

How Does Nicotine Withdrawal Manifest Itself?

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ABSTRACT

In this paper, I sought to understand how nicotine withdrawal symptoms manifest, both psychologically and physiologically, with the goal of better understanding how these factors contribute to the maintenance of nicotine addiction. Previous research has found nicotine withdrawal to affect variables such as the intensity of nicotine cravings, emotional regulation, and cognitive performance. In this current case study, I tested the strength of these relationships by examining naturalistic daily changes in their variables longitudinally over a period of one week. Nicotine intake was measured by calculating the total dosage (ml/mg) of nicotine consumed each day, while self-report scales were used to assess craving intensity, emotional regulation levels, and subjective cognitive functioning by a cognitive self-assessment. The results of this study found significant correlations of nicotine amount with emotional regulation and craving levels, but not with cognitive functioning levels. These findings suggest that nicotine withdrawal manifests as intense cravings and difficulties with regulating emotions; however, no relationship with cognitive function was established. A possible practical application of these findings could be the use of craving and emotional regulation levels as indicators of relapse risk. Future research should build upon this study by making some improvements to the design and methodology, such as using a larger sample size to increase generalizability, use objective measures such as physiological or neuroimaging techniques to provide more accurate and reliable data, and extend the study duration, to examine the long-term effects of withdrawal on the variables of interest.

1. Introduction

1.1 Research Problem

Nicotine withdrawal causes undesirable symptoms that consequently reinforce the continued use of the drug. Quitting nicotine frequently results in deficits in cognitive functioning, such as working memory, concentration, and response time. Furthermore, nicotine withdrawal can cause difficulties with emotional regulation,

manifesting as emotional outbursts, anger, and anxiety. In addition, cravings for nicotine can begin immediately after quitting and is frequently the most severe and undesirable symptom of nicotine withdrawal. I wish to know about the physiological and psychological consequences of nicotine withdrawal so that I can help people better manage, cope with, and recover from nicotine addiction.

1.2 Literature Review

One factor previously found to predict how nicotine withdrawal symptoms manifest is the severity of cravings experienced (Robinson et al., 2011). For example, in a randomized controlled trial by Robinson et al. (2011), researchers randomly assigned treatment seeking smokers to either an abstainer condition or a control (free-will smoking) condition. All participants in both conditions attended four laboratory sessions and completed the Positive and Negative Effect Scale (PANAS), the Center for Epidemiologic Studies' Depression Scale (CES-D), and the Wisconsin Smoking Withdrawal Scale (WSWS) over the course of 14 days, as well as a physiological measurement (ECG). The PANAS is a 20-item scale used to measure positive and negative affect over the previous week. The CES-D is a 20-item self-report measure used to assess depression symptoms in nonclinical populations. The WSWS is a 28-item self-report used to evaluate nicotine withdrawal symptoms across seven different subscales: Anger, Anxiety, Sadness, Concentration, Craving, Sleep, and Hunger, on a 5-point Likert scale that ranges from 0 (strongly disagree) to 5 (strongly agree). The

study's multimodal findings suggest that more dependent smokers experience more negative affect, craving, and reactivity to unpleasant emotional cues, regardless of smoking abstinence status. The in-session ratings (i.e., WSWS craving scores) indicated that increased craving was associated with a worsening of mood for relapsers and controls, but not for abstainers. Based on these results, the researchers suggested that heavier and more dependent smokers experience greater negative affect (e.g., irritability, anxiety, etc.) and craving symptoms at baseline, with convincing evidence across multiple types of measures

(e.g., retrospective questionnaires, in-session ratings, physiological measurement).

