Very Light Daily Smoking in Young Adults: Relationships Between Nicotine Dependence and Lapse

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Abstract

Introduction: Very light daily smoking is increasingly common among young adults. Evidence suggests that levels of nicotine dependence vary significantly among young adults who engage in very light daily smoking. However, the links between dependence and clinically relevant outcomes (e.g., lapse) in this population remain unclear. The goal of this study was to address this gap by evaluating how well different nicotine dependence scales predict lapse behavior among very light daily smoking young adults.

Methods: Very light daily smokers (1-5 cigarettes/day) aged 18-25 participated in an initial laboratory session, during which nicotine dependence was assessed using four commonly used measures: the Fagerström Test for Cigarette Dependence (FTCD), the Hooked On Nicotine Checklist (HONC), the Transdisciplinary Tobacco Use Research Centers (TTURC) Nicotine Dependence Inventory, and the Wisconsin Inventory of Smoking Dependence Motives (WISDM). After a baseline period, eligible participants (n=40) completed a 10-day abstinence incentive period in which they attempted to refrain from smoking to earn monetary rewards. Cox proportional hazards models were used to test whether dependence predicted days to first lapse.

Results: FTCD scores significantly predicted days to lapse, as did scores on the FTCD item assessing time to first cigarette of the day (TTFC). No other dependence measures predicted time to lapse. Both the FTCD and TTFC continued to independently predict time to lapse after controlling for smoking frequency and duration.

Conclusions: The FTCD may be a particularly useful tool for capturing clinically meaningful variability in nicotine dependence among young adults who engage in very light daily smoking.

Implications

This is the first study to directly link self-reported nicotine dependence with the ability to achieve and maintain abstinence among very light daily smoking young adults. The results may aid clinicians in selecting amongst variable measures of nicotine dependence when assessing and treating this population.

INTRODUCTION

According to recent national survey data, an estimated 3.2 million young adults (those aged 18-25) in the U.S. smoke cigarettes daily.¹ Over 25% of them report smoking between 1 and 5 cigarettes/day, a pattern that has been categorized in various ways in the literature.² For instance, some have used the term “very light smoking” to denote smoking on at least 4 days/week but averaging no more than 5 cigarettes/day,³ while others have used the term “light smoking” to indicate smoking an average of fewer than 10 cigarettes/day.⁴ For the purposes the present study, we use the term *very light daily smoking* to refer to the daily use of cigarettes at an average rate of 1-5 cigarettes/day. Regardless of how the behavior is labeled, studies have demonstrated that low levels of cigarette use are associated with adverse health outcomes.⁵⁻⁷ For example, one found that people who smoke 1-4 cigarettes/day are over three times more likely to die from heart or lung disease than non-smokers.⁸ Thus, very light daily smoking among young adults is a significant public health concern.

Furthermore, many young adults who engage in very light daily smoking report that it would be difficult for them to quit.^{9,10} This difficulty likely stems, in part, from symptoms of nicotine dependence that can develop quickly after smoking initiation.¹¹ Research suggests that perceived loss of autonomy over smoking, tolerance, withdrawal symptoms, and craving to smoke can appear within the first months of cigarette use, if not sooner.¹²⁻¹⁴ In addition to these core features of dependence, very light daily smoking among young adults may be driven by secondary dependence motives, instrumental and contextual factors¹⁵ that appear particularly relevant at lower levels of cigarette use.¹⁶⁻¹⁸ In sum, research indicates that nicotine dependence symptoms can emerge rapidly even at low levels of smoking and may pose a clinically significant obstacle to cigarette abstinence for young adults who are very light daily smokers.

