The Role of Addiction Mindsets in Smoking Cessation: Scale Development and Pilot Randomized Trial

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Abstract

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Lay theories about the malleability of human attributes, also known as fixed and growth mindsets, have been shown to impact behavior in many domains. The goal of this work was to measure and test the role of mindsets in nicotine addiction. In Study 1, data (N = 600) from both current smokers and non-smokers led to the development of a single-factor 6-item measure of mindset called the Addiction Mindset Scale (AMS). In Study 2, a survey of daily smokers (N = 200) showed that higher scores on the AMS, indicative of growth mindset, were positively and significantly associated with greater motivation to quit, greater commitment to quitting, greater self-efficacy to abstain, greater attribution of failure to lack of effort as opposed to ability, and fewer self-reported barriers to cessation (all p's < .05). In Study 3, participants (N = 398) were randomly assigned to receive a growth mindset intervention or to a control group that did not receive anything. All participants were provided a smartphone application (app) that taught them skills to quit smoking and their cessation and engagement with the app were assessed after two

months (92% outcome data retention). The groups did not differ on engagement with the quit-smoking app, but the intervention group showed descriptively higher quit rates. A per protocol analysis showed that participants who used the programs as intended showed greater engagement with the app and higher odds of cessation. Taken together, the studies illustrate the relationship between addiction mindset and smoking cessation and underscore the promise of a growth mindset intervention to change addictive behaviors.

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CHAPTER 1: INTRODUCTION

Cigarette smoking is the leading cause of preventable death and disease in the United States (U.S. Department of Health and Human Services, 2014). Although the majority of people addicted to nicotine desire to quit, only a small proportion are able to achieve sustained abstinence (Hughes, Keely, & Naud, 2004; U.S. Department of Health and Human Services, 2014). These challenges suggest that new approaches are needed to help people overcome nicotine addiction. One possible way to increase cessation rates involves understanding and intervening on users' beliefs about addiction. There is a large body of research on the role of beliefs in behavior change. For example, theories of self-efficacy and expectancies have shown that people's confidence in their capacity to achieve a goal predicts their likelihood of success (Bandura, 1998). A second theory suggests that people's intentions to change behavior or engage in goal-directed behavior is a function of their beliefs and attitudes towards the behavior (Montano & Kasprzyk, 2015). Specific to health behaviors, the Health Belief model suggests that people's beliefs about the barriers and benefits of changing behavior ultimately determines whether they can successfully change (Rosenstock, 1974). Adding to this rich literature, recent advances in social psychology have shown that beliefs about the factors underlying these behaviors, or *mindset,* have far reaching consequences (Burnette, O'Boyle, VanEpps, Pollack, & Finkel, 2012; Dweck, 2012). The purpose of this research is to extend and apply the theory on mindset to the domain of addiction. Given the public health burden of cigarette smoking, this research will specifically focus on addiction to cigarettes.

A review of mindsets

People develop lay theories about the nature of human attributes such as intelligence, personality, etc. (Dweck, Chiu, & Hong, 1995). These lay theories, also referred to as fixed and

growth mindsets, are fundamental belief systems about the malleability of different human attributes. Within Dweck and colleagues' theoretical framework, a person holding a *fixed mindset* about an attribute (e.g. intelligence or addiction) considers that it is a permanent, trait-like entity that is firmly entrenched in an individual's personality that is virtually unchangeable (Dweck et al., 1995). In contrast, a person holding a *growth mindset* about that attribute believes that the attribute is malleable and every person has the capacity to change (Dweck et al., 1995). For example, a person holding a fixed mindset about intelligence tends to endorse ideas like "everyone is born with a certain intelligence and they can't change that" or "intelligence is a basic quality about a person that cannot change" (Dweck et al., 1995). In comparison, someone who endorses a growth mindset about intelligence tends to endorse ideas like "anyone can change how intelligent they are". These opposing beliefs are usually measured on a single continuum anchored by fixed beliefs on one end and growth mindset on the other end of the continuum (Dweck et al., 1995, Dweck, 1999). However, they are often referred to in the literature in a dichotomous fashion, i.e., researchers frequently refer to fixed and growth mindsets as though they are separate theories (Dweck, 1999; Leith et al., 2014). Note that throughout this dissertation, any references to these opposing beliefs in this way are reflective of this common practice.

Dweck and colleagues have shown these belief systems to be fairly stable over time (Dweck et al., 1995, Dweck, 2000). These belief systems function like knowledge structures, or mental models about how flexible or invariant people's traits are (Chiu, Hong, & Dweck, 1997; Plaks, Levy, & Dweck, 2009). People tend to draw more often than not from one of these perspectives when evaluating their own behavior and the world around them (Dweck et al., 1995). However, mindsets can also be changed by experimental manipulation: presenting people

with information and evidence for change can shift endorsements of mindsets for different attributes (e.g., Blackwell et al., 2007).

Mindsets in different domains

Research has shown that endorsement of fixed vs. growth mindsets are domain-specific – for example, a person who has a fixed mindset of intelligence does not necessarily have a fixed mindset about personality, athletic ability, or other attributes (Dweck et al., 1995; Schroder, Dawood, Yalch, Donnellan, & Moser, 2016). For this reason, it is important to be able to measure mindsets and explore their relationship with behavior change in many domains to establish and evaluate the theory as opposed to assuming generality from one set of findings. Most of the research on mindsets have been in the domain of intelligence. For example, research has shown that children who endorse a growth mindset of intelligence achieve better grades in middle and high school compared to children with a fixed mindset (Blackwell, Trzesniewski, & Dweck, 2007; Burnette, Russell, Hoyt, Orvidas, & Widman, 2017).

However, the theory has been extended to and applied in many other domains. Among adults who are shy or who are anxious around social interaction, those who showed a greater endorsement of growth mindset of shyness tended to evaluate social situations as a learning opportunity as opposed to something that should be avoided (Beer, 2002). In research on prejudice, people who endorsed a fixed view of personality showed greater endorsement of stereotypes and prejudiced behavior compared to people who endorsed a growth mindset of personality (Carr, Rattan, & Dweck, 2012). Research conducted in organizational behavior has found that managers' beliefs about the malleability of personality and work ability predicted their appraisal of employee performance and willingness to coach employees (Heslin & VandeWalle, 2008).

Mindsets have also been applied to behaviors affecting people's physical and mental health. Research has shown that people's views of athletic ability as fixed was associated with a lack of motivation for physical exercise (Biddle, Wang, Chatzisarantis, & Spray, 2003). Further, among people who were trying to lose weight, those who endorsed a growth mindset of body weight were less likely to gain weight after facing dieting setbacks (Burnette, 2010; Burnette & Finkel, 2012). In the mental health literature, people who view anxiety as malleable (growth mindset of anxiety) reported fewer mental health symptoms (Schroder, Dawood, Yalch, Donnellan, & Moser, 2015). A review of youth mindsets and mental health symptoms found a significant association between fixed beliefs (on a variety of domains such as personality and anxiety) and mental health problems (Schleider, Abel, & Weisz, 2015). Taken together, the literature on mindsets in multiple domains suggests that endorsing fixed or growth beliefs can affect domain-specific behavior.

Mindset and behavior change processes

Endorsing a fixed vs. growth mindset has been shown to impact a variety of psychological processes, which in turn tend to influence successful behavior change (Blackwell, Trzesniewski, & Dweck, 2007; Burnette et al., 2012; Dweck, 2010). A meta-analysis of fixed vs. growth mindsets showed how mindset is related to self-regulatory processes such as goal setting, maintaining goal-directed behavior and evaluating expectations of success, which in turn affect behavioral outcomes (Burnette, O'Boyle, et al., 2012). Each of these processes are reviewed below.

First, research has shown that people who endorse different mindsets tend to set different types of goals. Specifically, those who endorse a fixed mindset tend to set *performance goals*, in which they simply aim to perform as well as they can without a need to improve upon the

existing ability. In contrast, those with a growth mindset are more likely to set *learning goals*, which including striving to master a skill or grow one's ability to satisfy themselves (Burnette et al., 2012; Dweck et al., 1995).

Second, mindset has been shown to be associated with how people react when facing setbacks or challenges: having a growth mindset can help people perceive adopt *mastery strategies,* i.e., acquire and practice new skills needed to achieve their goal (Burnette et al., 2012; Dweck et al., 1995). This translates to greater persistence towards goal-directed behaviors, for example, spending more time studying for a test (in the case of intelligence), or more time exercising (in the case of weight loss) (Dweck, 1999). Contrasting this, people with a fixed mindset are more likely to react with *helpless strategies* when faced with challenges (Dweck, 1999). For example, they divert their attention and resources away from their goal, making it less likely that they will succeed (Schroder, Fisher, et al., 2017).

Finally, mindset has been shown be associated with different expectations about whether effort will lead to successful behavior change (Burnette, O'Boyle, et al., 2012). People with a growth mindset tend to believe that putting in effort will lead to success (*positive effort expectations)*, which actually translates to greater success (Burnette et al., 2012). In contrast, people with a fixed mindset do not tend to have positive effort expectations because they believe their abilities are fixed. Increased effort, in their view, will not lead to greater change. It should be noted that these effects are particularly prevalent under challenging situations or when facing setbacks to goal attainment (Burnette & Finkel, 2012; Burnette, O'Boyle, et al., 2012; Schroder et al., 2015). Indeed, some scientists argue that a growth mindset functions to bolster a type of psychological resilience in stressful situations and help people in persisting despite difficulties (Burnette, O'Boyle, et al., 2012; Schroder, Yalch, et al., 2017). The associations between

mindset and behavioral outcomes are borne out by experimental studies that have changed mindset in an effort to change the behavior of interest. The next section presents an overview of these studies and their findings.