In addition to cravings, another factor previously found to predict symptoms of nicotine withdrawal is levels of emotional dysregulation (Rogers et al., 2019). For example, in a randomized controlled trial by Rogers et. al (2019), researchers randomly assigned participants (n = 188) to an active group or control group. The Difficulties with Emotion Regulation Scale (DERS) was administered to participants on quit day and during the post-quit follow-up assessments (1-, 2-, 4-, 12- weeks post-quit). The DERS is a 36-item self-report measure that assesses participants' ability to regulate negative emotional states on a 5-point Likert scale ranging from 1 (almost never) to 5 (almost always). The researchers looked at how the baseline DERS total score predicted withdrawal symptoms over time.

Withdrawal symptoms were modelled using data from the quit-day and post-quit assessments, and data analysis revealed that those with the highest baseline DERS scores experienced the most withdrawal symptoms during the quit week, followed by the greatest increase and decrease in withdrawal symptoms, when compared to those with lower baseline DERS scores. Based on these results, the researchers suggest that individual differences in baseline levels of emotion dysregulation were significantly associated with quit day withdrawal symptoms. Another possible mechanism which nicotine symptoms manifest is through changes in cognitive performance (Wesnes et al., 2013).

In an experimental study conducted by Wesnes et al. (2013), researchers assigned thirty healthy males (n = 30) to either receive a placebo drug or an experimental drug to see how they affected cigarette consumption and withdrawal symptoms (i.e., changes in cognitive performance)

during ad libitum (free-will) smoking versus abstinence. Researchers proposed that after 24 hours of nicotine abstinence, withdrawal would manifest cognitively, impairing the quality of cognitive functions such as attention and memory (short-term and long-term). The participants were administered tests to measure attention, specifically, digit vigilance reaction time and choice reaction time. Digit vigilance reaction time (DVT) is a simple task designed to assess vigilance while performing rapid visual tracking and accurate target stimuli selection. It emphasises alertness and vigilance while putting little emphasis on two other aspects of attention: selectivity and capacity. Respondents are instructed to locate and cross out either sixes or nines that appear at random within 59 rows of single digits on two different pages. Choice Reaction Time (CRT) assesses overall alertness as well as motor speed. It is a two-choice reaction time test, but with two possible stimuli and two possible responses, stimulus and response uncertainty are introduced. The patient is required to respond to one stimulus but not to another. Periods of abstinence showed a statistically significant decline in performance ($p = .05$) in measures of attention, specifically digit vigilance reaction time ($p < .001$) and choice reaction time ($p < .001$). Based on these results, the researchers suggest that nicotine withdrawal manifests itself after 24 hours of abstinence by impairing cognitive functions of attention and long-term memory.

1.3 Hypotheses

Based on the above literature review, I predicted the following hypotheses:

Hypothesis #1: If nicotine amounts decrease then cravings will increase.

Hypothesis #2: If nicotine amounts decrease then emotional regulation will decrease.

Hypothesis #3: If nicotine amounts decrease then cognitive performance will decrease.

2. Methods

2.1 Participants

The first author, a twenty-two-year-old cisgender woman, served as the sole participant in this $N = 1$ case study. The subject is a Camosun College undergraduate student who completed the current study as part of a PSYC 245 (Drugs and Behavior) assignment and chose this topic because of personal interest in the effects of nicotine withdrawal. The subject was a regular nicotine user, and the nicotine amounts consumed over the course of this study were within the participant's normal ranges.

2.2 Materials and Procedures

The subject performed a correlational case study or $N = 1$ to test concurrently the three hypotheses by examining naturalistic daily changes in the variables longitudinally. To do so, the subject kept a study journal with them at all times over this study's three-week period in order to record self-observations of the following three variables: (1) nicotine amount, (2) craving intensity (3) emotional regulation, (4) cognitive functioning.

Nicotine Amount - To measure the frequency and dosage of nicotine, participants recorded in their study journal three times a day (i.e., morning, afternoon, evening) the amounts of nicotine consumed during this study. From these records, the amount of nicotine per unit (mg/PU) was calculated by multiplying the amount of nicotine per 1ml (mg/ml) by the smoking

unit (15 e-vaporizer puffs = 1 cigarette). The total amount of nicotine was taken by adding the three scores up in each day of this study. If the participant did not consume nicotine on a given day, then the total amount of nicotine for the subjects' day was scored as zero.