Importantly, low-level smokers – including very light daily smoking young adults – vary widely in the degree to which they exhibit nicotine dependence.^{10,18,19} For example, a study examining the association between smoking behavior and Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV) nicotine dependence criteria in first-year undergraduates revealed subgroups of light-smoking individuals with and without clinically significant levels of dependence.²⁰ Likewise, large interindividual differences in dependence were found in a study of adolescents (aged 13-17) who smoked 1-5 cigarettes/day.²¹ Dependence was assessed using the modified Fagerström Tolerance Questionnaire, a measure for which scores range from 0-9. The average, standard deviation, and range of scores obtained by adolescents were 3.4, 1.4, and 0.83-5.3, respectively, underscoring the highly variable levels of nicotine dependence exhibited among very light daily smokers. While relatively little is known about what underlies this variability, evidence suggests that it is meaningfully associated with smoking behavior. For instance, level of dependence among light or intermittent adolescent smokers was found to predict the frequency of their cigarette use through young adulthood over and above concurrent smoking heaviness.²² Given the strong links between nicotine dependence and cessation outcomes,^{23,24} the extent to which very light daily smoking young adults are successful during quit attempts likely varies as a function of their dependence. To our knowledge, this possibility has not been addressed directly, leaving it unclear how variation in dependence among this population relates to cessation outcomes.

One of the challenges in understanding the relationship between nicotine dependence and cessation outcomes among very light daily smoking young adults is that it is not clear which measures are best suited for assessing dependence in this population. Available measures include a range of self-report instruments tapping tolerance and withdrawal symptoms and the

motivation behind cigarette use, traditional diagnostic criteria for dependence, and physiological correlates of smoking heaviness as a proxy for dependence.²⁵⁻²⁷ In addition, despite the multifaceted nature of nicotine dependence, most studies of very light daily smokers have used only one dependence scale. Accordingly, it is possible that many existing studies offer an incomplete picture of dependence among this group. To address this, there have been calls for research on low-level smokers that employs multiple measures of dependence so that the relative utility and validity of instruments can be evaluated.^{25,28} It remains to be seen whether various measures of dependence are differentially related to quit outcomes in very light daily smoking young adults.

The aim of this study was to examine the association between nicotine dependence and clinically relevant smoking behavior among very light daily smoking young adults. Our goal was to evaluate how well different dependence scales predicted abstinence outcomes among this group. Thus, the study included four well-known self-report measures of dependence. To model smoking cessation and lapse behavior, we employed a 10-day incentivized abstinence period adapted from previous research,^{29,30} during which participants were instructed to try to abstain from smoking for the entire period and were rewarded for doing so with a descending schedule of monetary reinforcement. This method and reinforcement schedule were selected because they have proven effective at inducing interindividual variability in lapse behavior.³⁰

METHODS

Participants

Participants were recruited via community advertisements and screened by telephone. To be eligible, participants were required to: be 18-25 years old; report that they have been smoking for at least one year; report that they currently smoked between 1-5 cigarettes/day for at least the last three months and that they never smoked more than 5 cigarettes/day; indicate that they did

not plan on quitting within the next month; indicate that they had access to a device with webcam and internet access; and have a baseline salivary cotinine reading greater than 10 ng/ml (to verify smoking status).

Procedure

The Pennsylvania State University's Institutional Review Board approved this study. The study comprised an initial baseline/training session, a seven-day baseline ecological momentary assessment (EMA) period, a second training session, and a 10-day abstinence incentive EMA period (AIP). At the start of the baseline/training session, participants provided a saliva sample, which was used to measure cotinine levels (NicAlert). A baseline breath carbon monoxide (CO) sample was also collected using a piCO+ Smokerlyzer. Subsequently, participants completed self-report measures assessing demographics and nicotine dependence as part of a larger battery. Measures not included in the present analyses are listed in Supplementary Table 1. Participants could earn up to US\$350.

During the baseline EMA period, participants were instructed to smoke normally and completed brief surveys on study-provided smartphones upon awakening and before bed. They also completed five signal-contingent surveys throughout the day at predetermined times within a 12-hour window, with surveys separated by approximately two hours. Survey items assessed current location, opportunity to smoke, cigarette accessibility, smoking urge, time since smoking, and other variables that are not a focus of this study. In addition to signal-contingent surveys, participants were instructed to complete a brief event-contingent survey each time they smoked. Lastly, participants completed a video-based CO monitoring procedure adapted from previous research.²⁹ Specifically, participants submitted video recordings of themselves providing a CO sample twice per day (between 8am-12pm and 8pm-12am, with a minimum of 8-hrs between

samples) using a piCO+ monitor. Participants uploaded videos via REDCap.³¹ To be considered valid, each video needed to include: 1) an initial view of the CO monitor reading zero, 2) the participant fully exhaling into the CO monitor, 3) an audible “hiss” of four or more seconds during exhalation, and 4) a clear depiction of the final CO reading. Participants answered an item indicating whether they had smoked that day each time that they uploaded a video.