Changing mindsets to change behavior

Experimental research has shown that interventions fostering a growth mindset show promise for behavior change. In adolescents, an educational intervention fostering a growth mindset of intelligence improved math grades in middle school when compared to a control group who were taught general memorization skills where grades declined over time (Blackwell et al., 2007). Similar interventions in the educational context have yielded positive effects on student grades in high school and rural populations (Burnette et al., 2017). Mindset interventions in education have also been tested on a national level and have found to be beneficial and scalable (Paunesku et al., 2015). A study of parents who received a growth mindset intervention of intelligence showed such training to result in an improvement in their children's reading ability (Andersen & Nielsen, 2016).

A growth mindset intervention supporting a malleable view of personality in the context of peer aggression in middle school reduced hostile and aggressive desires over the course of 8 months (Yeager, Miu, Powers, & Dweck, 2013). Other interventions also promoting a growth mindset of personality in adolescents reduced middle school students' stress and improved their coping behaviors when they experienced adversity in school (Yeager et al., 2014). In the domain of social and intergroup relationships, people who were taught a growth mindset of prejudice were less anxious and more friendly when engaging in a cross-race conversation than those who were taught a fixed view of prejudice (Carr, Dweck, & Pauker, 2013; Carr et al., 2012).

Health-oriented mindset interventions such a growth mindset intervention about body weight has been shown to prevent weight gain among people who are overweight (Burnette & Finkel, 2012). In the domain of mental health, a growth mindset intervention about personality in youth led to an improved sense of perceived control and a reduction in depressive symptoms (Schleider & Weisz, 2017). Despite the growing literature in the study of mindsets, no work to date has explored the application of this theory to addictive behavior.

Addiction Mindsets: Definition

The goal of this work is to fill this gap in the literature by defining and developing a measure of mindsets about addiction and examining the relationship between addiction mindsets and addictive behavior, with a specific focus on smoking cessation. Based on a common definition of mindset in the literature (e.g., Dweck et al., 1995), a belief system about the malleability of addiction is referred to as an *addiction mindset*. A person can have a *fixed mindset about addiction*, in which they believe that addiction is a permanent attribute of a person and cannot change. Alternately, they can have a *growth mindset about addiction*, whereby they believe that addiction is not permanent.

Why might addiction mindsets be important?

How do people gain these differing beliefs and why is it important to be able to measure these beliefs? Ideology supporting the permanence of addiction is prevalent in popular and scientific discourse (e.g. "once an addict, always an addict"). For example, the disease model of addiction posits that addiction is permanently rooted in the biology of a person. This is the view of addiction presented by the National Institutes of Health. Indeed, the National Institute of Drug Abuse defines addiction as "a chronic, relapsing brain disease that is characterized by

compulsive drug seeking and use, despite harmful consequences"[1]. However, presenting addiction as a brain disease can promote a fixed mindset about addiction (Wiens & Walker, 2015). Other researchers suggest that people have a choice in engaging with addictive behavior or in stopping to use a substance (e.g., Heyman, 2013). This choice model of addiction suggests that people have the capacity to change their addiction and supporters of this view may be expressing a growth mindset of addiction, although there are no data available in support of this. It is important to study how people's beliefs about addiction affect their behavior because some addiction researchers as well as recovering addicts have suggested that certain beliefs (e.g. that addiction is a chronic disease) are harmful for recovery (Hammer et al., 2013a) but date there is little research support that.

In summary, there is some qualitative evidence that beliefs about addiction may affect treatment outcomes, but there is no systematic evidence exploring whether beliefs about addiction do affect outcomes. The goal of this work is to provide the framework (i.e., addiction mindsets), measure people's beliefs, and empirically test how these contrasting beliefs are related to different facets of addictive behavior and recovery. This work will explore a set of studies to examine these questions empirically as a first step towards systematically evaluating whether beliefs about addiction affect smoking cessation.

Present studies: Applying mindsets to the domain of addiction

Motivational processes

Addiction mindset may impact several behaviors and motivational factors. First, if smokers endorse a fixed mindset (i.e., the belief that addiction cannot change), then they themselves may be less motivated to try to quit because of the belief that successful change is not possible in the

[1] https://www.drugabuse.gov/publications/drugs-brains-behavior-science-addiction/drug-abuse-addiction

long term. Using the results of the meta-analysis by Burnette et al (2012) as a guide, it can be hypothesized that smokers with a fixed mindset may not have positive expectations of success and therefore, less success in quitting than smokers with a growth mindset.

Previous work on mindset has also shown that people with a growth mindset persist longer in goal-directed behavior, especially in the face of setbacks or challenges (Burnette 2012, Dweck 1999). Applying this to the smoking cessation domain, smokers with greater endorsement of a growth mindset of addiction may show greater commitment to quitting smoking, as characterized as a willingness to persist in abstinence efforts despite difficulties (Kahler et al., 2007). In contrast, it is possible that a smoker who endorses a fixed view of addiction (e.g. "I am addicted to smoking and can't do much to change it") may be less committed to quitting or less willing to persist in a quit attempt when facing setbacks. Some qualitative evidence supports this: smokers who attribute their behavior to an internal addiction (similar to a fixed mindset) expressed lower confidence in their ability to quit smoking (Berg et al., 2013). However, there is no empirical evidence to date for these hypotheses. Therefore, to evaluate whether mindset about addiction is associated with motivational processes, Study 2 explores the associations between smokers' mindsets and their motivation to quit, commitment to quitting and self-efficacy (confidence) to quit smoking.

Evaluating failure to quit smoking

People with a fixed mindset might be more afraid of failing to achieve a goal because they believe that the failure only confirms a permanent flaw in themselves (Dweck, 2006). In the context of education and intelligence, past research found that people with a fixed mindset tend to attribute failure more to an internal lack of ability to change more than people with a growth mindset (Dweck, 1999; Dweck et al., 1995). Thus, it is possible that smokers with a fixed

mindset may also attribute failure to the internal and unchangeable attribute of addiction compared to smokers with a growth mindset. Qualitative research on heavy smokers has shown some support for these hypotheses. In interviews of heavy smokers, most participants attributed their failure to quit to internal factors such as physical addiction, over 92% of the respondents said they couldn't quit because of anticipated withdrawal being too difficult to overcome and 51% of respondents listed fear of failure as a reason to not attempt to quit smoking (Thompson, Thompson, Thompson, Fredickson, & Bishop, 2003). The reasons to which people attribute failure is important to explore because smokers' viewed failure to quit as a factor that would discourage them from trying again (Thompson et al., 2003). These beliefs are consistent with a fixed mindset of addiction and suggests that at least some smokers are perceiving internal, stable factors as reasons for their failure to quit, which is contributing to their lack of confidence to try quitting again. To evaluate this hypothesis, Study 2 presents smokers with a failure to quit scenario and evaluates their attributions for failure in the scenario as well from their own experiences.

Cessation and behavior change

Since theory and research suggest that motivation and expectations of success are strongly related to quitting success, it is possible that having a fixed vs. growth mindset affects the chance of successful smoking cessation (Gwaltney, Metrik, Kahler, & Shiffman, 2009; Jardin & Carpenter, 2012). No work to date has evaluated whether there is an association and/or causal link between belief systems around addiction and successfully changing addictive behaviors. Study 3 aims to develop and test a growth mindset intervention focused on changing smokers' beliefs about addiction. Study 3 will show an experimental approach to changing smokers' mindsets about addiction and explore whether the intervention is successful at promoting a

growth mindset, improving persistence in goal-directed behavior, and successful behavior change in a smoking cessation program.

CHAPTER 2: MEASURING MINDSET

Study 1: Development of the Addiction Mindset Scale (AMS)

In order to evaluate the relationship between addiction mindset and smoking cessation, a reliable measure of lay mindsets about addiction is needed. Study 1 focused on the development of a measure of addiction mindset using data from both smokers and non-smokers. Non-smokers were included in the development of this measure because belief systems around addiction might not be limited to those who engage in addictive behavior and might exist in and be measurable in all people.

Generating the item pool

Ten items were directly adapted from existing measures of mindset by replacing the mindset domain word (e.g., intelligence was changed to addiction). This method of adapting items is commonly used by researchers of mindset (e.g., Schroder, Dawood, Yalch, Donnellan, & Moser, 2016). Twelve additional items were created and refined with input from two researchers who have extensive experience in treating addiction to nicotine and other substances, and a team of four researchers with expertise on fixed and growth mindsets. The twenty-two total items were created for initial testing. Half of the items were reverse coded to address acquiescence response bias. The list of items is found in Appendix – B.

Method

Participants

A sufficiently large sample (Clark & Watson, 1995) of daily smokers (N = 300) and non-smokers (N = 300) participated in an online survey and responded to the initial set of 22 items described above. They also provided demographic data (e.g., age, gender, education, etc). We used targeted recruitment to achieve a sample that had a balance of gender (50% female) and

smoking status (50% non-smokers). Participants were recruited via Amazon Mechanical Turk, which is widely used in behavioral research and has been found to provide high quality data (Buhrmester, Kwang, & Gosling, 2011). Further, Mechanical Turk has proved to be a reliable recruitment method for smokers and people with other substance abuse, and those with a varying set of addiction beliefs (Shapiro, Chandler, & Mueller, 2013; Wiens & Walker, 2015). The sample was 84% White, and the mean age of participants was 32.9 years (SD = 10.36). The majority had a high school education (89.6%) and were employed (86.5%). Among the sample that smoked, 24% smoked a pack of cigarettes or more (i.e., 20 or more) per day.

