Within-person	.00	.04	[−.07, .08]	.00	.99
Negative affect					
Between-person	.21	.05	[.10, .31]	.08	<.001
Within-person	.01	.04	[−.08, .09]	.00	.90

Note. Covariates included smoking at *t*−1, treatment group, time, and baseline cigarettes per day.

Higher awareness was also associated with higher positive affect and lower negative affect. This is the first ES study, to our knowledge, to show that higher awareness is related to affective states among individuals trying to quit smoking, and is consistent with other ES studies reporting that facets of mindfulness are associated with affect in the moment (Brown & Ryan, 2003; Killingsworth & Gilbert, 2010). Although an earlier study did not find that *acting with awareness* predicted affect (Blanke et al., 2018), that study was not in smokers. It is possible that awareness increased positive affect among smokers by bringing attention to pleasurable experiences to enhance natural reward processing (Garland et al., 2014). Similar to craving, higher awareness may help smokers to bring attention to negative affective states that arise and maintain awareness on their experiences (emotions, sensations, etc.), learning that negative affect will eventually subside (Segal et al., 2002).

Positive and negative affect did not predict smoking within-person, yet individuals who reported higher positive affect and lower negative affect throughout the study smoked less. This finding is consistent with prior ES studies indicating little or no association when testing positive and negative affect as immediate antecedents of smoking, whether in smoking cessation treatment or ad libitum smoking (Shiffman et al., 2002; Shiftman et al., 2004). However, in the current study, there was an association between affect and smoking across the study, consistent with the interpretation that mood might influence smoking over longer timeframes. For example, over time, individuals might increase smoking in an attempt to regulate both positive (e.g., responding to a lack of stimulation; Shiffman, 1993) and negative affect (Baker et al., 2004).

The finding that negative affect did not predict smoking may be surprising given that participants were mostly female (75% of N = 228), and female smokers are more likely to smoke following negative mood (Weinberger & McKee, 2012). However, participants were also mostly female in an earlier study in which smoking was not predicted by negative affect (82% of N = 28; Shiftman et al., 2004). One possibility is that we did not capture this relationship because our ES for negative affect did not include *feeling stressed*, which has been found to predict ad lib smoking (Shapiro et al., 2002). It is also possible that associations between positive and negative affect and smoking were not captured because we did not sample these variables postquit, given that affect (in particular, negative affect) has been strongly associated with smoking lapses in prior ES studies (Minami et al., 2014; Shiffman et al., 2007; Shiffman et al., 2020), but not with ad lib smoking (Shiffman et al., 2002; Shiftman et al., 2004). Further direct testing on the relationship between both negative and positive affect and smoking is needed given the considerable literature on the impact of affective states on appetitive risk behaviors including smoking (Akbari et al., 2020; Ferrer et al., 2020). Future studies should also test whether sex/gender moderates the relationship between affective states and smoking in the moment.

Similarly, although awareness did not predict smoking within-person, individuals who reported higher awareness throughout the study smoked less. This finding suggests that while higher awareness may not be related to reduced smoking in the moment, over time, higher awareness might promote lower levels of smoking, an effect that might be more meaningful to smoking cessation in the longer term. For example, behavioral treatments have been associated with sleeper effects, or the emergence or growth in effects from end of treatment to follow-up (Bell et al., 2013). Future ES studies might test for such effects by measuring awareness and smoking/lapses beyond treatment.

Findings indicated that treatment group was not significantly associated with awareness. This is consistent with the primary report that Craving to Quit and ES-only comparably increased mindfulness (FFMQ) and reduced smoking and craving across treatment (Garrison et al., 2018). These findings suggest reactivity to ES methods, which is a concern for studies of substance use in which participants are motivated to change their behavior and thus may be particularly vulnerable to ES reactivity (Shiffman, 2009). Furthermore, rating one's awareness multiple times per day might increase awareness and mindfulness, even without mindfulness training.