During the AIP, participants completed the same EMA surveys and video-based CO monitoring procedure described above. Cigarette abstinence during the AIP was reinforced using the following descending payment schedule: \$20/day for days 1-2; \$15/day for days 3-4; \$10/day for days 5-6; \$5/day for days 7-8; and \$2.50/day for days 9-10. Participants could earn up to a total of \$105 for abstaining during the 10-day period. The criteria for determining abstinence are described below. As noted, the reinforcement schedule was selected based on previous research.^{29,30}

Measures

Demographics. Basic demographic information was collected using standard forms.

Fagerström Test for Cigarette Dependence (FTCD). The FTCD (formerly the Fagerström Test for Nicotine Dependence, or FTND³²) is a six-item self-report measure developed from the Fagerström Tolerance Questionnaire.³³ Items were summed to yield a total score, with higher scores indicating greater dependence. In addition, scores on the FTCD item assessing time to first cigarette of the day (TTFC; response categories: ≤ 5 minutes, 6–30 minutes, 31–60 minutes, and >60 minutes) were examined separately, as research indicates that this single item is a robust indicator of dependence and a strong predictor of cessation outcomes.^{34,35}

Hooked On Nicotine Checklist (HONC). The HONC is a 10-item yes/no measure that examines loss of autonomy over tobacco use.³⁶ We computed a continuous sum of endorsed responses, with higher scores indicating greater loss of autonomy.

Transdisciplinary Tobacco Use Research Centers (TTURC) Nicotine Dependence Inventory. The TTURC Nicotine Dependence Inventory is an 18-item measure that assesses nicotine dependence criteria as specified in the DSM-IV.²⁰ Dichotomous scoring classifies participants as dependent if they endorse three or more of seven dependence criteria. Alternatively, the questionnaire can be scored continuously by summing the number of endorsed items. Both scoring approaches were used in the current study.

Wisconsin Inventory of Smoking Dependence Motives (WISDM). The WISDM is a 68-item Likert scale that assesses different motivations to smoke.³⁷ Thirteen subscales (e.g., automaticity, craving) can be calculated by averaging the relevant item scores. A total score is taken by summing all subscale scores. Primary dependence motives and a secondary dependence motives scores can be computed by averaging relevant subscales.¹⁵ We calculated scores for total dependence, primary dependence motives, and secondary dependence motives, with higher scores indicating greater dependence in each case.

Abstinence Verification and Days to 1st Lapse. As noted above, we used a video-based procedure adapted from prior research to monitor smoking abstinence during the AIP,²⁹ an approach that has recently been validated using same-day CO readings obtained in the laboratory.³⁸ We used a series of rules to verify abstinence and determine the number of days to first lapse. Participants were classified as abstinent if they submitted two CO readings of ≤ 6 ppm each within the required time frames and did not endorse smoking on any EMA surveys or when uploading their videos. As the appropriate CO cutoff to use varies by the model of monitor being used,³⁹ we

selected 6ppm based on manufacturer recommendations. If a participant's CO was >6ppm on the morning of day 1 of the AIP and they denied smoking, they were considered abstinent if their second CO reading for day 1 was at least a 50% reduction from their first reading. Prior work with these monitors has successfully used CO cutoffs of 6-7ppm and 50% reduction rule.^{30,40} If a participant did not submit a CO video and denied smoking, they were considered abstinent if they submitted the videos required immediately prior to and following the one that was missed (i.e., if they did not miss two or more consecutive videos) and if the CO readings for each of these videos was $\leq$ 6ppm. Participants needed to submit at least one video each day to be classified as abstinent. Regardless of CO level, a participant who reported smoking was considered lapsed. A lapse on day 1 was assigned a score of 1, first lapse on day 2 a score of 2, and so on. Those who did not lapse during the 10-day AIP were assigned a score of 10.

