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Isolating the Role of Psychological Dysfunction in Smoking Cessation Failure: Relations of Personality and Psychopathology to Attaining Smoking Cessation Milestones

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Abstract

Research exploring psychological dysfunction as a predictor of smoking cessation success may be limited by nonoptimal predictor variables (i.e., categorical psychodiagnostic measures vs. continuous personality-based manifestations of dysfunction) and imprecise outcomes (i.e., summative point prevalence abstinence vs. constituent cessation milestone measures). Accordingly, this study evaluated the unique and overlapping relations of broad-spectrum personality traits (positive emotionality, negative emotionality, and constraint) and past-year psychopathology (anxiety, mood, and substance use disorder) to point prevalence abstinence and three smoking cessation milestones: (1) initiating abstinence; (2) first lapse; and (3) transition from lapse to relapse. Participants were daily smokers ($N=1365$) enrolled in a smoking cessation treatment study. In single predictor regression models, each manifestation of internalizing dysfunction (lower positive emotionality, higher negative emotionality, and anxiety and mood disorder) predicted failure at one or more cessation milestone. In simultaneous predictor models, lower positive and higher negative emotionality significantly predicted failure to achieve milestones after controlling for psychopathology. Psychopathology did not predict any outcome when controlling for personality. Negative emotionality showed the most robust and consistent effects, significantly predicting failure to initiate abstinence, earlier lapse, and lower point prevalence abstinence rates. Substance use disorder and constraint did not predict cessation outcomes, and no single variable predicted lapse-to-relapse transition. These findings suggest that personality-related manifestations of internalizing dysfunction are more accurate markers of affective sources of relapse risk than mood and anxiety disorders. Further, individuals with high trait negative emotionality may require intensive intervention to promote the initiation and early maintenance of abstinence.

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¹In a previous analysis of an overlapping sample, we examined whether individuals with psychiatric disorders (versus a reference group with no history of any psychopathology) differed in point-prevalence abstinence rates (Piper, et al., 2010). The current analysis differs from this prior paper in several ways: (1) we examine cessation milestones while the earlier paper did not; (2) we report predictive relations for personality traits; (3) we examine the presence vs. absence of each disorder separately rather than Piper et al.'s approach of using a single psychiatrically healthy reference group for all analyses.

Keywords

Personality; Psychopathology; Smoking Cessation; Relapse; Internalizing Disorders

The majority of smoking cessation attempts end in failure. Of smokers who participate in cessation treatments, only 10–40% achieve long-term abstinence (USDHHS, 2008). One explanation for the high relapse rate is that many smokers have psychological dysfunction that make them particularly prone to relapse (Hughes, 1999). Indeed, many smokers have comorbid psychopathology, such as anxiety, mood, and substance use disorders (Grant, Hasin, Chou, Stinson, & Dawson, 2004) and these disorders may pose an important source of relapse risk. In fact, psychopathology may be becoming more highly concentrated amongst chronic smokers over time because smokers without comorbidities may be more likely to quit successfully (Hughes, 1999, 2011). It is therefore critically important to understand the role of psychopathology in smoking cessation failure.

In general, mood, anxiety, and substance use disorders tend to predict worse cessation outcomes, particularly amongst individuals with more recent episodes of psychopathology (e.g., Breslau, Peterson, Schultz, Andreski, & Chilcoat, 1996; Brown et al., 2008; Covey, Hughes, Glassman, Blazer, & George, 1994; Ford, Vu, & Anthony, 2002; Hays et al., 1999; Japuntich et al., 2007; Niaura et al., 2001). However, the literature is not always consistent, as some studies have not found a link between psychopathology and smoking relapse (Hayford et al., 1999; Hitsman, Borrelli, McChargue, Spring, & Niaura, 2003; Piper et al., 2010), which raises the question of whether prior work has mapped the relations between smoking cessation and the vulnerabilities undergirding psychological disturbance in an optimal fashion. It may be that methods previously used to explore relations between psychopathology and cessation have been nonoptimal or insensitive.

Psychiatric Disorders versus Personality Traits as Predictors of Smoking Cessation

One potential source of imprecision might be the use of categorical diagnoses as predictor variables. Dimensional indicators of psychological dysfunction such as personality traits may be superior to categorical psychiatric diagnoses in the prediction of smoking cessation outcomes for both psychometric and substantive reasons. Indeed, Kruger (1999) found that patterns of comorbidity across common, categorically-defined psychiatric disorders cohere with a dimensional model of psychopathology represented by two factors: an internalizing dimension comprising anxiety and depressive mood disorders and an externalizing dimension comprising substance use and disruptive behavior disorders. In a subsequent study (Krueger, McGue, & Iacono, 2001), these psychopathologic dimensions were closely associated with broad-spectrum personality traits of higher negative emotionality (i.e., heightened negative moods and defensive-avoidant behavior), lower positive emotionality (i.e., diminished positive moods and appetitive-approach behaviors), and lower constraint (i.e., impulsivity, risk taking, and rebelliousness). These findings have led some to theorize that psychiatric disorders represent extreme points on the personality continuum (e.g., Krueger & Tackett, 2003), such that anxiety disorders represent high negative emotionality, mood disorders represent high negative and low positive emotionality, and substance use disorders represent low constraint. Furthermore, personality and psychopathology may be alternate manifestations of common higher-order dimensions of internalizing (low positive and high negative emotionality; mood and anxiety disorder) and externalizing (low constraint; substance use disorder) dysfunction (Krueger, et al., 2001). Thus, personality traits and psychiatric disorders may both tap underlying psychological disturbances that may disrupt smoking cessation.