There were several limitations to the current study. First, as previously acknowledged (Garrison et al., 2018), the sample was largely female, white, and college educated, and more work is critically needed to understand these mechanisms in a representative population, in particular because factors such as sex/gender and SES are associated with smoking behavior. Individuals in this study were also motivated to quit smoking, and enrolled in a smoking cessation intervention, therefore findings may not generalize to smokers who do

not report being motivated to quit. The included sample also completed a minimum number of ES surveys (33%) and differed from the excluded sample by lower baseline CPD, possibly indicating that the included sample was more willing to engage in treatment. Next, compliance with ES was just under 50% for the maximum 6 ES surveys per day and could be improved. However, participants completed on average 3 ES surveys per day, for 63.4 ES surveys across the 22-day treatment, resulting in a rich ES dataset with which to test hypothesized relationships. Sensitivity analyses were also conducted with the full sample, and the same pattern of results was obtained. Our analytical strategy was also robust to missing data. Nevertheless, the extent and pattern of missing data remain a limitation of the article, as we cannot demonstrate that the assumption that data are missing at random was met. Another limitation was that we were unable to utilize a psychometrically supported ES measure of awareness as no such measure was available. It is possible that participants may not have understood the ES item, "How aware were you of what you were doing?" However, beginning support for this ES measure was provided by the small-medium correlation with the *acting with awareness* subscale of the FFMQ. Finally, this study tested whether associations between awareness, affect and craving predicted smoking. It is possible that relationships between these factors are bidirectional, in line with the argument that successful self-regulation can also increase well-being and mindfulness (Masicampo & Baumeister, 2007). Despite these limitations, this study provides an ecological representation of associations between awareness, craving, affect and smoking behavior in the daily lives of smokers who were trying to quit smoking. Strengths of this study include the use of ES and the analytic approach, which allowed testing of both within- and between-person associations between these factors.

In conclusion, findings from this study indicate that higher awareness was associated with higher positive affect and lower negative affect and craving, in the moment, among individuals in treatment for smoking cessation. Therefore, future research should examine whether training individuals in awareness, such as in MBIs, might be a mechanism for increasing awareness to modify other key psychological variables related to smoking behavior change –affect and craving. Higher awareness may help to alleviate craving and improve affect among individuals trying to quit smoking, despite not being associated with an immediate reduction in smoking. Further testing of the clinical significance of these findings is warranted. Future studies might also test additional facets of mindfulness to obtain a more complete understanding of the mechanisms of MBIs. Finally, given the significance of these factors to other health behaviors, future studies could test if these findings generalize to other addictive substances and behaviors that impact health and well-being.

References

Akbari, M., Hasani, J., & Seydavi, M. (2020). Negative affect among daily smokers: A systematic review and meta-analysis. *Journal of Affective Disorders*, *274*, 553–567. https://doi.org/10.1016/j.jad.2020.05.063

Allen, S. S., Bade, T., Hatsukami, D., & Center, B. (2008). Craving, withdrawal, and smoking urges on days immediately prior to smoking relapse. *Nicotine & Tobacco Research: Official Journal of the Society for Research on Nicotine and Tobacco*, *10*(1), 35–45. https://doi.org/10.1080/14622200701705076

Atkins, D. C., & Gallop, R. J. (2007). Rethinking how family researchers model infrequent outcomes: A tutorial on count regression and zero-inflated models. *Journal of Family Psychology*, *21*(4), 726–735. https://doi.org/10.1037/0893-3200.21.4.726

Babb, S. (2017). *Quitting smoking among adults—United States, 2000–2015*. https://www.cdc.gov/mmwr/volumes/65/wr/mm6552a1.htm

Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using self-report assessment methods to explore facets of mindfulness. *Assessment*, *13*(1), 27–45. https://doi.org/10.1177/1073191105283504

Baker, T. B., Piper, M. E., McCarthy, D. E., Majeskie, M. R., & Fiore, M. C. (2004). Addiction motivation reformulated: An affective processing model of negative reinforcement. *Psychological Review*, *111*(1), 33–51. https://doi.org/10.1037/0033-295X.111.1.33

Bell, E. C., Marcus, D. K., & Goodlad, J. K. (2013). Are the parts as good as the whole? A meta-analysis of component treatment studies. *Journal of Consulting and Clinical Psychology*, *81*(4), 722–736. https://doi.org/10.1037/a0033004

Berkman, E. T., Dickenson, J., Falk, E. B., & Lieberman, M. D. (2011). Using SMS text messaging to assess moderators of smoking reduction: Validating a new tool for ecological measurement of health behaviors. *Health Psychology*, *30*(2), 186–194. https://doi.org/10.1037/a0022201