Craving Intensity - To measure the intensity of cravings, I recorded in their study journal three times a day (i.e., morning, afternoon, evening) the intensity of nicotine cravings experienced on each day during this study. Participants rated on a 0 to 5 scale the intensity of cravings felt at each time of the day, and the average of the three scores were used as the final score for each day. The following response anchors were used on this craving intensity scale: 0 = none at all, 1 = slight, 2 = moderate, 3 = considerable, 4 = extreme, 5 = unbearable.

Emotional Regulation - To measure emotional regulation, each participant rated on a scale how "in control" of their feelings they were during each day of this study. Participants recorded in their study journals three times a day (i.e., morning, afternoon, evening) their emotional regulation scores, and the average of the three scores was used as the final score for each day. The following response anchors were used on this emotional regulation scale: 0 = not at all, 5 = moderately, 10 = a great deal.

Cognitive Functioning - To measure cognitive functioning, the participant answered nine questions about cognitive functions (i.e., attention, memory) using a 0 – 4 scale. This self-assessment required participants to total up the number of each anchors scored (i.e., give 0 points for statements rated as never, 2 points for statements rated as sometimes, and 4 points for statements rated as always) to obtain a final score. Participants completed the cognitive functioning scale twice a day (i.e., afternoon, evening) and took the average of

the two scores to use as the score for each day. The following response anchors were used on the cognitive functioning scale: 0 = never, 1 = rarely, 2 = sometimes, 3 = often, 4 = always. The following anchors were used to obtain the final score on the cognitive functioning scale: 0 = normal cognition, up to 12 = mild cognitive impairments, 13 – 24 = moderate cognitive impairments, 25 – 36 = severe cognitive impairments (see Appendix A).

2.3 Statistical Analyses

To assess the strength and statistical significance of associations between variables predicted by the three hypotheses, I performed Pearson r product moment correlations of their predictor variable (nicotine amount), with their outcome variables (craving intensity, emotional regulation, and cognitive functioning). For testing Hypothesis #1, I correlated the total nicotine amount consumed by the participant each day with the participant's average craving intensity score each day. For testing Hypothesis #2, I correlated the total nicotine amount consumed each day with the participant's average emotional regulation score each day. For testing Hypothesis #3, I correlated the total nicotine amount consumed each day with the participant's average cognitive functioning score on the same day. A correlation coefficient was considered statistically significant if the probability of its random occurrence (p) was $< .05$ (i.e., less than 5% of the time expected by chance alone)..

3. Results

As shown in Table 1, results of the correlational analyses indicated that both emotional regulation and craving levels were significantly and positively correlated with nicotine amount. Emotional regulation levels

were significantly correlated with nicotine amount ($r = .67, p = .001$; see Figure 1). Similarly, craving level was significantly correlated with nicotine amount ($r = -.56, p = .01$; see Figure 2). In contrast, no statistically significant correlations were found between cognitive functioning levels and nicotine amount ($r = -.30, p = .21$; see Figure 3). Based on a comparison of the correlation coefficients, emotional regulation showed the strongest correlation with nicotine amount. The results found that when people consumed more nicotine, they experienced higher levels of both emotional regulation and cravings for nicotine. However, there was no significant relationship between cognitive functioning and nicotine consumption. The correlation between emotional regulation and nicotine intake was the strongest among the variables used in this study.

4. Discussion

4.1 Summary of Results

Based on previous research, I hypothesized that decreases in nicotine amount would be followed by changes in three variables: increase the level of craving (Hypothesis #1), decrease in regulating emotions (Hypothesis #2), and decrease in cognitive functioning (Hypothesis #3). The data obtained from this study supported the predicted relationship of nicotine amount with craving and emotional regulation (Hypothesis #1 & #2) but not with cognitive functioning (Hypothesis #3). Future research should use an experimental design to establish causal roles of nicotine amounts upon emotional regulation and craving.