We predict that personality traits may yield more powerful and interpretable predictions of cessation in comparison to psychiatric disorders because they: (a) may capture more faithfully the continuous underlying constructs that actually create heightened cessation vulnerability; and (b) model vulnerability that is in common across diverse groups of people that would be inappropriately sequestered within seemingly disparate diagnostic classes. For some individuals, a particular psychological dysfunction that putatively interferes with smoking cessation may be manifested in ways that do not fit diagnostic criteria. In such cases, people with meaningful levels of underlying dysfunction, but who are undiagnosed, would obfuscate the relation between psychological disturbance and cessation. By contrast, underlying dysfunctions that impact smoking cessation may perhaps be expressed as subtle alterations in affect, behavior, beliefs, and social processes that are best captured in personality assessment

Indeed, extant research shows that personality traits related to higher negative emotionality, lower positive emotionality, and lower constraint predict poorer smoking cessation outcomes (e.g., Cosci et al., 2009; Gilbert, Crauthers, Mooney, McClernon, & Jensen, 1999; Kahler, Spillane, Metrik, Leventhal, & Monti, 2009; Leventhal, Ramsey, Brown, LaChance, & Kahler, 2008). However, prior work has not compared characterological and psychopathologic manifestations of internalizing and externalizing dysfunction as predictors of cessation. Given the points raised above, it is important to characterize the relative predictive validities of psychodiagnostic categories and personality dimensions and to explore whether these variables have overlapping or incremental relations to smoking cessation outcomes after controlling for their covariance. If either personality or psychopathology predicts cessation success after controlling for their covariance, then that particular manifestation of psychological disturbance is more likely to be closer to the underlying source of risk.

Parsing the Smoking Cessation Process into Constituent Milestones

The use of an unrefined outcome variable may also be a source of imprecision in research of psychopathology and smoking cessation. Most of the completed studies in this area have used abstinence status at some specific point in time (e.g., 6-month point-prevalence abstinence) as the primary dependent variable. This outcome may be nondiscriminating in the sense that it reflects cessation failure that could be due to highly diverse and distinct types of failure. Recent research and theory (Shiffman et al., 2006) indicate that successful cessation depends upon attainment of several constituent, dynamic “milestones”: (i) attaining initial abstinence (i.e., 24 hours without smoking), (ii) maintaining abstinence without a lapse (i.e., at least one cigarette), and (iii) if a lapse occurs, avoiding relapse (i.e., resumption of regular smoking). Cessation failure can represent a breakdown at any one of these component stages, each of which could be indicative of distinct underlying mechanisms (Japuntich et al., 2011; Shiffman, et al., 2006). Failing to obtain initial abstinence may reflect inability to cope with acute withdrawal or an avoidance of quitting (Niaura et al., 1999). After initiating abstinence, external cues (e.g., smoking-related stimuli) or internal cues (e.g., emotional states) often trigger lapses (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004; Shiffman et al., 1996), suggesting that lapse vulnerability could reflect the strength of associative processes or coping skills. Vulnerability to full relapse may be the product of tobacco dependence processes being primed by nicotine and ultimately reinstated (Chiamulera, Borgo, Falchetto, Valerio, & Tessari, 1996). Given that the separate milestones may be affected by unique influences, it possible that distinct forms of psychological disturbance (i.e., internalizing versus externalizing dysfunction) could affect each milestone differently. Thus, use of a single type of outcome that blurs effects across these different pathways to cessation failure might shroud relatively strong and clear

relations of psychopathology (or other indicators of psychological dysfunction) with particular components of the cessation process.

The Current Study

The current investigation evaluated personality traits and psychiatric disorders as predictors of smoking cessation milestones and point prevalence abstinence among individuals participating in a smoking cessation treatment study (Piper et al., 2009). We first examined the individual predictive influence of each personality trait and psychiatric disorder without accounting for personality-psychopathology overlap. We then examined whether relations of personality and psychopathology with cessation outcomes were overlapping or incremental to one another.

We predict that indicators of internalizing dysfunction (i.e., high negative and low positive emotionality; mood and anxiety disorder) will demonstrate particularly strong relations with inability to achieve 24 continuous hours of initial abstinence. This prediction is based, in part, on evidence that each of these measures of internalizing tendency are associated with more extreme changes in affective state upon acute withdrawal and difficulty coping with withdrawal symptoms (Brown, Lejuez, Kahler, & Strong, 2002; Cook, Spring, McChargue, & Hedeker, 2004; Gilbert et al., 1998; Strong et al., 2009; Vujanovic & Zvolensky, 2009), which may interfere with very early cessation success (al'Absi, Hatsukami, Davis, & Wittmers, 2004; Brown et al., 2009). We also hypothesize that indicators of externalizing dysfunction (i.e., low constraint; substance use disorder) will demonstrate particularly robust associations with initial lapse following a period of abstinence. The basis of this prediction is that externalizing tendencies manifest in impulsive acts, and lapses to smoking tend to be provoked acutely by exposure to provocative stimuli or "smoking triggers" (e.g., Shiffman et al., 2007). Thus, we hypothesize that those high in externalizing tendencies may smoke a cigarette impulsively when exposed to such triggers, even following extended periods of abstinence. Given the limited prior data on factors that promote lapse-relapse transitions, we did not make any hypotheses regarding whether psychopathology or personality would associate with this milestone. Finally, based on the notion that personality traits more closely capture underlying psychological dysfunction that interferes with cessation and provides psychometric advantages to psychiatric diagnoses, we predict that personality traits will generally yield stronger predictive relations with cessation outcomes than diagnoses when examined both in single predictor models and in models adjusting for personality-psychopathology covariance.

Method

Participants

Participants were 1504 individuals from Southeastern Wisconsin recruited via media announcements (for details see Piper, et al., 2009). Inclusion criteria were: (1) smoke at least 10 cigarettes per day for the past 6 months; (2) carbon monoxide (CO) level greater than 9 ppm; and (3) motivation to quit smoking. Exclusion criteria were: (a) current use of non-cigarette forms of tobacco; (b) contraindications to study medications (e.g., medication interactions seizure); (c) six or more alcoholic beverages daily; (d) pregnancy or breast-feeding; and (e) physical or mental health condition precluding study completion (e.g., eating disorder, psychosis).