Biener, L., & Abrams, D. B. (1991). The Contemplation Ladder: Validation of a measure of readiness to consider smoking cessation. *Health Psychology*, *10*(5), 360–365. https://doi.org/10.1037/0278-6133.10.5.360

Bishop, S. R., Lau, M., Shapiro, S., Carlson, L., Anderson, N. D., Carmody, J., Segal, Z. V., Abbey, S., Speca, M., Velting, D., & Devins, G. (2004). Mindfulness: A proposed operational definition. *Clinical Psychology: Science and Practice*, *11*, 230–241. https://doi.org/10.1093/clipsy.bph077

Blanke, E. S., Riediger, M., & Brose, A. (2018). Pathways to happiness are multidirectional: Associations between state mindfulness and everyday affective experience. *Emotion*, *18*(2), 202–211. https://doi.org/10.1037/emo0000323

Bolger, N., & Laurenceau, J.-P. (2013). *Methodology in the social sciences*. Guilford Press.

Brewer, J. A., Elwafi, H. M., & Davis, J. H. (2013). Craving to Quit: Psychological models and neurobiological mechanisms of mindfulness training as treatment for addictions. *Psychology of Addictive Behaviors: Journal of the Society of Psychologists in Addictive Behaviors*, *27*(2), 366–379. https://doi.org/10.1037/a0028490

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, *84*(4), 822–848. https://doi.org/10.1037/0022-3514.84.4.822

Cambron, C., Hopkins, P., Burningham, C., Lam, C., Cinciripini, P., & Wetter, D. W. (2020). Socioeconomic status, mindfulness, and momentary associations between stress and smoking lapse during a quit attempt. *Drug and Alcohol Dependence*, *209*, 107840. https://doi.org/10.1016/j.drugalcdep.2020.107840

Carpenter, J. K., Conroy, K., Gomez, A. F., Curren, L. C., & Hofmann, S. G. (2019). The relationship between trait mindfulness and affective symptoms: A meta-analysis of the Five Facet Mindfulness Questionnaire (FFMQ). *Clinical Psychology Review*, *74*, Article e101785. https://doi.org/10.1016/j.cpr.2019.101785

Chambers, R., Gullone, E., & Allen, N. B. (2009). Mindful emotion regulation: An integrative review. *Clinical Psychology Review*, *29*(6), 560–572. https://doi.org/10.1016/j.cpr.2009.06.005

Elwafi, H. M., Witkiewitz, K., Mallik, S., Thornhill, T. A. IV, & Brewer, J. A. (2013). Mindfulness training for smoking cessation: Moderation of the relationship between craving and cigarette use. *Drug and Alcohol Dependence*, *130*(1–3), 222–229. https://doi.org/10.1016/j.drugalcdep.2012.11.015

Fernandez, A. C., Wood, M. D., Stein, L. A., & Rossi, J. S. (2010). Measuring mindfulness and examining its relationship with alcohol use and

negative consequences. *Psychology of Addictive Behaviors*, *24*(4), 608–616. https://doi.org/10.1037/a0021742

Ferrer, R. A., Taber, J. M., Sheeran, P., Bryan, A. D., Cameron, L. D., Peters, E., Lerner, J. S., Grenen, E., & Klein, W. M. P. (2020). The role of incidental affective states in appetitive risk behavior: A meta-analysis. *Health Psychology*, *39*(12), 1109–1124. https://doi.org/10.1037/hea0001019

Garland, E. L., Froeliger, B., & Howard, M. O. (2014). Mindfulness training targets neurocognitive mechanisms of addiction at the attention-appraisal-emotion interface. *Frontiers in Psychiatry*, *4*, 173. https://doi.org/10.3389/fpsyt.2013.00173

Garrison, K. A., Pal, P., O'Malley, S. S., Pittman, B. P., Gueorguieva, R., Rojiani, R., Scheinost, D., Dallery, J., & Brewer, J. A. (2018). Craving to Quit: A Randomized Controlled Trial of Smartphone app-based Mindfulness Training for Smoking Cessation. *Nicotine & Tobacco Research: Official Journal of the Society for Research on Nicotine and Tobacco*, *22*(3), 324–331. https://doi.org/10.1093/ntr/nty126