4.2 Relation of Results to Past Research

The ability of this correlational study to predict craving levels based on nicotine amount is in line with previous research. Robinson et al. (2011) found that the amount of nicotine ingested was associated with increase and severity of cravings. While Robinson et al. (2011) had treatment seeking smokers use multimodal reports (i.e., retrospective questionnaires) to assess their nicotine and craving levels, I longitudinally assessed these variables in college students. The similarity of both our conclusions despite using different research designs suggests a generalized relationship exists between increased nicotine consumption and higher craving levels.

My correlational study between emotional regulation and nicotine amount was able to suggest a relationship between these variables, as past research did. Rogers et al. (2019) found that levels of emotional regulation were associated with nicotine amounts by administering self-report measures and collecting baseline emotional regulation data. In my correlational study, emotional regulation levels and nicotine amounts were strongly associated. Despite using different research designs, the similarity of our conclusions suggests that there is a generalized relationship between increased nicotine consumption and levels of emotional regulation.

The current correlational study failed to confirm the relationship between cognitive functioning levels and nicotine consumption reported by previous research. Wesnes et al. (2013) found that after 24 hours of abstinence from nicotine, cognitive functioning was significantly impaired. Researchers measured cognitive functioning (i.e., memory and attention) using choice reaction time and digit vigilance reaction time and after 24 hours of nicotine

abstinence, impairments were observed in attention and long-term memory. In contrast, my correlational study used a self-report questionnaire regarding cognitive functioning levels. The methodology of my current study differed from that of the Wesnes et al. (2013) study in three major ways that might account for the discrepant results. First, the measures used to obtain cognitive functioning levels could have affected the findings. In the current study, the correlational measures relied only upon self-reports of cognitive functioning, which are subjective. Future studies should test whether the objectively verified aspects of cognitive functioning outlined by Wesnes et al. (2013), but not subjective self-assessments, predict cognitive functioning levels. Second, the measures used to obtain cognitive functioning scores in both studies may lack convergent validity (i.e., the extent that the scores on your measure are related to scores on another measure that measure the same construct). In the study by Wesnes et al. (2013), cognitive functioning was measured objectively, using an automated program to administer the choice reaction time test and the digit vigilance reaction time test, whereas in the current correlational study, I used a cognitive functioning self-report questionnaire that asked subjective questions such as “I have difficulty remembering things that happen or what people told me” (see Appendix 1). Third, the sample sizes used in each study could have affected the findings. Studies with larger sample sizes are more likely to obtain statistically significant results. In the study by Wesnes et al. (2013), the sample size was much larger ($n = 30$) than in the current correlation study ($n = 1$). A larger sample size is more likely to be significant because it provides more accurate the greater the chance of discovering significant trends or results that would otherwise be

masked by a smaller sample size. Future studies should examine whether nicotine amounts predict the severity of cognitive functioning deficits by using an objective measure rather than a subjective measure, and a larger sample size.

4.3 Implications of Results

Possible practical applications of our current findings are the severity of withdrawal symptoms that decreased nicotine intake may be associated with. For instance, the current study suggests when quitting nicotine, that the severity of withdrawal symptoms will increase (i.e., emotional dysregulation and craving). These findings suggest that when quitting or abstaining from nicotine, withdrawal symptoms will increase in the short term, and decrease in the long term, depending on your intake of nicotine. Based on these results, I suggest to non-smokers to continue abstaining from nicotine, as the withdrawal symptoms are aversive and severe, and I suggest to smokers, when quitting or reducing nicotine intake, to replace the nicotine with a healthier alternative, such as exercise or meditation.