Procedure

Participants rated their agreement with each of the 22 statements on a (1) strongly agree – (6) strongly disagree scale. No midpoint was provided in the scale, consistent with other measures of mindset (Dweck et al., 1995). After each statement, participants responded to a yes or no question: "Was the meaning of this statement very clear?" If they selected no, they were prompted to elaborate in an open-ended response.

Results

First, similarities and differences in the factor structure across smokers and non-smokers were examined. The 22 items used in the study were submitted to an exploratory factor analysis with principal axis factoring separately for smokers and non-smokers and the two scree plots were examined (scree plots are presented in Figure 1). In the smoker sample, the first factor alone accounted for 44.8% of the total variance. Two additional factors had eigenvalues exceeding 1, but together they accounted only for an additional 15.8% of the total variance. In the non-smoker sample, the first factor alone accounted for 44.2% of the total variance. Three

additional factors had eigenvalues exceeding 1, but together they accounted only for an additional 20% of total variance.

Tuckers's congruence coefficients were compared for the three factors that emerged in both samples to obtain a metric of similarity. The first factor was nearly identical (r_c = .99), the second had a good overlap (r_c = .96) and the third factors were different (r_c =.69). Across both smokers and non-smokers, 21 out of the 22 items loaded on the first factor and clearly appeared to be assessing fixed vs. growth mindset when examined from a face validity perspective. Despite the overlap in the second factor, no unique meaningful interpretation was available for these items. Therefore, the items that had clear loadings on the first factor were retained, while ten items that loaded on multiple factors either in the smoker sample or in the non-smoker sample were removed, in line with best practices for scale development (Costello & Osborne, 2005). Among smokers, six items with high loadings on the first factor also had non-trivial loadings on the second or the third factor. Among non-smokers, seven items cross-loaded on the first and second, or first and fourth factors. One item ("addiction is something you either have or don't have") uniquely loaded on a third factor and was removed. While over 90% of the respondents rated all the items as clear, two more items were removed for lack of clarity based on open-ended feedback from participants. Clarity ratings for all items can be found in Appendix – B.

Based on the congruence between the results from the smoker and non-smoker samples, the two samples were combined, and a factor analysis was conducted with the remaining ten items. This analysis resulted in a 10-item solution loading heavily on a single factor. The scree plot indicated only one factor with an eigenvalue over one. This single factor solution accounted for 52% of the variance. Six of these items with the highest loadings were chosen (three of which

are reverse coded) to keep the scale as short as possible for easy and time-efficient administration. When only these six items were included in factor analysis, the first and only factor accounted for 54.8% of the variance. The internal consistency of the scale consisting of these six items was relatively high (Cronbach's $\alpha = .83$). Further, the six-item version and the ten-item version were very highly correlated ($r = .97$, $p < .001$), suggesting that a brief measure was sufficient. This measure was finalized and labeled the "Addiction Mindset Scale (AMS)." Item loadings and descriptive statistics for the six items are presented in Table 1. The measure, with scoring and instructions, is available in the appendix. Mean AMS scores for different demographic groups are presented in Table 2. Current smokers scored lower on growth mindset than current non-smokers ($p < .001$), and overall, men had higher growth mindset scores than women ($p = .01$). Mindset did not vary by race, ethnicity, education or employment status.

Discussion

The AMS consists of a single factor that assesses addiction mindset, anchored by fixed beliefs at one end and growth mindset at the other end. This is very similar to other fixed vs. growth mindset scales (Dweck et al., 1995), which also treat mindset as a single factor. The AMS is internally consistent, has face validity and has a consistent factor structure across both smokers and non-smokers. The items on the scale were also rated very clear by participants and are easy to understand and respond to by participants from varying ages and education levels. Current non-smokers scored higher on the AMS (indicative of growth mindset) compared to smokers. Although there are no data to fully explain why this might be the case, it is possible that participants with experience smoking over some years have also experienced failure to quit and have fostered the idea that addiction is permanent (Thompson et al., 2003). It is difficult to draw conclusions about the current non-smokers in the study because the sample may or may not

include former smokers. It is worth exploring the factor structure among former smokers in future research. The gender difference found in the data is also surprising because there are no robust parallels in the literature for gender differences in belief systems about other attributes. This difference may be specific to this sample, or it may be specific to the domain of addiction. There are documented gender differences in how people tend to use substances, their recovery from addiction and experience of withdrawal, as well as stereotypes and social norms around how women are expected to behave with respect to addictive behavior (Becker, McClellan, & Glover Reed, 2017; Tuchman, 2010), which in turn may affect their belief systems about addiction. Future work should explore how addiction mindset differs across different groups and why they might differ.

CHAPTER 3: ADDICTION MINDSET AND PSYCHOLOGICAL PROCESSES RELATED TO QUITTING SMOKING

Study 2

As a first step towards examining the utility of the AMS in predicting behavior change, the associations between addiction mindset and several psychological processes related to behavior change were explored. First, relations between mindset and motivation to quit were examined in this study. If people believe that it is possible for smokers in general to overcome their addiction (growth mindset), then they themselves may be more motivated to quit because of higher projected odds of success. Similarly, those who believe in the potential for change may also correspondingly, they may also have higher self-efficacy to quit.[2]

The third process examined in this study was commitment to quitting smoking, as characterized as a willingness to persist in staying abstinent despite the discomfort of withdrawal (Kahler et al., 2007). Growth mindset is known to be predictive of persistence in challenging situations (Burnette, O'Boyle, et al., 2012), so it was hypothesized that a smoker with a growth mindset may be more willing to persist because of the belief that exerting effort can change an addiction. A fourth process explored in this study was the relationship between mindset and perception of barriers to cessation. People with a fixed mindset are more afraid of failing to achieve a goal because they perceive that failure only confirms the permanence of the quality in themselves (Dweck, 2006). For this reason, they may try to avoid trying to change and may perceive more barriers to quitting smoking.

[2] Note that self-efficacy may be related to mindset about addiction but is theoretically different from mindset about addiction. Self-efficacy is a specific belief about one's capacity to achieve a goal. A smoker's abstinence self-efficacy is their level of confidence that if they tried to quit smoking, they would be successful. Contrast to this, mindsets are global beliefs about whether human attributes are fixed or malleable. A smoker's mindset about addiction is their belief about whether addiction itself is permanent or not.

Past research found that people with a fixed mindset tend to attribute failure more to an internal lack of ability than to external reasons such as effort (Dweck, 1999; Dweck et al., 1995). Thus, the fifth process explored in this study was whether smokers' mindset was associated with attributing failure to a lack of ability vs. effort. Finally, the study examined whether mindset is related to participant characteristics such as current smoking status and level of dependence. Participant characteristics were also controlled for while examining the associations between mindset and the psychological variables above to determine the extent to which these associations were above and beyond their common association with smoking status and previous quit attempts. Finally, associations between growth mindset and intention to quit in the future were examined in this work. Although there is no previous literature to support an a priori hypothesis, it is possible that smokers with a greater growth mindset may be more interested in engaging in a quit attempt if they project higher odds of success.

Method

Participants

Participants who were current daily smokers (N = 200) were recruited from Amazon Mechanical Turk. The mean age of participants was 31.93 years (SD = 10.00 years), the sample was 51% male, 84% White, smoked an average of 10 cigarettes every day (median = 5). The majority had a high school education (74%), were employed (74%), had never married (59%), and had no children (66%).

Measures

Mindset

Participants completed the six item AMS (see Appendix - A for the measure) developed in Study 1 (Cronbach's $\alpha = .86$). Higher scores indicate more growth mindset while lower scores indicated more fixed mindset.

Motivation, confidence and commitment

Using a four-item survey (e.g. "Would you like to give up smoking if you could do so easily?" (Richmond, Kehoe, & Webster, 1993)), participants reported their levels of motivation to quit ($\alpha = .73$). They reported their self-efficacy or confidence in cutting down number of cigarettes smoked and quitting completely (e.g. "If you decided to quit smoking completely, how confident are you that you would be able to do it?") on a 4-point scale ranging from not at all to very sure ($\alpha = .78$; Crittenden, Manfredi, Warnecke, Cho, & Parsons, 1998). As smoker with high self-efficacy is confident that he or she can successfully quit, and this belief has been found to reliably predict cessation (Gwaltney et al., 2009). They completed an eight item measure of their commitment to quitting smoking (Kahler et al., 2007). Commitment was measured with statements such as "I'm willing to put up with whatever discomfort I have to in order to quit smoking" on a five point strongly disagree (1) to strongly agree scale (5) ($\alpha = .93$).

Barriers to smoking cessation

Next, participants completed the perceived barriers to quitting smoking checklist (Abrams et al., 2003) which assesses smokers' endorsements of common reasons that get in the way of someone being able to quit successfully (e.g. "I don't know how to go about quitting smoking" or "there are too many difficult things going on in my life right now") ($\alpha = .78$).

Current smoking and dependence

Participants completed the 6-item Fagerström Test of Nicotine Dependence (FTND) (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991), and reported the number of cigarettes they smoked per day.

Number of quit attempts in the last year

Participants self-reported the number of quit attempts they made (willingly going 24 hours at least without smoking with an active intention to quit) in the past 12 months.