Garrison, K. A., Pal, P., Rojiani, R., Dallery, J., O'Malley, S. S., & Brewer, J. A. (2015). A randomized controlled trial of smartphone-based mindfulness training for smoking cessation: A study protocol. *BMC Psychiatry*, *15*, 83. https://doi.org/10.1186/s12888-015-0468-z

Goldberg, S. B., Hanley, A. W., Baldwin, S. A., Bernstein, A., & Garland, E. L. (2020). Does mindfulness practice promote psychological functioning or is it the other way around? A daily diary study. *Psychotherapy: Theory, Research, & Practice*, *57*(3), 310–322. https://doi.org/10.1037/pst0000286

Heppner, W. L., Spears, C. A., Correa-Fernández, V., Castro, Y., Li, Y., Guo, B., Reitzel, L. R., Vidrine, J. I., Mazas, C. A., Cofta-Woerpel, L., Cinciripini, P. M., Ahluwalia, J. S., & Wetter, D. W. (2016). Dispositional mindfulness predicts enhanced smoking cessation and smoking lapse recovery. *Annals of Behavioral Medicine*, *50*(3), 337–347. https://doi.org/10.1007/s12160-015-9759-3

Jamal, A., Phillips, E., Gentzke, A. S., Homa, D. M., Babb, S. D., King, B. A., & Neff, L. J. (2018). Current cigarette smoking among adults—United States, 2016. *Morbidity and Mortality Weekly Report*, *67*(2), 53–59. https://doi.org/10.15585/mmwr.mm6702a1

Jones, A., Remmerswaal, D., Verveer, I., Robinson, E., Franken, I. H. A., Wen, C. K. F., & Field, M. (2019). Compliance with ecological momentary assessment protocols in substance users: A meta-analysis. *Addiction*, *114*(4), 609–619. https://doi.org/10.1111/add.14503

Kabat-Zinn, J. (1994). *Wherever you go, there you are: Mindfulness meditation in everyday life*. Hyperion.

Kahneman, D., Krueger, A. B., Schkade, D. A., Schwarz, N., & Stone, A. A. (2004). A survey method for characterizing daily life experience: The day reconstruction method. *Science*, *306*(5702), 1776–1780. https://doi.org/10.1126/science.1103572

Karyadi, K. A., VanderVeen, J. D., & Cyders, M. A. (2014). A meta-analysis of the relationship between trait mindfulness and substance use behaviors. *Drug and Alcohol Dependence*, *143*, 1–10. https://doi.org/10.1016/j.drugalcdep.2014.07.014

Killingsworth, M. A., & Gilbert, D. T. (2010). A wandering mind is an unhappy mind. *Science*, *330*(6006), 932. https://doi.org/10.1126/science.1192439

Landmann, S., Cludius, B., Tuschen-Caffier, B., Moritz, S., & Külz, A. K. (2020). Changes in the daily life experience of patients with obsessive-compulsive disorder following mindfulness-based cognitive therapy: Looking beyond symptom reduction using ecological momentary assessment. *Psychiatry Research*, *286*, Article e112842. https://doi.org/10.1016/j.psychres.2020.112842

Lau, M. A., Bishop, S. R., Segal, Z. V., Buis, T., Anderson, N. D., Carlson, L., Shapiro, S., Carmody, J., Abbey, S., & Devins, G. (2006). The Toronto Mindfulness Scale: Development and validation. *Journal of Clinical Psychology*, *62*(12), 1445–1467. https://doi.org/10.1002/jclp.20326

Lindsay, E. K., & Creswell, J. D. (2017). Mechanisms of mindfulness training: Monitor and Acceptance Theory (MAT). *Clinical Psychology Review*, *51*, 48–59. https://doi.org/10.1016/j.cpr.2016.10.011

Maglione, M. A., Maher, A. R., Ewing, B., Colaiaco, B., Newberry, S., Kandrack, R., Shanman, R. M., Sorbero, M. E., & Hempel, S. (2017). Efficacy of mindfulness meditation for smoking cessation: A systematic review and meta-analysis. *Addictive Behaviors*, *69*, 27–34. https://doi.org/10.1016/j.addbeh.2017.01.022

Masicampo, E. J., & Baumeister, R. F. (2007). Relating mindfulness and self-regulatory processes. *Psychological Inquiry*, *18*(4), 255–258. https://doi.org/10.1080/10478400701598363