RESULTS

Sample Characteristics

Data were collected between November 2014 and August 2016. Forty-six participants were enrolled. Of these, 5 did not meet requirements for compliance during the baseline EMA period ($\geq$ 50% survey completion) and were withdrawn prior to the 10-day AIP. Baseline questionnaire data for one additional participant were lost due to technical error. Results include data from the remaining 40 participants (16 females, 24 males). Self-identified race/ethnicity of the sample was as follows: 50.0% White, 27.5% Asian, 12.5% Multiracial, 7.5% Black or African American, 2.5% Native Hawaiian or Other Pacific Islander, 87.5% not Hispanic or Latino, 12.5% Hispanic or Latino. Additional sample characteristics are summarized in Table 1.

Nicotine Dependence

Table 2 provides descriptive statistics and bivariate correlations for nicotine dependence measures. To facilitate interpretation, responses on the TTFC item were recoded into two categories for analyses: ≤ 60 minutes and > 60 minutes. (The distribution of responses across the original four categories was as follows: 2.5% of the sample selected ≤ 5 minutes, 12.5% selected 6–30 minutes, 15% selected 31–60 minutes, and 70% selected > 60 minutes.) Eighty-eight percent of participants met DSM-IV criteria for nicotine dependence based on the TTURC Nicotine Dependence Inventory. On average, dependence levels were low-to-moderate based on scores on continuous measures, although there was significant variability and a wide range for each. There were moderate-to-strong correlations ($.57 < r < .99$) among the HONC, TTURC, and WISDM. In contrast, the FTCD and TTFC, which were highly correlated, generally displayed weaker correlations with the other dependence metrics ($-.03 < r < .43$).

Days to First Lapse During the AIP

Table 3 summarizes the frequency and percentage of participants lapsing for the first time on each day of the AIP. Twenty-three participants were classified as lapsed based on concordant CO and self-reported smoking, 12 were classified as lapsed on the basis of missing two CO samples in a day, and 5 were classified as lapsed on the basis of high CO alone (discordant self-report). Results did not change significantly when the 12 participants classified based on missing data were removed.

Association Between Nicotine Dependence and Days to First Lapse

Cox proportional hazards models were used to examine whether nicotine dependence levels predicted time to first lapse during the AIP. Each nicotine dependence measure was used as a predictor for days to first lapse in a univariate Cox model, using the *coxph()* function of the *survival* package (version 3.1.8)⁴¹ in R (version 3.5.1).⁴² Tied event times were handled using the

"exact partial likelihood" approach. Results from the Cox regression analyses are presented in Table 4. Supplementary Figures 1 and 2 depicts survival curves for significant predictors. The FTCD significantly predicted time to first lapse (hazard ratio [HR]=1.57, 95% confidence interval [CI]=1.15–2.14, $p=0.004$), such that higher scores were associated with fewer days to lapse. When examined separately, TTFC also significantly predicted latency to first lapse (HR=3.91, 95% CI=1.58–9.68, $p=0.003$). Specifically, a TTFC of ≤ 60 minutes was associated with fewer days to lapse than a TTFC of >60 minutes. Of note, the relationship between the FTCD and outcomes during the AIP was not driven solely by the TTFC item, as the FTCD remained a significant predictor of time to first lapse when the TTFC item was excluded from the total score (HR=1.84, 95% CI=1.14–2.97, $p=0.012$).

To evaluate the extent to which the FTCD and TTFC predicted days to first lapse when controlling for smoking frequency and duration, each was entered into a separate multivariate Cox model along with number of cigarettes/day and years smoking (taken from a questionnaire completed during the baseline/training session). Both the FTCD (adjusted HR=1.44, 95% CI=1.03–2.03, $p=0.035$) and TTFC (adjusted HR=3.24, 95% CI=1.24–8.52, $p=0.017$) continued to independently predict time to lapse after accounting for these factors.

DISCUSSION

The key finding of the present study was that the FTCD and TTFC both predicted days to first lapse during an incentivized abstinence period in very light daily smoking young adults. Namely, higher FTCD scores and shorter TTFC (i.e., ≤ 60 minutes compared to >60 minutes) were associated with fewer days to lapse. This expands upon prior research demonstrating that a portion of younger light daily smokers exhibit clinically significant nicotine dependence.^{20,21} Similarly, it is consistent with research on non-daily intermittent smokers that found that any

level of self-reported dependence was linked to worse outcomes during nicotine replacement treatment.⁴³ To our knowledge, this is the first study to link nicotine dependence among very light smoking young adults with outcome during an abstinence attempt. Given that those with higher dependence also tended to lapse earlier, it seems likely that dependence may contribute to the difficulty initiating and maintaining abstinence reported by some very light daily smoking young adults.^{9,10} Characterizing the factors that predict lapse within the first few days of a cessation attempt is especially important in light of the strong evidence that early lapses increase the risk of eventual relapse.⁴⁴⁻⁴⁶