4.4 Conclusion

I originally conducted the current studies to understand the relationship between nicotine intake and the manifestation of withdrawal symptoms to help smokers better cope with, manage, and recover from nicotine addiction. The correlational results in this study suggest that abstaining from nicotine causes withdrawal to manifest itself through craving intensity and difficulty managing emotions, while there was no significant relationship between cognitive functioning and nicotine intake. It remains for future studies to conduct an experiment

with these significant variables to observe if there is a causal relationship present, and therefore discover ways to better manage quitting nicotine.

References

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Table 1

Correlations for Study Variables

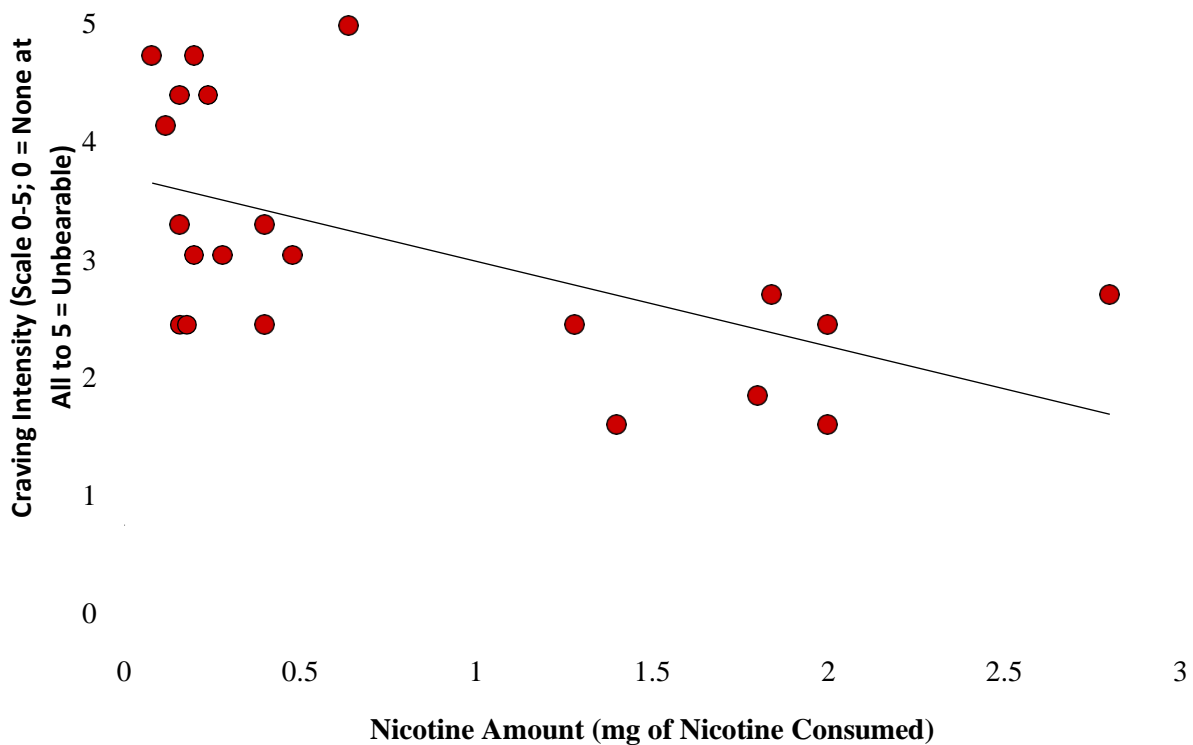
Variables	<i>r</i>	<i>n</i>
Nicotine amount & Craving Intensity	-.57*	21
Nicotine amount & emotional regulation	.64*	21
Nicotine amount & cognitive functioning	-.30	21

Notes. *r* = correlation coefficient, *n* = number of days sampled.

* $p < .05$.