May, J., Andrade, J., Kavanagh, D. J., Feeney, G. F. X., Gullo, M. J., Statham, D. J., Skorka-Brown, J., Connolly, J. M., Cassimatis, M., Young, R. M., & Connor, J. P. (2014). The craving experience questionnaire: A brief, theory-based measure of consummatory desire and craving. *Addiction*, *109*(5), 728–735. https://doi.org/10.1111/add.12472

Minami, H., Yeh, V. M., Bold, K. W., Chapman, G. B., & McCarthy, D. E. (2014). Relations among affect, abstinence motivation and confidence, and daily smoking lapse risk. *Psychology of Addictive Behaviors*, *28*(2), 376–388. https://doi.org/10.1037/a0034445

Moore, R. C., Depp, C. A., Wetherell, J. L., & Lenze, E. J. (2016). Ecological momentary assessment versus standard assessment instruments for measuring mindfulness, depressed mood, and anxiety among older adults. *Journal of Psychiatric Research*, *75*, 116–123. https://doi.org/10.1016/j.jpsychires.2016.01.011

National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health. (2014). *The health consequences of smoking—50 years of progress: A report of the Surgeon General*. Centers for Disease Control and Prevention (US). https://www.ncbi.nlm.nih.gov/books/NBK179276/

Nielsen, L., Riddle, M., King, J. W., Aklin, W. M., Chen, W., Clark, D., Collier, E., Czajkowski, S., Esposito, L., & Ferrer, R. (2018). The NIH science of behavior change program: Transforming the science through a focus on mechanisms of change. *Behaviour Research and Therapy*, *101*, 3–11. https://doi.org/10.1016/j.brat.2017.07.002

Oikonomou, M. T., Arvanitis, M., & Sokolove, R. L. (2017). Mindfulness training for smoking cessation: A meta-analysis of randomized-controlled trials. *Journal of Health Psychology*, *22*(14), 1841–1850. https://doi.org/10.1177/1359105316637667

Roberts, K. C., & Danoff-Burg, S. (2010). Mindfulness and health behaviors: Is paying attention good for you? *Journal of American College Health*, *59*(3), 165–173. https://doi.org/10.1080/07448481.2010.484452

Rollnick, S., Heather, N., Gold, R., & Hall, W. (1992). Development of a short 'readiness to change' questionnaire for use in brief, opportunistic interventions among excessive drinkers. *British Journal of Addiction*, *87*(5), 743–754. https://doi.org/10.1111/j.1360-0443.1992.tb02720.x

Rupp, C., Gühne, D., Falke, C., Doebler, P., Andor, F., & Buhlmann, U. (2020). Comparing effects of detached mindfulness and cognitive restructuring in obsessive-compulsive disorder using ecological momentary assessment. *Clinical Psychology & Psychotherapy*, *27*(2), 193–202. https://doi.org/10.1002/cpp.2418

Ruscio, A. C., Muench, C., Brede, E., MacIntyre, J., & Waters, A. J. (2016). Administration and Assessment of Brief Mindfulness Practice in the Field: A Feasibility Study Using Ecological Momentary Assessment. *Mindfulness*, *7*(4), 988–999. https://doi.org/10.1007/s12671-016-0538-4

Ruscio, A. C., Muench, C., Brede, E., & Waters, A. J. (2016). Effect of Brief Mindfulness Practice on Self-Reported Affect, Craving, and Smoking: A Pilot Randomized Controlled Trial Using Ecological Momentary Assessment. *Nicotine & Tobacco Research: Official Journal of the Society for Research on Nicotine and Tobacco*, *18*(1), 64–73. https://doi.org/10.1093/ntr/ntv074

Sala, M., Brosof, L. C., & Levinson, C. A. (2019). Repetitive negative thinking predicts eating disorder behaviors: A pilot ecological momentary assessment study in a treatment seeking eating disorder sample.

Behaviour Research and Therapy, *112*, 12–17. https://doi.org/10.1016/j.brat.2018.11.005

Segal, Z. V., Williams, J. M. G., & Teasdale, J. D. (2002). *Mindfulness-based cognitive therapy for depression: A new approach to preventing relapse*. Guilford Press.