Of the 1504 randomized participants, 1365 had complete calendar data for the first 14 days, received a psychiatric interview, and provided a valid personality profile, which constituting the final sample used in the analysis. Participants with ($n=1365$) versus without ($n=139$) complete data did not significantly differ on any demographic, baseline smoking, or point

prevalence abstinence outcome. This study was approved by the University of Wisconsin Health Sciences Internal Review Board.

Procedure

Following a phone screen, participants attended three baseline sessions, which included a study description and informed consent, medical assessment, CO breath test, demographic and smoking history questionnaires, personality assessment, and a psychiatric interview. Eligible participants were randomized to one of six treatment conditions: Bupropion SR ($n=264$; 150 mg twice per day for one week pre-quit and 8 weeks post-quit); Nicotine lozenge ($n=260$; up to nine 2 or 4 mg lozenges per day, based on dose per package instructions for 12 weeks post-quit); Nicotine patch ($n=262$; 24-hour patch of 21, 14, and 7 mg titrated over 8 weeks post-quit); Nicotine patch + Nicotine lozenge ($n=267$); Bupropion SR + Nicotine lozenge ($n=262$) or Placebo ($n=189$; five conditions that matched the five active conditions). All participants received six sessions (10–20 minutes each) of manualized individual smoking cessation counseling administered by bachelor-level case managers supervised by a licensed clinical psychologist.²

Measures

Fagerström Test of Nicotine Dependence (FTND)—The FTND is a well-studied six item measure of dependence severity (Heatherton, Kozlowski, Frecker, & Fagerström, 1991).

World Mental Health Survey Initiative Version of the Composite International Diagnostic Interview (CIDI)—The CIDI is a well-validated structured interview, which provided information for diagnosing past-year (i.e., active disorder within the last 12 months) and lifetime *DSM-IV* psychiatric disorders (Kessler & Ustun, 2004). The CIDI was administered by trained interviewers and included only modules for key disorders to reduce participant burden. Analyses focused on past year diagnoses (rather than lifetime) because of evidence suggesting that recent psychopathology has a greater impact on cessation outcomes (Japuntich, et al., 2007; post-hoc analyses in the present sample indicated that none of the lifetime disorders were significantly associated with any smoking cessation milestones).

To reduce the number of tests (and type-I error) and because certain disorders had low base rates, we analyzed only the following higher order categories of psychopathology: anxiety disorders ($n = 188$, 13.8%; social phobia [$n = 85$, 6.2%], panic attacks [$n = 105$, 7.7%]), and/or generalized anxiety disorder [$n = 35$, 2.6%]), mood disorders ($n = 61$, 4.5%; major depressive episodes [$n = 61$, 4.5%], dysthymia [$n = 17$, 1.3%] and/or (hypo)mania [$n = 6$, 0.4%]),³ and substance use disorders ($n = 80$, 5.9%; alcohol abuse [$n = 70$, 5.1%], alcohol dependence [$n = 13$, 1.0%], drug abuse [$n = 3$, 0.2%], and/or drug dependence [$n = 6$, 0.4%]).

Multidimensional Personality Questionnaire—Brief Form (MPQ-BF)—The MPQ-BF includes 155 true/false self-statements (Patrick, Curtin, & Tellegen, 2002). Items index emotional, social, cognitive, and behavioral features, constituting three distinct broad-spectrum dimensions: positive emotionality (i.e., disposition to experience positive emotions and tendency toward appetitive-approach behaviors), negative emotionality (i.e., disposition

²As reported in a previous analysis (Japuntich, Piper, Leventhal, Bolt, & Baker, 2011), all five medication conditions decreased rates of failure to achieve initial abstinence and most (with the exception of the nicotine lozenge) decreased lapse risk, however only the nicotine patch and bupropion + lozenge conditions affected the lapse-relapse transition.

³Participants who experienced (hypo)manic episodes but did not have any major depressive episodes in the past year ($n = 11$, 0.8%) were not included in the mood disorder group because we were interested in internalizing manifestations of psychopathology. Additional analyses including these participants did not change the results.

to negative emotions and tendency to engage in defensive-withdrawal behaviors), and constraint (i.e., lower impulsiveness, risk taking, and rebelliousness). The MPQ-BF has demonstrated excellent psychometric properties and correspondence with the full MPQ (Patrick, et al., 2002). The current analysis utilizes only the three broad-spectrum MPQ scales; these scales have shown the greatest coherence with psychiatric diagnoses (Krueger, et al., 2001). Using Patrick et al.'s (2002) recommendations for identifying invalid profiles based on inconsistent or polarized responding, profiles from 18 (1%) participants were excluded.

Smoking Cessation Milestones—A smoking calendar using time-line follow-back was used to collect information on daily smoking (Brigham et al., 2008). The timeline follow-back procedure appears to accurately detect presence vs. absence of smoking (e.g. lapsing/relapsing), which makes it suitable for use in the present study (Shiffman, 2009).

Calendar data was used to create three milestone variables calculated over the 6-month follow up period (Japuntich, Leventhal, et al., 2011; Shiffman, et al., 2006). *Initial abstinence* was a binary variable indicating whether or not participants reported smoking zero cigarettes on at least one day in the first 14 days following their target quit day. Computed for participants who achieved initial abstinence ($n = 1205$), *initial lapse* was the number of days from the initial date at which zero cigarettes were smoked to the subsequent first day of any smoking. *Lapse-to-relapse transition*, calculated for participants who lapsed ($n = 892$), was defined as the number of days from the lapse day until the first of seven consecutive days of smoking. For participants who never lapsed or relapsed during the study, milestone variables were defined as the number of days from their last milestone until the end of follow-up. Participants with missing calendar data for the first 14 days ($n = 75$) were not included in all analyses. Those who withdrew from the study prior lapsing ($n = 32$) or relapsing ($n = 39$) were censored at the number of days from their last milestone until their withdrawal date.