The FTCD outperformed other dependence measures in predicting abstinence outcome in our sample. Unlike the FTCD, the HONC, TTURC, and WISDM did not predict abstinence outcomes in the present sample. Notably, this finding is discrepant from prior research indicating that the HONC and TTURC diagnostic scoring were predictive of naturalistic smoking progressions among college students.²⁸ Likewise, our results differ from previous research demonstrating that light daily smokers may be especially driven by secondary dependency motivations.¹⁷ It is possible that sample differences account for these differences; the present study examined a subset of young adult light smokers, while prior work has examined both daily and non-daily smokers. A related possibility is that the differences in how the scales were designed may have contributed to our findings. For instance, the HONC was originally developed to assess the onset of dependence in adolescents, and it may diverge from other measures in important ways when used outside of this context.²⁵ Finally, it should also be noted that other dependence scales or subscales (e.g., WISDM, which approached significance in the current study) might emerge as significant predictors with larger samples. Regardless, the present

findings indicate that the FTCD may be the best predictor of abstinence outcomes among very light smoking young adults.

Our findings are consistent with a growing body of literature highlighting the clinical utility of the FTCD. There is considerable evidence that the FTCD is a well-suited, if not the best-suited, measure to predict lapse behavior in a variety of settings. A study of adult heavy smokers found that FTCD scores were predictive of latency to lapse during a laboratory-based analog of an incentivized abstinence attempt.⁴⁷ Similarly, Sweitzer and colleagues³⁰ found that the FTCD outperformed the TTURC, WISDM and Nicotine Dependence Syndrome Scale (NDSS) in predicting abstinence outcome during a weeklong incentivized quit attempt among adults aged 18-65 who smoked at least 5 cigarettes/day.³⁰ The FTCD has also been shown to predict cessation outcomes across four placebo-controlled trials of adult daily smokers aged 18 and older.³⁴ Furthermore, longitudinal investigations have found that the FTCD predicts smoking status both one week and six months post-quit.²⁴ In sum, despite critiques that the FTCD provides narrow coverage of dependence and has an inconsistent factor structure, its consistency in predicting abstinence outcomes combined with its brevity suggests it may be a useful clinical screener.²⁷

Results from the present study are also in line with previous research demonstrating the predictive value of TTFC as a single-item measure of nicotine dependence. For example, in addition to the FTCD, Sweitzer et al.³⁰ found that earlier TTFC predicted earlier lapse, even after controlling for cigarettes/day and craving. More broadly, a recent systematic review of the literature revealed that shorter TTFC has been consistently linked to a decreased likelihood of making a cessation attempt and to poorer outcomes among those who try to quit.³⁵ Indeed, some work suggests that the TTFC item may accounts for the majority of the predictive validity of the

FTCD.^{30,34} In the current study, however, the FTCD continued to significantly predict lapse after removing the TTFC from the total score, indicating that the remaining FTCD items were capturing useful information. Regardless, our findings add to accumulating evidence that TTFC is a clinically useful assessment tool.

Given the success of the FTCD and TTFC, researchers have begun considering what factors underly their linkages to abstinence success. Research aimed at assessing the construct validity of dependence measures concluded that the FTCD captures how aversive respondents find abstinence as well as their perceived need to smoke in response to withdrawal symptoms.²⁷ Another study also found convergent validity between the FTCD and measures that assess difficulty maintaining abstinence due to withdrawal symptoms.⁴⁸ Responses to the TTFC item are also thought to reflect the motivational significance of the nicotine withdrawal symptoms that arise after overnight abstinence from cigarettes.³⁵ Thus, the success of the FTCD and TTFC in the present study suggests that very light daily smoking young adults may be motivated to avoid withdrawal symptoms during cessation attempts.