Serre, F., Fatseas, M., Swendsen, J., & Auriacombe, M. (2015). Ecological momentary assessment in the investigation of craving and substance use in daily life: A systematic review. *Drug and Alcohol Dependence*, *148*, 1–20. https://doi.org/10.1016/j.drugalcdep.2014.12.024

Shapiro, D., Jamner, L. D., Davydov, D. M., & James, P. (2002). Situations and moods associated with smoking in everyday life. *Psychology of Addictive Behaviors*, *16*(4), 342–345. https://doi.org/10.1037/0893-164X.16.4.342

Shiffman, S. (1993). Assessing smoking patterns and motives. *Journal of Consulting and Clinical Psychology*, *61*(5), 732–742. https://doi.org/10.1037/0022-006X.61.5.732

Shiffman, S. (2009). Ecological momentary assessment (EMA) in studies of substance use. *Psychological Assessment*, *21*(4), 486–497. https://doi.org/10.1037/a0017074

Shiffman, S., Balabanis, M. H., Gwaltney, C. J., Paty, J. A., Gnys, M., Kassel, J. D., Hickcox, M., & Paton, S. M. (2007). Prediction of lapse from associations between smoking and situational antecedents assessed by ecological momentary assessment. *Drug and Alcohol Dependence*, *91*(2-3), 159–168. https://doi.org/10.1016/j.drugalcdep.2007.05.017

Shiffman, S., Gwaltney, C. J., Balabanis, M. H., Liu, K. S., Paty, J. A., Kassel, J. D., Hickcox, M., & Gnys, M. (2002). Immediate antecedents of cigarette smoking: An analysis from ecological momentary assessment. *Journal of Abnormal Psychology*, *111*(4), 531–545. https://doi.org/10.1037/0021-843X.111.4.531

Shiffman, S., Scholl, S. M., Mao, J., Ferguson, S. G., Hedeker, D., & Tindle, H. A. (2020). Ecological momentary assessment of temptations and lapses in non-daily smokers. *Psychopharmacology*, *237*(8), 2353–2365. https://doi.org/10.1007/s00213-020-05539-3

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology*, *4*, 1–32. https://doi.org/10.1146/annurev.clinpsy.3.022806.091415

Shiftman, S., Paty, J. A., Gwaltney, C. J., & Dang, Q. (2004). Immediate antecedents of cigarette smoking: An analysis of unrestricted smoking patterns. *Journal of Abnormal Psychology*, *113*(1), 166–171. https://doi.org/10.1037/0021-843X.113.1.166

Spears, C. A., Houchins, S. C., Stewart, D. W., Chen, M., Correa-Fernández, V., Cano, M. Á., Heppner, W. L., Vidrine, J. I., & Wetter, D. W. (2015). Nonjudging facet of mindfulness predicts enhanced smoking cessation in Hispanics. *Psychology of Addictive Behaviors*, *29*(4), 918–923. https://doi.org/10.1037/adb0000087

Spears, C. A., Li, L., Wu, C., Vinci, C., Heppner, W. L., Hoover, D. S., Lam, C., & Wetter, D. W. (2019). Mechanisms linking mindfulness and early smoking abstinence: An ecological momentary assessment study. *Psychology of Addictive Behaviors*, *33*(3), 197–207. https://doi.org/10.1037/adb0000451

Trull, T. J., & Ebner-Priemer, U. (2014). The Role of Ambulatory Assessment in Psychological Science. *Current Directions in Psychological Science*, *23*(6), 466–470. https://doi.org/10.1177/0963721414550706

U.S. Department of Health and Human Services. (2020). *Smoking cessation: A report of the Surgeon General*. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. https://www.hhs.gov/sites/default/files/2020-cessation-sgr-full-report.pdf

Weinberger, A. H., & McKee, S. A. (2012). Gender differences in smoking following an implicit mood induction. *Nicotine & Tobacco Research: Official Journal of the Society for Research on Nicotine and Tobacco*, *14*(5), 621–625. https://doi.org/10.1093/ntr/ntr198

Wilson, D. B. (n.d). *Practical meta-analysis effect size calculator* [Online calculator]. https://www.campbellcollaboration.org/escalc/html/EffectSizeCalculator-Home.php

Received June 16, 2020
Revision received April 29, 2021
Accepted May 22, 2021 ■