Point prevalence abstinence (PPA)—Seven-day PPA (“Have you smoked at all, even a puff, in the last seven days?”; yes/no) was assessed at 8 weeks and 6 months following the target quit day. Self-reports were confirmed by a CO < 10 ppm assessed using a Bedfont Smokerlyzer. Consistent with the intent to treat principle, participants who withdrew from the study by the 8-week ($n = 69$) and 6-month ($n = 88$) assessments were coded as smoking. PPA determinations did not take into account status for each of the milestone variable and were solely based on past-seven-day smoking.

Analytic Plan

Preliminary analyses involved computing descriptive statistics and intercorrelations amongst personality, psychopathology, demographic, and nicotine dependence variables.

For primary analyses, we calculated regression models to test relations of each personality trait and psychiatric disorder to the three smoking cessation milestones and PPA at 8 weeks and 6 months post-quit. For each psychiatric disorder, the predictor was entered as a binary variable contrasting the presence (vs. absence) of that particular disorder. We chose this approach as opposed to using a reference category of no history of any psychopathology because we were interested in the unique versus overlapping effects of each disorder in combined models (see below). For each personality trait, a standardized ($M = 0$, $SD = 1$) MPQ-BF scale score was entered as a continuous variable. Logistic regression was used in models predicting initial abstinence and PPA (abstinent = 0; non-abstinent = 1). Cox proportional hazards regression survival analysis was used in models predicting lapse and relapse. Participants were censored at the time of their last contact if they did not lapse or

relapse ([re]lapsing = 1). Two sets of models were tested for each outcome: (1) an individual model which included a single psychiatric disorder or personality trait as the sole predictor; and (2) a combined model which included all six simultaneous predictors (the three traits and three disorders) to examine unique effects of each predictor.

All analyses controlled for a dummy-coded treatment variable representing all conditions. Every analysis was tested in a baseline model and then in an adjusted model controlling for demographics (age, gender, ethnicity [Caucasian vs. Non-Caucasian]) and FTND. So as not to overlook any potential associations in this initial study of psychological predictors of cessation milestones, we set significance to .05 for all analyses without multiple test correction. However, we also report significance determinations after a Holm alpha correction in which each predictor is considered within a family of tests for multiple outcomes (Holm, 1979) so readers can interpret the findings under more conservative significance corrections (see Tables 2 and 3).

Results

Sample Characteristics

Descriptive information about the demographics, FTND scores, psychopathology, and MPQ-BF raw scores are provided in Table 1. Rates of psychopathology and MPQ-BF scores did not significantly differ across the treatment conditions.

Regarding cessation milestones, 160 (11.7%) participants never achieved initial abstinence. Of those who achieved abstinence ($n = 1205$), 892 (74.0%) lapsed with a median latency of 19 days after their first day of abstinence. Among participants who lapsed ($n = 892$), 562 (63.0%) relapsed with a median latency of 44 days in between the initial lapse and the onset of relapse. PPA rates in the overall sample were 46.3% and 34.9% at 8 weeks and 6 months, respectively.⁴

Intercorrelation of Personality, Psychopathology Demographics, and Tobacco Dependence

There were modest correlations among several traits and psychiatric disorders (Table 1). Generally, manifestations of internalizing dysfunction were more strongly associated with each other than with other variables. Constraint was inversely correlated with substance use disorder but not mood or anxiety disorders. Several significant associations of personality traits and psychiatric disorders to demographics and FTND scores were also found (Table 1).

Personality and Psychopathology as Predictors of Smoking Cessation

Individual models—As shown in Table 2, lower positive emotionality significantly predicted higher initial lapse risk, but was not significantly related with other milestones or PPA. Negative emotionality significantly predicted failure to initiate abstinence, higher lapse risk, and lower 8-week and 6-month PPA rates across models differing in covariate adjustment, but did not predict lapse-to-relapse transition. Past-year anxiety disorder significantly predicted failure to initiate abstinence, but not other milestones or PPA. Mood disorder significantly predicted lapse risk and lower 8-week PPA, but these relations were not significant in adjusted models. Neither constraint nor substance use disorder significantly predicted any milestone or PPA.

⁴PPA rates are not equal to milestone relapse rates because some participants could have had seven consecutive days of smoking and then resumed abstinence prior to 8-week and 6-month post-quit assessments.

Combined models—As illustrated in Table 3, the association between lower positive emotionality and higher initial lapse risk was significant in baseline combined models, but was not significant after adjusting for covariates ($p = .09$). Negative emotionality significantly predicted failure to initiate abstinence and lower 8-week and 6 month PPA rates across models differing in covariate adjustment. The relation between negative emotionality and lapse was significant in the baseline model, but not significant in the adjusted model ($p = .07$). Mood and anxiety disorder were not significantly related to any outcome in combined models.

Post-hoc analyses to disentangle the effects of emotional disorder and personality—In certain cases, anxiety and mood disorder were significant predictors in individual models, but not significant in combined models (see Tables 2 and 3). To explain why the effect of anxiety disorder on initial abstinence was partialled out, we first tested a model including anxiety and mood disorders as the sole simultaneous predictors of failure to obtain initial abstinence, which showed that anxiety disorder retained a significant effect ($p = .02$). In a second model including anxiety disorder, positive emotionality, and negative emotionality as predictors, anxiety disorder no longer had an effect ($p = .32$). Thus, anxiety disorder had significant incremental predictive value for initiating abstinence over and above mood disorder, but not over and above personality.