Intention to Quit

They also reported whether they intended to quit in the next week, month, year, later than a year, or did not intend to quit at all.

Attributions for failure

Finally, we examined how participants responded to failure to quit smoking and how they would attribute their failure. In order to measure attributions for failure, participants were asked to imagine that they had engaged in a quit attempt but failed. This type of scenario has been used

in similar research on mindset (for e.g., see Grant & Dweck, 2003). Specifically, they imagined the following scenario of failing to quit, "You decide to quit smoking because you want to improve your health. After you decide to quit, you remove all the cigarettes from your house and just stop smoking cold turkey. A week after you quit, you start smoking again." Following this, they were asked, "Why do you think you started smoking again in this scenario?" and asked to rate two possible explanations for failing to quit on a strongly agree to strongly disagree scale. One measured attribution to lack of ability to quit: "I started smoking again because I was not able to overcome my addiction" and the other measured attribution to lack of effort: "I started smoking again because I did not try hard enough"). Participants were also instructed to think back to their last quit attempt (a time when they willingly tried to give up smoking for at least 24 hours) and asked to respond to the same two questions on attributions for failure to quit smoking. Participants (N = 21) did not have to answer these questions if they had never attempted to quit. The order in which the surveys were presented was counterbalanced so that half the participants completed the vignette first and the other half completed the other surveys first.

Statistical Analyses

Linear or logistic regression analysis was used to test for correlations and associations between mindset and all other variables. Because the association between mindset and motivation, self-efficacy, or commitment could simply be a reflection of how much people smoke or their quit history, all regression analyses controlled for these covariates: number of cigarettes smoked per day and previous quit attempts. Analyses also controlled for age of

participants since age may affect responses to motivation, commitment, etc. Additionally, in order to add to the scale validation process, a confirmatory factor analysis (CFA) was conducted on the AMS data collected in this study. Since this was not part of the planned analysis protocol, the results of this CFA are reported in Appendix – C.

Results

Motivation, commitment and confidence

Table 4 presents details on all the regression models. However, the results were highly similar to the zero-order correlations (correlations without controlling for any other variables), as can be seen in Table 3. Higher scores on the AMS were positively associated with motivation to quit (β = .17, p = .02) and commitment to quitting (β = .37, p <.001). Higher AMS scores were also moderately associated with higher self-efficacy to cut down on cigarettes (β = .28, p<.001) and to quit completely (β = .36, p<.001).

Barriers to cessation

In smokers, higher AMS scores were associated with endorsing fewer barriers that prevented cessation (β =-.29, p <.001).

Current smoking and quit attempts

As shown in Table 3, Scores on the AMS were not correlated with current smoking levels (number of cigarettes per day) (r = .07, p = .66) or severity of nicotine dependence in this sample (r = -.02, p = .77). AMS was also not correlated with number of previous quit attempts in the past 12 months (r = .04, p=.87) or intention to quit in the next month, one year or later than one year (all p's>.05).

Attribution of failure

Smokers with higher AMS scores were less likely to attribute their failure to quit smoking to lack of ability to quit although this was not significant (β = -.13, p = .11). However, higher AMS scores were significantly associated with effort attribution (β = .17, p = .02), such that people with a growth mindset were more likely to attribute their imagined failure to lack of effort. When asked to think back to their own last failed quit attempt, lower scores on AMS were associated with greater attribution of their failure to lack of ability to quit (β = -.21, p < .05). However, mindset was not significantly associated with attributing failure to lack of effort (β = -.02, p = .74).

Discussion

Using the measure developed in the previous study, this work showed evidence for a correlational relationship between addiction mindset and various psychological processes related to quitting smoking. Smokers who endorsed a growth mindset were more motivated to quit smoking, more committed to quitting (i.e. willing to persist despite difficulty or discomfort) and had greater self-efficacy to cut down on their smoking and quit completely. Further, greater endorsement of a growth mindset was associated with perception of fewer barriers to cessation. These results are consistent with past research on fixed vs. growth mindset in other domains; people with a growth mindset tend to have positive effort expectations, and greater persistence (Burnette, 2010; Dweck et al., 1995) and this suggests that mindset in addiction may be similar to findings in mindset in other domains. It is possible that smokers who believe that addiction is a permanent part of someone may be less motivated to quit and less confident in their ability to do so. In conjunction with the evidence that smokers with a fixed mindset also showed lower

willingness to persist in quitting (i.e. commitment), the results from this study highlights the need for intervention or greater assistance to this group of smokers.

The results suggest that if a quit attempt is unsuccessful, smokers with a fixed mindset may attribute it to a lack of ability to overcome addiction while those with a more growth mindset may attribute it to other factors, such as lack of effort. This finding is consistent with similar studies in the domain of intelligence (Dweck et al., 1995). Attributing cessation failure to stable factors (e.g. "that's the sort of person I am") is likely to lead to the expectation that they will fail again in future, and those expectations can manifest in lower quit rates (Eiser, van der Pligt, Raw, & Sutton, 1985). Attributing failure to external factors may be indicative of the underlying belief that increased effort does lead to behavior change and sets positive expectations for future attempts with increased effort. Learning how people visualize the outcomes of a quit attempt is important because people often visualize possible outcomes when engaging in goal-directed behavior, and their expectations of failure or success have the potential to translate to actual behavioral outcomes (Sherman, Skov, Hervitz, & Stock, 1981).

It may seem surprising that mindset was not associated with current smoking or quit history. However, only daily smokers were recruited for Study 2. If people with a growth mindset were more likely to quit smoking, they were less likely to be included in the study; those with a growth mindset who continue to smoke may have other factors (e.g., greater nicotine dependence) that made it difficult to quit. Further, related research on body weight has found that mindset may not have a direct effect on outcomes (e.g. BMI) but may have indirect effects on weight by affecting related psychological processes such as coping skills or expectations of success (Burnette, 2010). Similarly, addiction mindset may influence psychological processes such self-efficacy or commitment to quitting, which are known to predict successful quitting.

Prospective research is therefore, necessary to assess the effects of growth vs. fixed mindset on successful smoking cessation. While exercising due caution on the correlational nature of data, the findings underscore the potential of future research exploring how addiction mindsets relate to successful quitting.

Limitations

The current data does not allow us to draw conclusions about causal effects of mindset on quitting smoking from this study. For example, while it is possible that having a growth mindset makes people motivated to quit, it is also possible that people who are motivated develop a growth mindset. This is a first step towards exploring the utility of addiction mindsets. Future research is needed to explore its association with related constructs such as intrinsic vs. extrinsic motivation. In addition, the data for the present studies were collected from a convenience sample using Amazon Mechanical Turk, which was predominantly white, young, and college educated. It is not known whether the results generalize beyond this sample. Sampling strategies were employed in this study to achieve a gender-balanced sample with a range of different age groups, smokers and non-smokers. However, the sample did not include people from a broad range of races and ethnicities, or income and socioeconomic levels. The results may therefore vary across different demographic groups.

CHAPTER 4: GROWTH MINDSET INTERVENTION FOR SMOKING CESSATION

Study 3

The results from Study 2 showed that there is an association between addiction mindset and various psychological and motivational processes associated with smoking cessation. However, it is unknown whether mindset has a causal effect on changing addictive behavior, and if so, the mechanisms by which it affects outcomes. The aim of this study therefore, was to examine whether mindset can be experimentally manipulated and test whether that manipulation changes addictive behavior. Towards this aim, Study 3 describes a randomized intervention trial designed to increase growth mindset about addiction among daily smokers who are intending to quit.

The goal of the growth mindset intervention was to provide information that changes participants' beliefs about the permanence of addiction, specifically with respect to smoking behavior. However, taking into consideration the difficulty of smoking cessation, and the knowledge that only about 6% of smokers are able to quit on their own (Hughes et al., 2004), changing beliefs about the permanence of attributes may not be sufficient to induce strong effects on behavior change. Therefore, all participants in the study were provided access to a smartphone application (SmartQuit) that taught them skills for smoking cessation. SmartQuit has been evaluated in other research to be effective in aiding participants with cessation efforts (Bricker et al., 2014, 2017). Providing everyone in the study with a skills-based app was helpful not just to provide participants help with their cessation efforts, but also to assess participants' usage of the SmartQuit program as an indicator of their progress towards cessation. Therefore, the study aimed to examine the effects of the provision of a growth mindset intervention on smoking cessation, as well as on participants' behavioral efforts towards cessation (as measured by how much people used SmartQuit). The study was powered on engagement with the smoking

cessation app since this is (a) a pilot study, (b) large samples are needed to power for cessation, and (c) preliminary data from a prior trial of SmartQuit showed that engagement was highly predictive of smoking cessation (Bricker et al., 2017). In order to be compatible with the technology-based skills application, the growth mindset intervention was delivered fully through email. Given that digital interventions for smoking cessation have shown moderate success, cost-effectiveness and high reach (Civljak, LF, Hartmann-Boyce, Sheikh, & Car, 2013; Whittaker et al., 2009), the chosen electronic delivery methods for the growth mindset intervention were advantageous as they provided additional insight on the feasibility and utility of such an intervention on a larger scale.