Figure 1

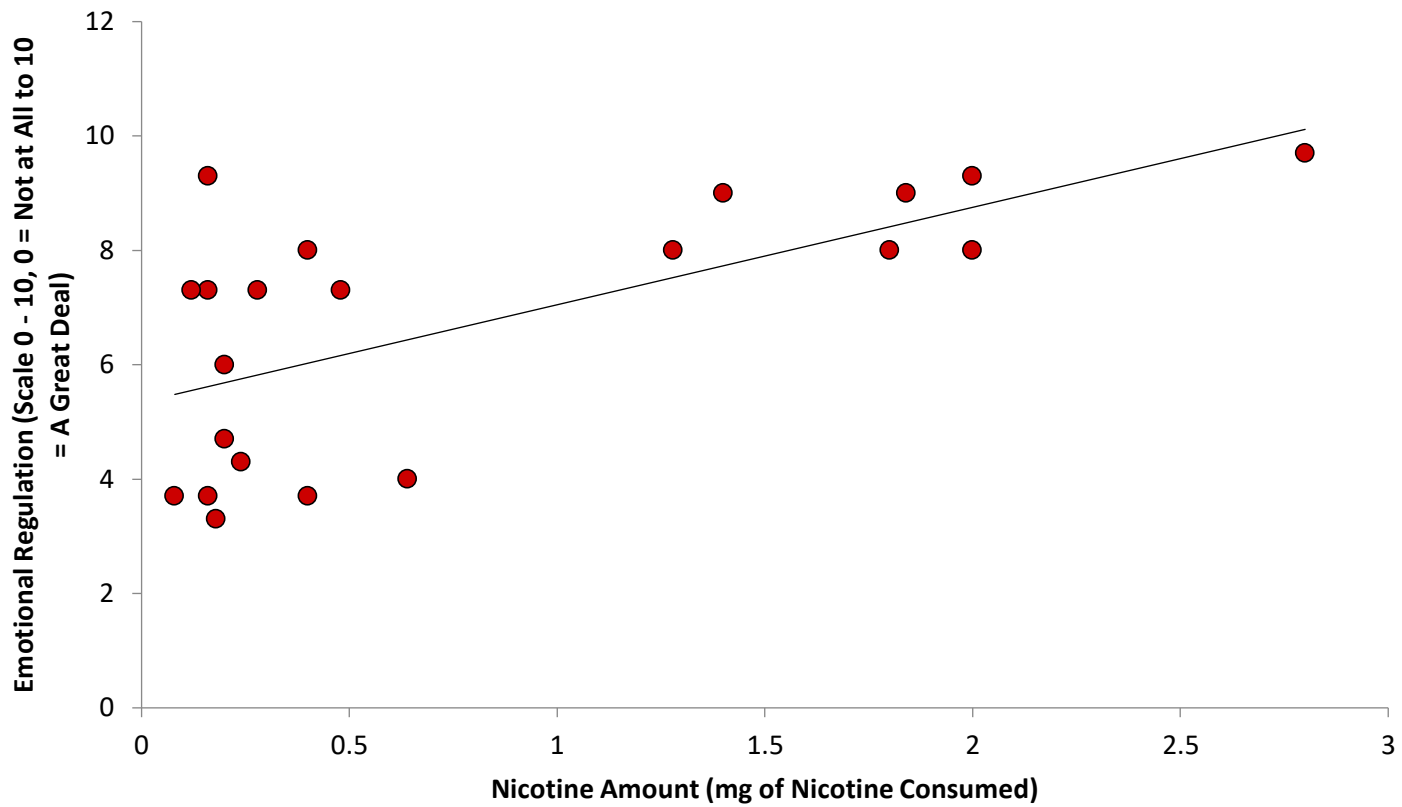
Association Between Nicotine Amount and Craving Intensity



Notes. Marker colour differentiates participants: red = participant #1. Some data might not be visible in the figure due to overlapping markers.