To explain why the effects of mood disorder on initial lapse risk and 8-week PPA were partialled out, we first tested models including mood and anxiety disorders as sole predictors, which showed that mood disorder continued to significantly predict lapse risk ($p = .04$) and 8 week PPA ($p = .03$). In separate models including mood disorder, positive emotionality, and negative emotionality as predictors, mood disorder did not significantly predict lapse risk ($p = .11$) and marginally predicted 8-week PPA ($p = .055$). Thus, mood disorder had significant predictive value over and above anxiety disorder, but this effect was attenuated when the prediction model comprised positive and negative emotionality.⁵

Discussion

In this study, we hypothesized that indicators of internalizing dysfunction would most strongly predict failure to initiate abstinence, whereas indicators of externalizing dysfunction would most strongly predict increased propensity to initial lapse. We also hypothesized that personality traits would show stronger predictive validities than psychiatric diagnoses. Results showed that, consistent with the conceptual basis of this work, the strongest predictive relations with cessation outcomes were obtained with personality rather than diagnostic variables. However, the results did not follow the expected pattern in that: (1) measures of internalizing dysfunction predicted both failure to achieve initial abstinence as well as lapse risk; (2) measures of externalizing dysfunction did not meaningfully relate with any cessation outcomes; (3) negative emotionality showed stronger and more wide-spanning effects on cessation outcome in comparisons to other indicators of internalizing tendency; (4) the use of milestones did not yield more powerful predictive relations than did the use of point-prevalence outcomes in several cases. Below, we review the findings in greater detail.

Psychopathology and Cessation Outcomes

While we hypothesized that both psychodiagnostic indicators of internalizing dysfunction (mood and anxiety disorders) would relate specifically to failure to achieve initial abstinence, only past-year anxiety disorder was associated with this outcome. This finding is

⁵Interactions between personality/psychopathology and time were not significant in predicting days to lapse or days from lapse to relapse.

consistent with evidence that anxiety features such as anxiety sensitivity (i.e., a cognitive construct indicative of fear of experiencing anxiety symptoms that is implicated in the etiology of multiple anxiety disorders; Reiss, Peterson, Gursky, & McNally, 1986) may play a role in cessation failure. Indeed, smokers higher in anxiety sensitivity perceive quitting as difficult and threatening, report greater acute nicotine withdrawal, and are more likely to lapse on the first day of a quit attempt (Zvolensky et al., 2007; Zvolensky, Stewart, Vujanovic, Gavric, & Steeves, 2009). Thus, anxiety-related pathology may pose barriers early in the cessation process.

By contrast, mood disorder did not predict failure to achieve abstinence, which may indicate that features specific to mood disorder (e.g., anhedonia, vegetative symptoms) do not disrupt ability to start a quit attempt. Nonetheless, mood disorder was significantly or marginally ($p = .06$ after adjusting for covariates) associated with higher risk of initial lapse and lower 8-week PPA, which coheres with prior findings demonstrating that recent mood symptoms are associated with early lapse following a period of abstinence (e.g., Japuntich, et al., 2007; Niaura, et al., 2001). It is possible that because depressed smokers exhibit a hypersensitivity to smoking-related cues during acute tobacco abstinence (Kushnir et al., 2010) and lower confidence in resisting smoking in high-risk situations (Cinciripini et al., 2003), they may be more vulnerable to lapse after achieving a period of abstinence.

Substance use disorder was not significantly associated with any outcome. Prior research examining the relation of substance use problems to smoking cessation has been mixed (e.g., Hayford, et al., 1999; Hays, et al., 1999), but substance use is more consistently associated with poor outcomes for heavier users (e.g., Ford, et al., 2002; Kahler, Spillane, & Metrik, 2010). Although rates of past-year substance abuse were sizeable in this study ($n = 73$, 5.3%), substance dependence was rare ($n = 19$, 1.9%). Rates of dependence may have been limited because study eligibility criteria excluded very heavy drinkers due to medication contraindications. Thus, relations between substance dependence and cessation milestones deserve further investigation.

Personality and Cessation Outcomes

Though we expected both of the characterological indicators of internalizing tendency (negative and positive emotionality) to exhibit similar predictions specific to ability to achieve abstinence, results revealed divergent patterns across these two traits. Negative emotionality was associated with broad, spanning relations with failure to initiate abstinence, higher initial lapse risk, and lower 8-week and 6-month post-quit PPA. While the risk posed by negative emotionality was only moderate in size (about a 30% increase in point-prevalence smoking outcomes with a one *SD* increase in the MPQ scale), this effect may be clinically significant, particularly when comparing relapse risk between those with low (< 1 *SD*) and high (> 1 *SD*) negative emotionality. In addition, negative emotionality made a significant independent contribution to prediction even with covariates such as nicotine dependence and the other traits and disorders in the prediction models. This suggests that negative emotionality might be a useful element in a multifactorial risk prediction model. Strength of withdrawal tends to determine quitting outcomes early in the quitting process (al'Absi, et al., 2004), and there is evidence that measures related to negative emotionality predict more severe acute withdrawal (Gilbert et al., 1998), which could explain why negative emotionality predicted failure to initiate abstinence. Other factors might also be involved such as distress tolerance, which is correlated with trait negative emotionality (Marshall-Berenz, Vujanovic, Bonn-Miller, Bernstein, & Zvolensky, 2010). This trait relates to ability to continue goal-directed behavior despite encountering discomfort, and has predicted ability to maintain abstinence for longer than 24 hours (Brown, et al., 2002). Negative emotionality may also play a role in one's confidence in their ability to quit smoking, and thus could leave individuals vulnerable to oscillations in

quitting self-efficacy when faced with temptations to smoke, which may ultimately promote a lapse (Gwaltney et al., 2001). Together, these processes may explain why individuals with higher negative emotionality had lower PPA rates following the end of treatment and 6-months post quit.

By contrast, positive emotionality did not associate with initiation of abstinence. However, it did predict propensity to initial lapse. Although the size of this effect was modest (6 to 8% reduction in risk with each one *SD* increase in positive emotionality), this trait was significantly related with lapse in model adjusting for nicotine dependence and demographics and another model adjusting for the other traits and psychiatric disorders. This finding adds to literature documenting that characteristics indicative of low positive emotionality (e.g., anhedonia) associate with lapse propensity (Leventhal, Waters, Kahler, Ray, & Sussman, 2009; Niaura, et al., 2001), and suggests that positive emotionality may provide incremental predictive validity for certain cessation processes over and above other measures of internalizing dysfunction. Positive emotionality did not predict PPA or other milestones, suggesting low positive emotionality may carry little risk in the latter stages of a cessation attempt (but see Doran et al., 2006). Taken together, it appears that different facets of internalizing tendencies (mood vs. anxiety disorder; positive vs. negative emotionality) play unique roles in the smoking cessation process.