Specific Aims

Drawing from the previous mindset interventions on weight loss and academic achievement, there is evidence that a growth mindset intervention leads to greater persistence in goal-directed behavior (e.g., Burnette et al., 2012, 2017). Extending this result to the context of smoking cessation, Study 3 evaluated whether a growth mindset intervention for addiction changed participants' mindset at follow-up, and whether it increased their persistence towards quitting and successful cessation. Specifically, there were four main questions examined in this study:

(1) **Outcome 1: Persistence with behavior.** The intervention group was hypothesized to demonstrate greater persistence towards cessation, as demonstrated by the greater usage of the SmartQuit program than the control group that did not receive a growth mindset intervention. This was measured using number of logins to the app (i.e. the number of times someone opened the app) and number of days the app was used.

(2) **Outcome 2: Cessation.** Since previous research suggests that greater engagement with SmartQuit is predictive of cessation (Zeng, Heffner, Copeland, Mull, & Bricker, 2016), the intervention group was also expected to show higher cigarette smoking quit rates than the control group.

(3) **Mediation.** Changes in outcomes were expected to be mediated by increased growth mindset score (measured with the AMS) in the intervention group compared to the control.

(4) **Moderation by baseline mindset.** Finally, similar to findings from other studies of mindset (e.g., Andersen & Nielsen, 2016), the cessation outcome was hypothesized to be moderated by baseline addiction mindset scores. Specifically, participants who started the study with lower baseline growth mindset of addiction were expected to benefit more from the intervention than those who started the study with higher baseline growth mindset, as they have more room for change than those who already score high on growth mindset.

Methods

Recruitment

Eligibility criteria.

The eligibility criteria were: (1) age >= 18 years, (2) smoked >= 5 cigarettes per day for the past 12 months, (3) ready to quit in the next 30 days, (4) lived in the United States, (5) could read English, (6) had access to a smartphone and could download an app, (7) had access to internet and personal email, (8) not currently enrolled in other smoking cessation treatment, (9) never participated in prior studies by the same research group, (10) willing to be randomized to treatment and willing to complete surveys at baseline and follow-up.

Participants and enrollment.

Adult smokers (*N* = 398) were recruited between June and October 2017. The study participant flow diagram (CONSORT) is shown in Figure 2. Recruitment strategies included the use of an online survey panel and Facebook ads to recruit a national sample. Targeted ads were used to ensure that the sample reached the gender and minority enrollment targets (minimum 25% minority and male representation). Potential participants initially completed a brief online screening survey to assess eligibility. If they screened eligible, they provide online consent, and completed a baseline survey and a contact form. Since enrollment occurred online, additional actions were taken to deter fraud. These included CAPTCHA authentication, review of IP addresses for duplicates or non-US origin participant IPs. The study was registered under the Clinical Trials Registry under NCT03174730.

Design and Randomization

Participants were randomized (1:1) to either the experimental group (Growth Mindset intervention + SmartQuit app, n=199) or the control group (SmartQuit app only, n=199)[3]. Using randomly permuted block randomization, stratified by heavy daily smoking (cut off: 20 cigarettes per day), and education (high school or less).

Blinding

Since the conditions in the study are non-equivalent, the study was presented to participants as "a research study comparing two technology based quit-smoking programs" in order to maintain research integrity and circumvent any possible placebo effects. The consent

[3] In selecting the design of this study, several alternative control groups were considered including adding reminder messages, general motivational messages and tips associated with other health behaviors (e.g. exercise). However, for reasons including incompatibility with the SmartQuit program or risk of generating additional confounds, these alternative controls were not implemented.

pages and study information simply said, “Both programs contain the same information and tips to help you quit smoking but differ based on the technology used. All participants need access to email and a smartphone.” Neither research staff nor study participants had access to randomized study arm assignments. Participants were debriefed at the end of the study with a letter explaining the full purpose and procedures used in the study.

Follow-up assessment

Participants completed a follow-up survey at two months after randomization. Two weeks before the survey was sent out, participants received $2 cash as a pre-incentive and a letter notifying them to expect the survey. Participants received $25 cash for completing the survey and an additional $10 cash bonus if they completed the online survey within 24 hours of receiving the invitation. Participants who did not complete the survey online were sequentially offered opportunities to do so by phone, mailed survey, and then, for main outcomes only, by postcard. This assessment method yielded 92% follow up rate at two months, with 66% of respondents filling the survey within 24 hours of receipt.

The Growth Mindset Intervention: MIND Tips

The Growth Mindset intervention consisted of a series of eight curated tips, called “MIND Tips” (MIND is an acronym for Mindset Intervention for Nicotine Dependence). The MIND tips were delivered to participants in the experimental group via email once every three days. The contents of the tips were determined by exploring the literature (e.g., Amodeo, 2015; Berg et al., 2013; Hammer et al., 2013; Szalavitz, 2015; Thompson et al., 2003) as well as surveying smokers on the specific aspects of addiction that people may consider permanent (or “fixed”). The MIND tips addressed addictive genes, addictive personality, the possible permanence of brain damage from addiction, the duration of withdrawal symptoms, whether

having urges years after quitting is a sign of addiction, and whether failure to quit is indicative of permanent addiction. The tips explained the topics and presented scientific evidence for changeability to change participant beliefs. These tips were developed with extensive pilot testing using smokers from the Seattle area, as well through survey testing with a national sample of smokers. Each tip was 6-8 pages long, contained small chunks of text, bright visuals, and presented evidence that these aspects are not permanent or determinant of one's addictive behavior. Every tip featured both a story of a (fictional) former smoker demonstrating a growth mindset and contained a relevant cue that prompted participants to use SmartQuit as a call to action after reading the tip. The emails themselves did not contain any intervention content but contained links to the tips which could be viewed online in both desktop and mobile. The reason for this was to be able to record page views for each tip and for each participant, which is not possible over email. When participants completed viewing each tip, they were given the option of downloading the tip in the form of a pdf. The content of the MIND tips can be found in Appendix – E.

Description of the SmartQuit program

Participants in both groups received access to SmartQuit, a smartphone app created to facilitate smoking cessation using Acceptance & Commitment Therapy (ACT; Hayes, Levin, Plumb-Vilardaga, Villatte, & Pistorello, 2013). Users were provided a login and password to open the app in the study. Once they logged in, the app helped them create a quit plan, set a quit date, and establish why they wish to quit. They could also upload photos of what is inspiring them to quit smoking, which is designed to elicit their core values motivating smoking cessation. The main screen of the app provided eight core ACT exercises that teach smokers skills to become mindful of their urges to smoke and let them pass without smoking. These exercises

were unlocked in sequence; subsequent ones becoming available 24 hours after previous ones were unlocked. The app also consisted of a tracking feature they could use to count urges passed without smoking (a core ACT-related process of acceptance of urges), and push notifications that prompted them to use the app. There was also an additional coaching menu, with over 40 extra help pages and suggestions for helping users remain motivated and learn skills to avoid relapse. Finally, the app awarded users with badges for completing certain activities, including a final "certificate of completion" if they completed a quit plan, viewing the main exercises, using the tracking feature, and viewing additional content from a help menu.

Measures

Demographics & Smoking History

Participants reported demographic information including their age, gender, race and ethnicity, sexual orientation, education and employment. Participants who were marked eligible in a short screener were provided up to a week to complete the baseline measures online and used varying amounts of time to fill the survey. They also self-reported whether they had different mental health conditions using the item, "Do you have any of the following mental health conditions? Check all that apply." The options included anxiety disorder, depression, schizophrenia, bipolar disorder, and other drug or alcohol use disorders. Participants reported the number of cigarettes they smoke per day, as well as the number of years they have been a regular smoker, the number of quit attempts in the past 12 months, whether they used e-cigarettes in the past 12 months. They also completed the Fagerström Test of Nicotine Dependence (FTND; Heatherton et al., 1991).

Mindset & motivational variables

Participants completed at baseline and at two-month follow up, the six-item measure of addiction mindset (AMS) developed in Study 1 (baseline α = .68, follow-up α = .73). Participants' levels of baseline avoidance and inflexibility towards thoughts, feelings and bodily sensations (ACT-processes) that prompt them to smoke was assessed using the AIS Scale (Bricker, Wyszynski, Comstock, & Heffner, 2013) at both baseline (α = .71) and two month follow up (α = .84). Participants filled the eight item measure of commitment to quitting smoking (Kahler et al., 2007), which assesses their willingness to persist in staying quit despite discomfort or other difficulties at both baseline (α = .91) and follow-up (α = .93). As a measure of self-efficacy for quitting smoking, participants reported their confidence in staying abstinent at two month follow up using an adapted single item, "on a 0-100 scale, where 0 is not at all and 100 is extremely confident, how confident are you that you will be abstinent 2 months later?" (Gwaltney et al., 2009).

Follow-up measures

Cessation and smoking behavior. Two months after the date of randomization, participants reported the last time they smoked a cigarette, how much they currently smoke, how many quit attempts they made and completed the FTND. Cessation was defined as 30-day point prevalence abstinence (PPA; i.e., no smoking at all in the past 30 days) at two-month follow up.

Persistence with using the app. Participants' use of the SmartQuit app was automatically recorded for the duration of the study. The main indicators of use recorded for this study were the number of logins, and the number of days of use. Another metric of interest was whether participants received the certificate of completion awarded inside the app. This was a special badge awarded to those users who viewed all the ACT exercises on the main page, completed

their quit plan, tracked urges passed and viewed any of the coaching content in the help menu. This completion milestone predicted four times higher odds of cessation in a previous trial (Zeng et al., 2016).