The present findings add to emerging research concerning how best to capture dependence among very light daily smokers. Moreover, the current results provide initial evidence that level of dependence has potentially significant implications for treatment success in this population. Understanding that the FTCD may be the most useful tool for predicting smoking cessation outcomes among very light daily smokers could aid clinical decision making. For instance, practitioners could use the FTCD – or perhaps even just the single item assessing TTFC – to help accurately triage very light daily smokers into cessation treatments of various intensities (e.g., self-guided strategies versus counseling). Specifically, clinicians may be guided by high FTCD (or TTFC) scores to recommend interventions that target factors predictive of

lapse. For instance, given that the FTCD appears to track withdrawal motivation, clinicians could consider utilizing psychoeducation to help prepare very light daily smokers who score high on the measure to prepare for and cope with withdrawal symptoms.

Studies attempting to replicate the current findings in the context of other interventions designed to facilitate abstinence (e.g., nicotine replacement therapies) would be valuable. Moreover, studies should determine if dependence as assessed with the FTCD and TTFC (compared to other measures) at the start of treatment is predictive of long-term, post-treatment outcomes, including abstinence or relapse rates, among this population. Finally, given that aversion to withdrawal appears to be an important predictor of lapse among very light daily smoking young adults, future research could explore how impactful various interventions that target early withdrawal symptoms are at extending latency to lapse in this population.

The present study is not without limitations. Participants who completed the AIP submitted, on average, 78.5%, of their CO-verification videos, which falls slightly below compliance rates found in research using similar methods.^{30,40} (Conversely, lower compliance rates have also been observed with more frequent assessments in an adolescent sample.⁴⁹) Higher video-submission compliance rates would allow more precise estimations of time of first lapse. However, we believe the data were sufficient to identify the day on which first lapse occurred. Another limitation is that there is no consensus on what level of (or reduction in) CO is indicative of smoking versus lapse in light daily smokers. As noted, we selected CO cutoffs that are more conservative than those used in prior literature. Although this decision was made based on emerging evidence that many extant CO cutoffs are too lenient,⁵⁰ it is possible that this choice increased the likelihood of false positives. Finally, it is important to note that relative utility of the FTCD versus other dependence measures appears to vary across smoking behaviors in young

adults. For instance, an examination of smoking in college students found that the HONC, TTURC, and NDSS – but not the FTCD – predicted the heaviness of smoking behavior over three years.³¹ Alternative scales/subscales may prove most useful for assessing smoking initiation, maintenance or escalation among young adults.

Notwithstanding these potential limitations, the current findings may have significant public health implications. Although rates of smoking are declining overall in the U.S., very light daily smoking is becoming increasingly popular, especially among young adults.^{1,7} Very light daily smokers incur many of the same health risks as their heavy smoking counterparts and report comparable difficulties when it comes to quitting.^{5,7,8} This study adds to the evidence that very light daily smokers experience symptoms of nicotine dependence that are typically associated with more severe use, and it extends prior work suggesting that some measures of dependence (i.e., FTCD and TTFC) are more useful than others in predicting cessation-related outcomes in this population. Understanding how to best detect key dependence symptoms among very light daily smoking young adults will help researchers and practitioners better characterize and target the difficulties this group faces during smoking cessation attempts.

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DECLARATION OF INTERESTS

Neither author has any conflicts of interest to disclose. The authors have full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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Table 1

Sample Characteristics (n = 40)

	<i>M</i>	<i>SD</i>	Range
Age in years	21.03	1.75	18 – 25
Annual household income	\$78,311	\$147,930	\$0 – 800,000
Cigarettes per day	3.18	1.22	1 – 5
Years smoking	2.80	1.10	1 – 5
Baseline CO reading (ppm)	7.40	3.10	2 - 16

Table 2

Descriptive Statistics and Bivariate Correlations for Nicotine Dependence Measures (n = 40)

	<i>M (SD)</i> or Frequency (%)	Range	1	2	3	4	5	6	7
1. FTCD	1.10 (1.43)	0 – 5 ^a							
2. HONC	4.90 (2.52)	0 – 9	.33*						
3. TTURC-Categorical	35 (88%)	n/a	-.03	.62**					
4. TTURC-Continuous	4.97 (1.75)	1 – 7	.19	.66**	.78**				
5. WISDM-Total	38.99 (12.10)	13.33 – 62.58	.29	.67**	.62**	.74**			
6. WISDM-PDM	2.45 (0.89)	1.00 – 4.90	.43**	.64**	.57**	.73**	.90**		
7. WISDM-SDM	3.24 (1.00)	1.04 – 5.14	.22	.65**	.61**	.70**	.99**	.81**	
8. TTFC	12 ≤60 min (30%), 28 >60min (70%)	n/a	.77**	.31	.08	.07	.23	.29	.20