In the current study, the MPQ-BF constraint score—a broad-spectrum measure spanning impulsivity, risk taking, and rebelliousness did—not predict cessation outcomes. Prior studies assessing narrow reflections of impulsivity (Doran, Spring, McChargue, Pergadia, & Richmond, 2004) and sensation seeking (Kahler, et al., 2009) have demonstrated associations with cessation failure. Thus, it is possible that only certain manifestations of behavioral undercontrol may carry risk for cessation failure.

Incremental Relations of Personality and Psychopathology to Cessation Milestones

Consistent with hypotheses, no psychiatric disorder significantly predicted cessation milestones over and above personality variables, whereas negative and positive emotionality retained significant effects after controlling for psychopathology. Psychometric factors could account for this pattern. For instance, risk of relapse due to psychological dysfunction may, in fact, be best modeled as a continuous variable and not as a binary variable. This could relate to the metric properties of a continuous assessment per se, and also due to the fact that heightened risk may occur in more individuals than just those with a psychiatric disorder (Krueger & Tackett, 2003). It also may be the case that personality does, in fact, provide better or construct indicators or coverage of the relevant content domain of risk. For instance, the tendency to repeatedly experience and be bothered by significant negative affectivity, versus the episodic expression of diagnostic features such as sleeping or eating problems (in the cases of mood disorder diagnoses), may be what actually derails quit attempts. The practical, or clinically useful, message of this research is that the simplest, most straightforward method for indexing risk related to psychological dysfunction may be to use a measure of trait negative emotionality.

Relative Performance of Milestones and Point-Prevalence Measures

Unexpectedly, the predictive relations with PPA measures were in some cases as strong or stronger those yielded by the milestone measures, suggesting that milestone variables may be less sensitive than PPA indexes. This could be due to several factors. One is that, to a great extent, ultimate long-term point prevalence provides a single measure of the net effects of each individual milestone. When a predictor affects multiple milestones (as was the case with negative emotionality in this study), the summative effects on point prevalence outcomes will be more robust than on the individual milestones. Similarly, certain

milestones may be generally less sensitive to individual difference factors. Indeed, no predictor was related to the lapse-to-relapse transition. Lapse-to-relapse processes may be triggered by nicotine-primed reinstatement of smoking behavior (Shiffman, et al., 2006), which may reflect core tobacco dependence traits (e.g., heavy smoking, smoking after awakening) rather than peripheral factors that may impact cessation failure, such as personality and psychopathology (Japuntich, Leventhal, et al., 2011).

While the use of the milestones did not yield superior predictive relations for all variables in the current work, they still conferred benefit. For instance, the influence of anxiety disorder was detectable only for failure to achieve initial abstinence but not PPA. Further, the milestones showed *where* it was in the cessation process that the predictor variables had their strongest effects. In the case of negative emotionality, cessation was disrupted in both ability to start the quitting process, and to a lesser extent, in lapsing once cessation was initiated. This information is clinically useful and suggests that individuals high in negative emotionality, regardless of their diagnostic status, may need additional counseling or pharmacological support early in the cessation attempt.

Limitations and Future Directions

Assessment of psychopathology in this study was limited to past-year diagnoses, which leaves unclear whether some episodes remitted prior to the quit day. We also did not assess certain disorders in order to reduce participant burden and we analyzed only higher order groupings of psychopathology because of low prevalence rates of some disorders. Given that certain disorders, including those not assessed in this study (e.g., PTSD; Brown, et al., 2008), and the time course of psychopathology, may be important (Haas, Munoz, Humfleet, Reus, & Hall, 2004), future examination of these factors as predictors of cessation milestones would be informative. Relatedly, the prevalence rates of mood and substance use disorders were somewhat modest, which may have limited power to detect effects for these predictors in some cases. Of note, we analyzed milestones for only individuals who reached a prior milestone. This approach is consistent with previously used methods (Japuntich, Leventhal, et al., 2011; Shiffman, et al., 2006) and reflects the clinical reality that reaching a previous milestone is a prerequisite for reaching another (e.g., those who never lapse cannot relapse). However, this approach could introduce bias in analyses of later milestones, and it also reduces power for such tests. It is important to note that PPA determinations did not take into account status for each of the milestone variable. Thus, whether or not participants achieved a particular milestone did not artifactually bias PPA outcomes. Also, measurement of milestones was based on self-report timeline follow back methods (Shiffman, 2009), which tend to be less accurate than real-time assessments.

Lastly, we conducted multiple tests without adjusting type-I error rates in this initial study. While most of the relations involving personality variables remained significant after a holm correction for multiple tests, all of the relations involving psychodiagnostic predictors were not significant following multiple test corrections. Thus, psychodiagnostic variables may be relatively weak predictors of smoking cessation outcomes. In fact, Hall et al. (2006) showed that smokers proactively recruited and treated for smoking in depression treatment clinics had significant long-term abstinence rates similar to general populations of smokers. Thus, the past-year psychiatric disorder may not reflect an underlying psychological dysfunction that impedes successful cessation, particularly when treatments are tailored to the individual needs of participants (Hall, et al., 2006). Alternatively, the current findings suggest that higher levels on internalizing personality traits, such as negative emotionality, may indeed suggest an underlying psychological diathesis that interferes with smoking cessation.

Conclusions

This study was the first investigation of personality and psychopathology as concomitant risk factors for failing to reach smoking cessation milestones. Overall, the results indicate that risk of cessation failure due to psychological dysfunction can be most efficiently modeled with personality measures of internalizing tendency, and a single trait measure tapping trait negative emotionality provides the greatest predictive value. This appears to constitute the basis of risk due to psychological dysfunction, rather than other more specific diagnostic features. Furthermore, this source of risk is most prominently expressed early in the quitting process.