Figure 2

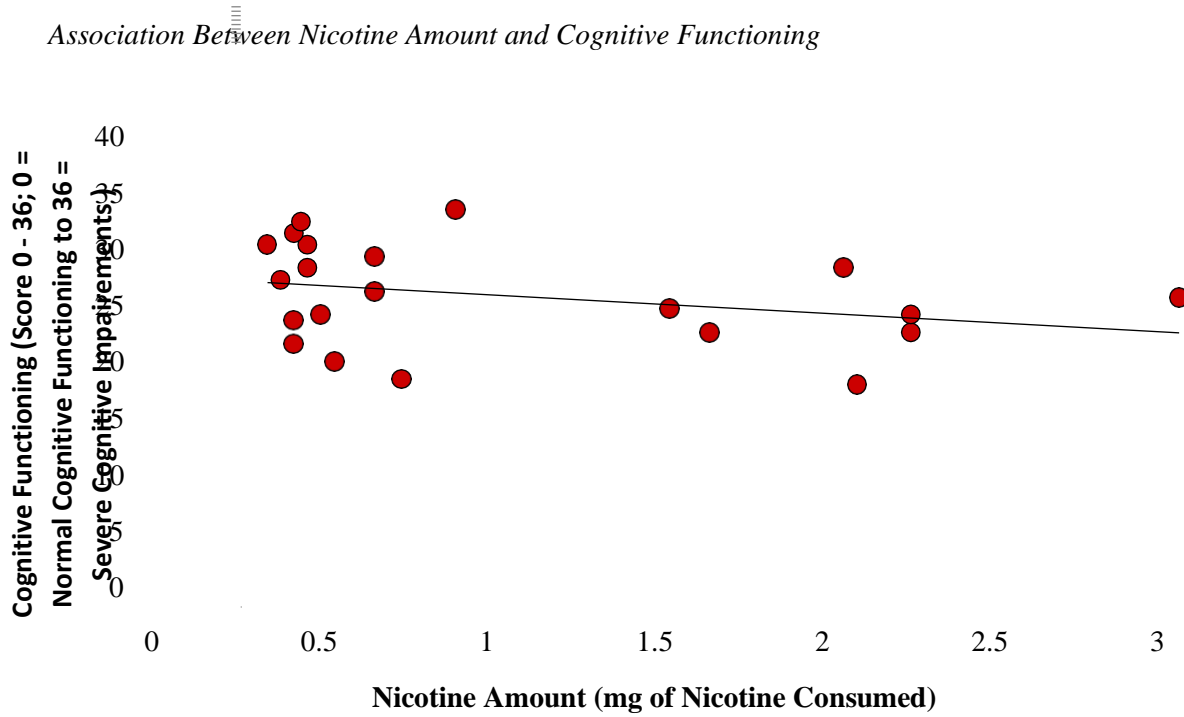
Association Between Nicotine Amount and Emotional Regulation



Notes. Marker colour differentiates participants: red = participant #1. Some data might not be visible due to overlapping markers.

Figure 3

Association Between Nicotine Amount and Cognitive Functioning



Notes. Marker colour differentiates participants: red = participant #1. Some data might not be visible in the figure due to overlapping markers.

Appendix A

Cognitive Functioning Self-Assessment Scale

In the last 6 hours....

0 = never 1 = rarely 2 = sometimes 3 = often 4 = always

1. I have difficulty staying focused on something I am reading or a Tv program I am watching.
2. I have difficulty remembering things that happen or what people told me
3. I forget what I am supposed to do
4. I forget where I put things
5. When I am speaking I forget what I was going to say
6. I have difficulty planning or making decisions
7. When I am working hard on something, I still get distracted by events around me
8. I do things without thinking
9. I tend to be slow in mental/physical tasks

Totals

0 = never 1 = rarely 2 = sometimes 3 = often 4 = always

- 0 = normal cognition
- Up to 12 = mild cognitive impairments
- 13 – 24 = moderate cognitive impairments
- 25 – 36 = severe cognitive impairments

Adapted and modified from the Cognition Self-Assessment Rating Scale (C-SARS; Nasrallah, 1990).