Statistical analysis

Using this available preliminary data on logins, a sample size of 300 was determined to provide 80% power to detect differences in number of logins between groups that would be classified as a small effect (Cohen's d = .2 and above). The sample size was increased to 398 after two months of recruitment to account for data loss from participants not downloading SmartQuit (see discussion section for more details). Differences between demographic variables across arms at baseline were examined using t-tests and Fisher's Exact tests for continuous and categorical variables. Logistic regression models were used to examine differences in cessation between groups. The primary analysis method was a complete case analysis with the intent-to-treat sample, which covers 92% of recruited sample, a high retention rate. A secondary sensitivity analysis was included treating missing cessation data coded as smoking to allow comparison with other trials (West, Hajek, Stead, & Stapleton, 2005).

Negative binomial regression models were used for predicting two engagement outcomes (number of logins and number of days logged in) to account for zero inflated distributions (Hilbe, 2011). To test whether differences in outcomes between groups was mediated by change in addiction mindset, three separate regressions models were constructed (MacKinnon, 2008) for each step of the mediation. Two models predicted the impact of treatment assignment on outcome and change in mediator from baseline to follow-up. The final predicted outcome from the change in mediator. For testing moderation of effects of treatment assignment on outcome, models predicting outcome from assignment included the baseline value of the moderator

(baseline AMS) and an interaction between group assignment and baseline value of the moderator. All analyses exploring group differences between the control and experimental group controlled for the randomization factors of education and heavy smoking to avoid loss of power (Kahan, Jairath, Doré, & Morris, 2014). Further covariates were included only if they were significantly and independently associated with both the predictor and outcome variables in models.

Results

Description of Sample

Table 5 shows the demographics of the sample across the intervention and control arms. The sample (n=398) was on average 42 years old, 51% female, 79% white and 17% self-identified as LGB. Nearly half the sample was unemployed, and self-reported at least one mental health condition, and 39% had high school or less education. Participants smoked 19 cigarettes per day on average, and over half (59%) of the sample scored high on nicotine dependence. The only significant difference in characteristics at baseline was self-efficacy to quit. By chance, the control group had significantly higher baseline self-efficacy to abstain from smoking ($p = .002$) and self-efficacy was predictive of cessation at two months ($p < .05$). Therefore, models predicting cessation from group assignment controlled for baseline self-efficacy.

Viewing MIND Tips

In the intervention group, 78% of the participants viewed at least one page of the MIND tips, and 22% of participants did not view any of the MIND content. On average, participants in the intervention group viewed 4.16 ($SD = 3.38$) tips out of 8 total tips and 21% of the group viewed all eight tips. Figure 3a shows a histogram of the number of MIND tips viewed by

participants in the intervention group. Table 6 shows the association between participants' baseline characteristics and number of tips viewed in this study.

Outcomes: Persistence with quit-smoking app usage

Across both groups, 72% of the participants logged in at least once to the SmartQuit app and 28% did not download/login to the app. Figure 3b shows a histogram of the number of days participants used the SmartQuit program. The control group was more likely to login at least once (76%) than the intervention group (68%, $p = .10$). As seen in Table 7**,** participants in the control arm logged in an average of 21.61 times and in the intervention arm, 19.46 times. Participants in the intervention arm were not more likely to login to the app than control arm participants ($p = .38$; $d = 0$). Similarly, intervention group participants logged in for an average of 11.73 days compared to the control group's 12.19 days and this difference was not significant ($p = .97$; $d = 0$). The proportion of participants receiving certificates of completion were almost the same in the intervention (31%) and control (30%) groups ($p = .74$; $d = .04$). Associations between individual baseline characteristics and usage of SmartQuit are shown in Appendix – D.

Outcomes: Cessation and smoking behavior

Results of a complete case analysis on cessation revealed a trend for higher quit rates in the intervention group (17%) than the control group (14%) (OR = 1.64; 95% CI = 0.90, 3.00; $p = 0.10$; $d = .27$). The results did not change when missing data were treated as smoking ($p = 0.14$; $d = .24$). In terms of cessation progress, the smokers in the intervention group were marginally more likely to cut down on smoking ($B = -1.90$, $p = .07$; $d = .20$) and show reduced dependence as measured by FTND score ($B = -.53$, $p = .05$; $d = .19$) compared to participants in the control group. Associations between individual baseline characteristics and cessation are shown in Appendix – D.

Exploring mindset as a change process

Figure 4 shows the results for the following analyses while controlling for baseline mindset: (a) Group assignment predicting mindset at follow-up, (b) Mindset at follow-up predicting outcomes and (c) Group assignment predicting outcomes. Although this direct path (c: group assignment predicting outcomes) is not significant in this model, recent reviews suggest that a direct effect is not required to test mediation through indirect effects (path a and b as listed above) (MacKinnon & Fairchild, 2010). The intervention group's mean AMS score after two months (M = 3.42, SD = 0.90) was not significantly different from the control group (M = 3.35, SD = 0.93; B = 0.05; 95% CI = -.13, .22; p = .59; d = .10). Overall, controlling for baseline AMS, participants' AMS score after two months was associated with persistence in using SmartQuit, as measured by number of logins (IRR = 1.27; 95% CI = 1.05, 1.55; p = .02; d = .13) and number of days of use (IRR = 1.26; 95% CI = 1.05, 1.51; p = .01; d = .13). Participants' AMS score at two-month follow up was also associated with cessation, controlling for baseline AMS (OR = 1.47; 95% CI = 1.04, 2.07; p = .03; d = .21).

Association between viewing MIND tips and AMS Score

Since the intervention group showed large variance in the number of MIND tips they viewed (see Figure 3a), an additional analysis explored if viewing more tips was associated with greater growth mindset at follow-up. After controlling for baseline mindset score, viewing more MIND tips was significantly associated with greater AMS scores at follow-up (B = 0.04, p = .03; f^2 = .28). This finding did not change even after controlling for possible third variables including participant motivation and self-efficacy. Figure 8 shows the relationship between viewing half or fewer MIND Tips and overall change in mindset score.

Moderation by baseline mindset

As shown in Figures 6, baseline mindset did not moderate the effect of the intervention on engagement or cessation (interaction *p*'s > .05).

Per-protocol analysis: Subgroup with any use

Taking into consideration the large (>20%) proportion of the sample who did not use the program as intended, it is difficult to draw strong conclusions about the effectiveness of the intervention among those who adhered to the intervention. If people did not download the SmartQuit app for example, it is difficult to estimate the effect of the intervention on app usage metrics. To examine the results with intended use, a per-protocol analysis using a subgroup of participants was additionally explored. This type of analysis cannot be used for drawing causal conclusions, but can be used to learn if participants' outcomes differed when they used the programs as intended (Sedgwick, 2015). In this post hoc analysis, the sample included those with at least one login to SmartQuit in the control group (N = 151) and at least one login to SmartQuit and one page-view of the MIND tips in the intervention group (N = 115). Since other participant characteristics (third variables such as motivation) may account for selection into usage subgroups and outcome differences, tests for differences in participant characteristics at baseline were conducted. The subset of the control group differed from the subset of the intervention on only three variables: gender (p = .05), number of self-identified LGB participants (p = .05) and on self-efficacy (p = .02) compared the intervention group, but no other differences. Analyses controlled for these differences wherever appropriate.

Per-protocol analyses: Results

Results for the subgroup of participants with >= 1 login are summarized in Table 8. When examining only the participants included in this analysis (N = 266), the intervention group logged in for more days on average (M = 20.10 days) compared to the control group (M = 15.46 days, p = .06; d = .23) and were more likely to get the certificate of completion in SmartQuit (50% vs. 38%, p = .07; d = .25). However, the intervention arm did not differ from the control group in number of logins to the SmartQuit app (p = .55; d = .03).

The subgroup of intervention group participants differed from the subgroup of the control on quit rates (21% vs. 13%) at two months follow up (OR = 2.13; 95% CI = 1.06, 4.27; p = .03; d = .42). The results were the same when missing data were coded as smoking (p = .03; d = .41). In terms of cessation progress, similar trends were observed for reduction of smoking, although the difference was not significant (B = -1.26, p = .33; d = .18). The subgroup of the participants in the intervention group also showed greater reduction in nicotine dependence (B = -.78, p = .02; d = .23) than the subgroup of control group. The mediation and moderation analyses with a subgroup of participants with >=1 login yielded very similar results to the intent-to-treat analysis (see Figure 5 and Figure 7).

Discussion

Study 3 presented a randomized smoking cessation trial of a growth mindset intervention for changing beliefs about addiction among daily smokers. The results of the trial showed that there were no significant differences between the intervention and control groups on engagement with SmartQuit (a quit-smoking program), or smoking cessation. The growth mindset intervention was expected to improve persistence with the SmartQuit program. The results did

not support this hypothesis, and in fact showed a trend that was opposite of this expectation: the control group was slightly more likely to login at least once and spend more time on the app. This trend raises questions about why the control group on average might be engaging more with SmartQuit. There are several potential reasons for this. First, it is possible that participants who received an app- based and an email-based intervention might have simply been provided too much content and over two different modalities and they did not have time for both. It is also possible that those who read the email tips may have gained a sense of program completion with the study and that may have reduced their participation with the SmartQuit program. A third possible reason is that participants were more responsive to the MIND tips over the app because the emails reached out to them and served as a cue for participation, compared to app use which has to be driven by the participant's own actions.