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Table 1
 Descriptive Statistics and Intercorrelation of Personality Traits, Past-Year Psychopathology, and Baseline Characteristics

	Intercorrelations					
	1.	2.	3.	4.	5.	6.
Personality and Psychopathology						
1. Positive emotionality, <i>M</i> (<i>SD</i>)	71.7 (15.1) ^c	-				
2. Negative emotionality, <i>M</i> (<i>SD</i>)	32.2 (13.7) ^c	-.10 ^{***}	-			
3. Constraint, <i>M</i> (<i>SD</i>)	81.8 (13.5) ^c	-.07 [*]	-.05	-		
4. Anxiety disorder, <i>n</i> (%)	188 (13.8%)	-.12 [†]	.24 [†]	-.002	-	
5. Mood disorder, <i>n</i> (%)	61 (4.5%)	-.10 ^{***}	.14 [†]	-.004	.22 [†]	-
6. Substance use disorder, <i>n</i> (%)	80 (5.9%)	-.01	.14 [†]	-.08 ^{**}	.14 [†]	.05
Sample Characteristics						
Age, <i>M</i> (<i>SD</i>)	44.8 (11.1)	-.14 [†]	-.11 [†]	.17 [†]	-.10 ^{***}	-.03
Female, <i>n</i> (%) ^d	796 (58.3%)	-.004	-.03	.17 [†]	.09 ^{**}	.05
Caucasian, <i>n</i> (%) ^b	1148 (84.1%)	.08 ^{**}	-.18 [†]	-.19 [†]	-.07 ^{**}	-.05
FTND, <i>M</i> (<i>SD</i>)	5.4 (2.1)	-.10 ^{***}	.12 [†]	.02	-.001	.04
Correlations with Personality and Psychopathology						
Age, <i>M</i> (<i>SD</i>)						-.08 ^{**}
Female, <i>n</i> (%) ^d						-.08 ^{**}
Caucasian, <i>n</i> (%) ^b						-.05 [*]
FTND, <i>M</i> (<i>SD</i>)						-.03

Note. *N* = 1365. Correlations among continuous variables are Pearson correlation coefficients. Correlations between continuous and dichotomous variables are point-biserial correlation coefficients. Correlations among dichotomous variables are Spearman rho coefficients. FTND = Fagerström Test of Nicotine Dependence.

^aFemale coded as 1, Male coded as 0.

^bCaucasian coded as 1, Non-Caucasian coded as 0.

^cRaw unstandardized score.

* *p* < .05,

** *p* < .01,

*** *p* < .001,

[†] *p* < .0001

Table 2

Results from Individual Models of Personality and Psychopathology Predicting Smoking Cessation Milestones over the 6 Months Following Target Quit Day

Predictor	Outcome											
	Failure to reach initial abstinence			Days from initial abstinence to first lapse ^a			Days from first lapse to relapse ^b			Point-prevalence non-abstinent at 6 months post-quit		
	OR (95% CI) ^c	p	HR(95% CI) ^d	p	HR(95% CI) ^d	p	HR(95% CI) ^d	p	OR (95% CI) ^e	p	OR (95% CI) ^e	p
<i>Baseline Models^e</i>												
Personality ^f												
Positive emotionality	0.87 (0.74–1.02)	.08	0.92 (0.86–0.98)	.01^h	0.93 (0.86–1.01)	.09	0.95 (0.86–1.06)	.39	0.95 (0.83–1.04)	.20	0.93 (0.83–1.04)	.20
Negative emotionality	1.34 (1.15–1.56)	.0002^h	1.10 (1.03–1.18)	.007^h	1.04 (0.95–1.13)	.38	1.27 (1.13–1.42)	<.0001^h	1.30 (1.15–1.47)	<.0001^h	1.30 (1.15–1.47)	<.0001^h
Constraint	1.07 (0.90–1.28)	.42	1.01 (0.94–1.07)	.86	0.99 (0.91–1.08)	.85	1.02 (0.92–1.14)	.69	1.04 (0.93–1.17)	.45	1.04 (0.93–1.17)	.45
Past year psychopathology												
Anxiety disorder	1.69 (1.09–2.61)	.02	1.07 (0.88–1.30)	.48	1.15 (0.91–1.45)	.25	1.34 (0.97–1.83)	.07	1.21 (0.88–1.67)	.25	1.21 (0.88–1.67)	.25
Mood disorder	1.12 (0.52–2.45)	.77	1.39 (1.03–1.87)	.03	1.17 (0.81–1.70)	.40	2.01 (1.15–3.51)	.01^h	1.59 (0.91–2.78)	.10	1.59 (0.91–2.78)	.10
Substance use disorder	1.17 (0.60–2.28)	.66	0.87 (0.65–1.16)	.34	0.91(0.62–1.32)	.61	0.85 (0.54–1.34)	.49	0.91 (0.57–1.44)	.67	0.91 (0.57–1.44)	.67
<i>Adjusted Models^g</i>												
Personality ^f												
Positive emotionality	0.91 (0.77–1.08)	.28	0.93 (0.87–1.00)	.04	0.95 (0.87–1.03)	.19	1.00 (0.89–1.12)	.99	0.96 (0.86–1.08)	.51	0.96 (0.86–1.08)	.51
Negative emotionality	1.22 (1.04–1.43)	.02	1.08 (1.01–1.16)	.03	1.03 (0.94–1.13)	.49	1.17 (1.04–1.32)	.01^h	1.22 (1.08–1.39)	.002^h	1.22 (1.08–1.39)	.002^h
Constraint	0.96(0.80–1.15)	.66	0.97 (0.91–1.04)	.37	0.96 (0.88–1.05)	.38	0.96 (0.85–1.08)	.48	1.00 (0.89–1.13)	.99	1.00 (0.89–1.13)	.99
Past year psychopathology												
Anxiety disorder	1.57 (1.00–2.47)	.049	1.05 (0.87–1.28)	.61	1.15 (0.91–1.46)	.25	1.22 (0.88–1.97)	.23	1.10 (0.78–1.53)	.59	1.10 (0.78–1.53)	.59
Mood disorder	0.93 (0.42–2.07)	.86	1.33 (0.99–1.79)	.06	1.11 (0.77–1.61)	.57	1.76 (0.99–3.12)	.054	1.42 (0.80–2.52)	.23	1.42 (0.80–2.52)	.23
Substance use disorder	1.15 (0.58–2.29)	.69	0.93 (0.69–1.25)	.61	0.95 (0.65–1.38)	.77	0.82 (0.51–1.31)	.40	0.91 (0.56–1.46)	.68	0.91 (0.56–1.46)	.68