FTCD = Fagerström Test for Cigarette Dependence, HONC = Hooked on Nicotine Checklist, TTFC = time to first cigarette of the day, TTURC = Transdisciplinary Tobacco Use Research Centers (TTURC) Nicotine Dependence Inventory, WISDM = Wisconsin Inventory of Smoking Dependence Motives.

^a All participants scored 0 on the FTCD item assessing number of cigarettes smoked per day.

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

Table 3

Days to First Lapse during the Abstinence Incentive Period (n = 40)

Days to First Lapse	Frequency	Percentage
1	12	30%
2	4	10%
3	7	17.5%
4	2	5%
5	1	2.5%
6	3	7.5%
7	2	5%
8	1	2.5%
9	0	5%
10	2	5%
Did not lapse	6	15%

Table 4

Results of Cox Regression Analyses Examining Predictors of Nicotine Dependence and Days to First Lapse (n=40)

Predictor	Hazard Ratio	95% CI	<i>p</i>
FTCD	1.57	1.15 – 2.14	0.004
HONC	1.01	0.87 – 1.19	0.862
TTURC-Categorical	0.96	0.30 – 3.12	0.946
TTURC-Continuous	1.09	0.85 – 1.40	0.489
WISDM-Total	1.03	1.00 – 1.07	0.065
WISDM-PDM	1.38	0.89 – 2.13	0.146
WISDM-SDM	1.49	0.99 – 2.24	0.058
TTFC	3.91	1.58 – 9.68	0.003

FTCD = Fagerström Test for Cigarette Dependence, HONC = Hooked on Nicotine

Checklist, TTFC = time to first cigarette of the day, TTURC = Transdisciplinary

Tobacco Use Research Centers Nicotine Dependence Inventory, WISDM = Wisconsin

Inventory of Smoking Dependence Motives.

Supplementary Table 1

Measures Included in Baseline Assessment Battery

Questionnaires

Barratt Impulsiveness Scale-Version 11¹

Behavioral Inhibition/Behavioral Activation Scales²

Brief Self-Control Scale³

Demographics and substance use information (forms created for study)

Center for Epidemiologic Studies Depression Scale⁴

Delay Discounting Questionnaire⁵

Fagerström Test for Cigarette Dependence⁶

Five Facets of Mindfulness Questionnaire⁷

Five Factor Model Rating Form⁸

Hooked On Nicotine Checklist⁹

Minnesota Withdrawal Scale-Revised¹⁰

Positive and Negative Affect Schedule¹¹

Sensitivity to Punishment and Sensitivity to Reward Questionnaire¹²

Snaith–Hamilton Pleasure Scale¹³

Temporal Experience of Pleasure Scale¹⁴

Transdisciplinary Tobacco Use Research Centers Nicotine Dependence Inventory¹⁵

Supplementary Table 1 (cont.)

UPPS-P Impulsive Behavior Scale¹⁶

Wisconsin Inventory of Smoking Dependence Motives¹⁷

Tasks

Cigarette Purchase Task¹⁸

Stop Signal Task^{19,20}

Effort Expenditure for Rewards Task²¹

Supplemental Figure 1. Kaplan-Meier survival curves depicting time to first lapse (in days) predicted by nicotine dependence as indicated by scores on the Fagerström Test for Cigarette Dependence (FTCD). Analyses reported in the manuscript treated FTCD scores as a continuous variable. However, for ease of presentation, survival curves were calculated and displayed for those with very low (scores of 0-2; dashed line) versus low-to-moderate (scores of 3-5; solid line) nicotine dependence.

Supplemental Figure 2. Kaplan-Meier survival curves depicting time to first lapse (in days) predicted by time to first cigarette of the day (TTFC; solid line for ≤ 60 minutes, dashed line for >60 minutes).

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