Following from the results on engagement, analyses of cessation data showed a trend for higher odds of cessation in the intervention group compared to the control group although this was not statistically significant. The participants who received the growth mindset intervention also reduced their daily smoking more and demonstrated greater reduction in nicotine dependence at the end of the study compared to the control group participants. Actual cessation rates should be interpreted in the light of a significant baseline difference in abstinence self-efficacy, which is highly predictive of smoking cessation. Considering this early difference, along with the fact that the study was underpowered to detect differences in cessation, the descriptive differences in quit rates between groups underscores the potential of a growth mindset intervention for changing addictive behavior. Although these differences obtained in this study were not statistically significant, they demonstrate practical significance. When scaled to a population level and considering the cost-effectiveness of technological interventions and health

benefits accrued from each additional person who quits or reduces smoking, even a 1% improvement in quit rates can be considered clinically significant (West, 2007). If shown effective in fully powered study, the 4% increase in cessation rates in this study shows that the addition of a growth mindset component to an app-based treatment is highly promising.

Addressing low engagement with assigned content

Overall, while all participants signed up for a technology-based smoking cessation study, over 20% of the sample did not use their assigned interventions. Unlike some other studies of smartphone apps for smoking cessation (e.g., Bricker et al., 2017; Iacoviello et al., 2017), this study did not require the participants to log in to be enrolled (imposing that condition would have proven costly and difficult to implement in this study for practical reasons). Other digital interventions that have not required one login for randomization have found that over half the recruited sample (57% - 82%) did not download/log in to their digital interventions (Arean et al., 2016; Roepke et al., 2015). These behaviors may be characteristic of technology-delivered interventions, where aspects of the technology external to the intervention (e.g., visual design of technology, amount of space in a participant's phone to download the app, not knowing how to install the app, extra steps involved in acquiring a password from email to input into a phone, etc.) may have affected participant engagement. Research has shown how such design features of web-interventions are largely overlooked in e-health and m-health research and may contribute to attrition rates as high as 90% in digital interventions (Ludden, Van Rompay, Kelders, & Van Gemert-Pijnen, 2015).

Participant characteristics can also be associated with participation in intervention programs. The associations between all the baseline characteristics measured in this study and viewing MIND tips (Table 6) and using SmartQuit (Appendix – D) can shed light on the types of

participants that tend to use programs more or less than others. For the growth mindset intervention, participants who were older tended to view more tips, a finding that is consistent with the engagement literature that finds that older participants tend to be more engaged with electronic health (e-health) interventions (Strecher et al., 2008; Wangberg, Bergmo, & Johnsen, 2008). Self-reported mental health conditions were associated with viewing fewer MIND tips, which is consistent with research that shows that mental health conditions are a predictor of lower engagement with e-health interventions (Christensen, Griffiths, & Farrer, 2009; Rotondi, Eack, Hanusa, Spring, & Haas, 2015). Participants who smoked more and showed higher nicotine dependence at baseline were also less likely to read the content, suggesting that much more needs to be done to retain their interest and address their needs in the content. Future work could improve on the intervention by exploring in greater detail why participants with these characteristics engaged less with the MIND content and how to tailor it to the subgroups to improve their engagement with the content. Baseline addiction mindset was not associated with the number of MIND tips participants read, suggesting that most participants were equally receptive to the content regardless of their beliefs about addiction at baseline.

Given that there is some loss of data to non-use of assigned content, a supplemental per-protocol analysis evaluated whether outcomes differed among those participants who used the program as intended. The results of this analysis showed a pattern more consistent with theoretical expectations: the participants in the intervention group logged in for a greater number of days and were more likely to achieve the certificate of completion, suggested that they were more engaged overall with SmartQuit. Overall, they persisted longer in behavior directed towards cessation. Although the sizes of these effects were small, participants in the growth mindset condition were more likely to achieve clinically significant progress in engagement.

Half of all participants who used the intervention fully adhered (i.e. received a certificate of completion) to the SmartQuit program compared to38% in the control group. Previous research has found obtaining the completion certificate was predictive of cessation, but rates of adherence were still quite low (Zeng et al., 2016). A growth mindset intervention may be beneficial in boosting adherence rates and improving persistence in digital treatment. Further, the subset of the intervention group who used the program as intended was twice as likely to quit as the control group and this difference was significant. They also showed greater reduction in nicotine dependence two months after starting the study.

The results from these supplemental analyses should be interpreted cautiously. Although it provides important insight on the outcomes of participants who adhered to the study protocol, the selection of participant subgroups cannot be used to draw causal conclusions because participants are no longer truly randomly assigned (Moher et al., 2012; Sedgwick, 2015). The loss of true comparability between study arms can lead to bias in drawing conclusions about the effectiveness of interventions because differences in outcomes may be a result of differences in participant characteristics (Sedgwick, 2015). Although the analyses used in this study explored baseline differences in subgroups using available data, there may be unmeasured variables that account for differences in outcome.

Exploring mindset as a mechanism of change

The main mechanism for change investigated in this study was increasing growth mindset about addiction, or greater endorsement for the belief that addiction can change. The intervention group did not have significantly greater growth mindset overall (as measured by the AMS) at follow up compared to the control group. Despite this, it is difficult to draw a clear conclusion about whether the intervention has moved the mindset process, because only 21% of the

participants read the entire intervention content. Additional analyses showed that the more MIND tips participants viewed, the higher they scored on growth mindset at follow-up even after controlling for baseline mindset and possible third variables. The full picture may be more nuanced: data suggested that within the intervention group, those who viewed four (median) or fewer MIND tips actually had a lower AMS score at follow-up, while those who viewed more than four tips had higher growth mindset at follow-up. It is possible that there is a dose-response relationship, and that these opposite effects presented as null findings on the group level.

There are many other alternative explanations to be considered. First, the SmartQuit program provided to all participants in this study employs an ACT-based process. Although there is no research to date examining the relationship between growth mindset and ACT, it is possible that they share some similarities in promoting a form of psychological flexibility (Kashdan & Rottenberg, 2010). In this study, avoidance and inflexibility score and addiction mindset were positively correlated at baseline ($r = 0.11$, $p = .03$), and their change scores were also positively correlated ($r = 0.22$, $p<.001$). If there is a theoretical link of psychological flexibility (or some other underlying similarity), the control group used in this study is likely not a true experimental control, in that those participants received an intervention – SmartQuit - that was moving some associated psychological processes. Second, it is possible that the mindset intervention has moved a different psychological process such as commitment to quitting, or self-efficacy.

When considering whether changing mindset is the most plausible mechanism of action, several types of data must be taken into consideration. On the one hand, the intervention itself has face validity, and the results suggested that high engagers had increased growth mindset and better outcomes. On the other hand, it is fully possible that there are other variables that were affected by the MIND tips and which led to improved outcomes. For example, receiving

information about addiction itself might have been beneficial, or the inclusion of fictional former smokers' stories may have provided positive role models for participants. The evidence from this study is inconclusive but highlights the need for future work to empirically alternative evaluate causal mechanisms.

Does the intervention benefit some participants more than others?

The results did not support the hypothesis that participants who start with a lower baseline level of growth mindset would benefit more from the intervention. There were no overall differences in outcomes based on participants' baseline levels of mindset in this study. This is contrary to other growth mindset interventions which found that those with a fixed mindset at baseline had more room to change and therefore, benefited more (Andersen & Nielsen, 2016) . It is possible that those effects are domain specific, and for addicted smokers, there are no clear differences based on participants' beliefs about addiction at baseline. Those with a baseline higher fixed mindset may have more room for change, but it is also possible that those with a higher baseline growth mindset are highly receptive to the intervention since it aligns well with their views. Aside from mindset, it is possible that the intervention worked differently for some groups. For example, it is possible that people who have smoked more heavily or for much longer have certain beliefs about how addiction works and respond differently than lighter smokers to information about addiction.

Limitations & Future Directions

The experimental group received a growth mindset intervention while the control group did not receive an equivalent treatment. Therefore, it is difficult to identify whether it is specifically the growth mindset intervention that has an effect on smoking behavior, or whether simply receiving any information is helpful to participants. The purpose and exact conditions of

the study were hidden from participants to the extent possible, minimizing any placebo effect of receiving an additional treatment. Future work should explore alternative study designs and control groups to add to this research. The sample size and loss of sample to non-use of assigned interventions limit the validity of the inferences from the study. It is possible that the steps for downloading and installing the app, entering log in details accessed by email may be cumbersome for some participants, resulting in loss of participation. Future studies should focus on making technology delivered interventions easier for participants of varying backgrounds to access and install on their devices. While the subgroup per-protocol analysis presents additional evidence for the effectiveness of the intervention, unmeasured third variables cannot be ruled out. Delivering all the content over the same technology may alleviate some burden on participants instead of having tips by email and skills delivered through phone. Text messages are a widely accessible technology that come on a phone platform that could be used to deliver bite size messages promoting a growth mindset. Further, the short follow-up of 2 months cannot capture health outcomes in the longer term perfectly, as several smokers tend to naturally relapse as time passes (Stead, Hartmann-Boyce, Perera, & Lancaster, 2013). Longer follow-up times are recommended for future work to explore the effects of a growth mindset intervention on abstinence. Finally, only self-reported abstinence was used without biochemical verification. However, experts suggest that biochemical verification is not required in studies where data are collected through web, or mail, without any face-to-face contact and which present limited demand characteristics (Benowitz et al., 2002; Cha, Ganz, Cohn, Ehlke, & Graham, 2017). Future research should explore the mechanism of action and baseline characteristics that may moderate the effects of a growth mindset intervention. The connection between mindset and ACT-related processes is particularly interesting and more work needs to be done to establish the

theoretical relationships between these constructs. In summary, this study showed that a growth mindset intervention for smoking cessation shows promise for behavior change. More research is needed to identify how it works, and how to increase participants engagement with the MIND tips.