Note. N = 1365. For each outcome, separate models were conducted for each predictor. Significant effects ($p < .05$) are bolded.

^aIncludes only individuals who achieved initial abstinence ($n = 1205$).

^bIncludes only individuals who lapsed ($n = 892$).

^cLogistic regression model.

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- ^d Cox proportional hazards regression survival model.
- ^e Models adjusted for only treatment (dummy coded to categorize all six conditions).
- ^f Standardized Multidimensional Personality Questionnaire—Brief Form scores ($M = 0, SD = 1$).
- ^g Models adjusted for treatment (dummy coded to categorize all six conditions), age, gender, ethnicity and Fagerström Test of Nicotine Dependence score.
- ^h Effect significant after holm correction within the family of tests for that predictor.

Table 3

Results from Combined Models of Personality and Psychopathology Predicting Smoking Cessation Milestones over the 6 Months Following Target Quit Day

Predictor	Outcome											
	Failure to reach initial abstinence			Days from initial abstinence to first lapse ^d			Days from first lapse to relapse ^b			Point-prevalence non-abstinent at 6 months post-quit		
	OR (95% CI) ^c	p	HR(95% CI) ^d	p	HR(95% CI) ^d	p	HR(95% CI) ^d	p	OR (95% CI) ^c	p	OR (95% CI) ^c	p
<i>Baseline Models^e</i>												
Personality ^f												
Positive emotionality	0.90 (0.76–1.06)	.22	0.93 (0.87–1.00)	.04	0.94 (0.86–1.02)	.13	0.99 (0.89–1.10)	.83	0.95 (0.85–1.07)	.41		
Negative emotionality	1.30 (1.10–1.53)	.002^h	1.09 (1.02–1.17)	.02^h	1.03 (0.95–1.13)	.46	1.25 (1.11–1.41)	.0002^h	1.31 (1.15–1.49)	<.0001^h		
Constraint	1.07 (0.90–1.28)	.42	1.01 (0.94–1.08)	.82	0.99 (0.91–1.08)	.76	1.03 (0.92–1.15)	.62	1.05 (0.94–1.18)	.39		
Past year psychopathology												
Anxiety disorder	1.38 (0.86–2.21)	.19	0.96 (0.77–1.18)	.67	1.11 (0.87–1.43)	.39	1.11 (0.79–1.55)	.56	0.95 (0.67–1.35)	.77		
Mood disorder	0.77 (0.34–1.74)	.53	1.31 (0.95–1.79)	.10	1.08 (0.74–1.59)	.69	1.71 (0.96–3.06)	.07	1.19 (0.65–2.17)	.57		
Substance use disorder	0.94 (0.47–1.90)	.87	0.85 (0.63–1.14)	.27	0.85 (0.58–1.25)	.41	0.72 (0.45–1.15)	.17	0.75 (0.46–1.22)	.25		
<i>Adjusted Models^g</i>												
Personality ^f												
Positive emotionality	0.94 (0.77–1.12)	.46	0.94 (0.88–1.01)	.09	0.95 (0.88–1.04)	.25	1.02 (0.91–1.15)	.69	0.97 (0.87–1.10)	.66		
Negative emotionality	1.19 (1.00–1.41)	.049	1.07 (0.99–1.15)	.07	1.02 (0.93–1.12)	.63	1.16 (1.02–1.31)	.02	1.23 (1.08–1.41)	.002^h		
Constraint	0.97 (0.81–1.16)	.72	0.98 (0.91–1.04)	.45	0.96 (0.88–1.05)	.36	0.97 (0.86–1.09)	.56	1.01 (0.89–1.14)	.89		
Past year psychopathology												
Anxiety disorder	1.42 (0.87–2.30)	.16	0.95 (0.77–1.18)	.65	1.13 (0.88–1.45)	.34	1.09 (0.77–1.55)	.62	0.91 (0.64–1.31)	.63		
Mood disorder	0.71 (0.31–1.63)	.42	1.26 (0.92–1.72)	.16	1.04 (0.71–1.52)	.85	1.62 (0.89–2.92)	.11	1.10 (0.60–2.02)	.76		
Substance use disorder	0.92 (0.45–1.90)	.83	0.90 (0.67–1.21)	.47	0.89 (0.60–1.31)	.54	0.72 (0.44–1.18)	.19	0.80 (0.49–1.32)	.39		

Note. N = 1365. For each outcome, combined models were conducted including all six simultaneous predictors. Significant effects ($p < .05$) are bolded.

^aIncludes only individuals who achieved initial abstinence ($n = 1205$).

^bIncludes only individuals who lapsed ($n = 892$).

^cLogistic regression model.

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- ^d Cox proportional hazards regression survival model.
- ^e Models adjusted for only treatment (dummy coded to categorize all six conditions).
- ^f Standardized Multidimensional Personality Questionnaire—Brief Form scores ($M = 0$, $SD = 1$).
- ^g Models adjusted for treatment (dummy coded to categorize all six conditions), age, gender, ethnicity and Fagerström Test of Nicotine Dependence score.
- ^h Effect significant after holm correction within the family of tests for that predictor.