CHAPTER 5: GENERAL DISCUSSION

People develop lay theories about the malleability of different human attributes, such as intelligence or personality (Dweck, 2012). These lay theories, called fixed vs. growth mindsets, refer to the beliefs that attributes such as intelligence are permanent or changeable (Dweck et al., 1995). Although research on people's mindsets have been extended to a variety of new domains (Dweck, 2012), no work to date has explored how people's beliefs about the permanence of addiction relates to their maintenance or cessation of addictive behaviors. The goal of this work was to apply the theory to addiction to fill this gap in the literature. The studies discussed in this dissertation are, to the author's knowledge, the first to extend the psychological research on fixed vs. growth mindsets to the domain of addiction. The goal of this work was to be able to define these beliefs, develop a questionnaire to measure these beliefs across people, explore how they relate to addiction, and explore whether an intervention boosting growth mindset can impact behavior change. Although there are a range of addictive behaviors, these studies focused specifically on smoking cessation. Three studies were presented to fulfill these aims.

Study 1 focused on the development and refinement of a measure of addiction mindset. To do this, a large sample of both smokers and non-smokers (N = 600) were surveyed on their addiction beliefs. Using participants' open-ended responses on the clarity of items and applying factor analytic methods, a six-item measure was developed and named the Addiction Mindset Scale, or AMS. The AMS consists of a single factor that assesses addiction mindset and is similar to other fixed vs. growth mindset scales in response choices and scoring (Dweck et al., 1995). The AMS showed good internal consistency and demonstrated similar factor structure across both current smokers and non-smokers in an online sample. This is important because it

suggests that experience with addictive behavior does not affect the factor structure of the measure itself.

Study 2 showed using a survey of daily smokers from the US (N = 200) that those who had higher scores on growth mindset also had higher motivation to quit, commitment to quitting and self-efficacy to cut down smoking or quit completely. Similar to findings in other domains of mindset such as intelligence (Dweck et al., 1995; Grant & Dweck, 2003), those who scored lower on the AMS were also more likely to attribute failure to quit to a lack of ability (i.e., a fixed internal component), while those who scored higher (i.e., a more growth mindset) were more likely to attribute it to lack of effort. This set of results suggests that mindset in the addiction domain functions similarly to mindset in the intelligence literature in terms of its relationship with motivation towards goal-directed behavior, and expectations of success. The results from this study showed no significant association between mindset about addiction and current smoking behavior or intention to quit. This is similar to findings from research on mindsets about body weight, which found that people's mindsets about weight did not predict their actual body weight (Burnette, 2010). Rather, it is possible that mindset can indirectly influence outcomes (e.g. BMI) through associations with other processes, such as outcome expectations or through use of coping skills (Burnette, 2010). In summary, Study 2 showed that people's mindset about addiction was correlated with motivational aspects of quitting smoking and reactions to failure to quit. This suggests that there is a relationship between beliefs about addiction and how likely someone is to quit, and these beliefs may be an important area of intervention. The final study explored these relationships more by using an experiment to manipulate people's mindset about addiction.

Study 3 was a randomized controlled trial of a growth mindset intervention for smoking cessation. Daily smokers who smoked at least five cigarettes a day were randomly assigned to a growth mindset intervention or a control group. Everyone in the study was provided a skills-based smartphone app that provided a structured program for smoking cessation. The growth mindset intervention was delivered using email. This study employed a technology-based intervention for multiple reasons. First, technology provides high reach and low cost, which allowed the testing of the growth mindset intervention on a national sample of smokers with varying backgrounds. Second, providing everyone with an app allowed for tracking participants' app use behavior as proximal outcome of the study that measured their engagement in an intervention designed for smoking cessation. Finally, using technology provides insight on the feasibility and utility of delivering a belief-change growth mindset intervention on a large scale. The results of Study 3 showed a trend for greater cessation in the growth mindset experimental group and no differences between groups on usage of the cessation app. The experimental group did not show greater growth mindset scores at follow-up compared to the control group. This could suggest that the growth mindset intervention did not change people's mindsets at follow-up, or it could have been because not enough participants read sufficient growth mindset content in the study. Among those who showed evidence of using the assigned programs as intended, participants in the growth mindset group did persist in using their smartphone app longer and were more likely to quit at two-month follow up compared to those in the control group. This study added evidence for an association between mindset and persistence in behavior change (as evidenced by longer app use), as well as with successful behavior change at follow up. The evidence for the causal role of mindset remained inconclusive in this study.

There are many similarities between addiction mindset and lay theories in other domains. Like most related studies have found, mindset about addiction can be measured in similar ways to mindset about intelligence or personality (Dweck et al., 1995). Mindset at baseline was not associated with intention to quit in study 2 or quitting behavior in study 3, and this is similar to research on mindsets in other domains like body weight (Burnette, O'Boyle, et al., 2012). Instead of having a direct effect on relevant outcomes, growth mindset may impact persistence in goal-directed behavior, which in turn affect success of behavior change (Burnette, Pollack, & Hoyt, 2012). In the third study, persistence in behavior was measured using engagement with a quit-smoking technology, which has both advantages and disadvantages.

The advantages and challenges of using technology to change addiction beliefs

Technology-based interventions for smoking cessation have been shown to be effective, cost-effective and valuable ways to reach out to large populations (Civljak et al., 2013; Whittaker et al., 2009). Since web-based intervention content can be accessed by users whenever they want and provides intervention designers the opportunity for adding on visual elements along with text to make content more engaging, the growth mindset intervention in Study 3 was delivered by email to participants. Usage data from Study 3 showed that a web-based growth mindset intervention was used and liked by most participants. However, a substantial group (21%) did not engage with it at all, which reflects the trend for low engagement with technology based interventions (Arean et al., 2016; Donkin et al., 2011). There is a need to boost engagement with the growth mindset intervention, especially given that those who actually engaged with the MIND content had better outcomes in the study. Future studies could employ user design principles to test the intervention with small samples of users iteratively before the actual trial or implementation (Yeager et al., 2016). Integrating an appropriate incentive structure might also

facilitate engagement with growth mindset interventions and outcomes (Manchi Chao, Visaria, Mukhopadhyay, & Dehejia, 2017). Increasing usage of the MIND content may also improve adherence to other treatments. For example, Study 3 also showed that a web-based growth mindset intervention can boost adherence to another digital smoking cessation program (in this study, SmartQuit). This shows how interventions can benefit from each other in the digital space, where adherence has historically remained a challenge (Donkin et al., 2011; Zeng, Heffner, Copeland, Mull, & Bricker, 2016). Integrating the MIND program into existing digital platforms may reduce some of the burden on participants to seek out content.

Changing beliefs about addiction in specific populations

Some participants may have greater fixed or growth beliefs than others, and some may be more receptive to change. Although beliefs about addiction varied by gender in Study 1, gender was not associated with mindset in Study 2 and all participants were equally receptive to the growth mindset intervention in Study 3 regardless of gender. An examination of the baseline characteristics of participants showed that those with higher nicotine dependence and those with self-reported mental health conditions were less likely to read the emailed MIND tips. Those with mental health conditions were also less likely to use their quit-smoking app. This pattern of low engagement among smokers with mental illness is well documented in the literature and reflects a need to tailor or customize interventions, including mindset interventions to smokers with mental illness (Rotondi et al., 2015). Taking into consideration that half the sample in Study 3 self-reported a mental health condition, and smokers with mental illness have lower quit rates (Lasser et al., 2000), there is an immediate need for understanding the beliefs about addiction in this group, and addressing them in appropriate ways.

The second factor that was associated with viewing less MIND tips was nicotine dependence and number of cigarettes smoked per day. Although, there was no correlation between nicotine dependence and mindset in Study 2, smokers with higher nicotine dependence tended to read less of the MIND content in Study 3. Nicotine dependence was not associated with engagement with the quit smoking app, but it was associated with viewing fewer MIND tips suggesting that perhaps the content of the growth mindset intervention itself was not engaging to smokers with higher nicotine dependence. Further investigation is required to identify why this groups of smokers with greater dependence and who smoke more were disengaging from content designed to foster a changeable view of addiction.

Finally, participants' own existing belief systems about addiction did not moderate any of the outcomes in Study 3, suggesting all participants were equally affected by the intervention regardless of their beliefs at baseline. Baseline mindset about addiction was also not associated with the number of MIND tips that participants read in the intervention condition in Study 3, suggesting that people were equally open to the content provided in the MIND tips regardless of their existing beliefs. In conjunction with the previous point about participants with higher nicotine dependence being less engaged with the MIND tips, it is especially interesting to note that it is not the case that smokers with higher dependence tend to be more fixed in their beliefs (in both Studies 2 and 3). Rather, there is some other explanation for this association between dependence and changing mindset that needs further investigation.

Generalizability to other samples, substances and contexts

All three studies employed online samples and included a range of participants of different backgrounds. Scale development was done with both non-smokers and smokers to create a tool that can accurately measure addiction mindset across samples and which can be

used across differing samples without worry of biased measurement. Studies 2 and 3 also recruited only adult daily smokers who smoke five or more cigarettes per day. Non-daily smokers have very different perceptions of smoking than daily smokers and might show different perceptions of addiction than the study sample. For example, they perceive smoking more as a habit which can be dropped anytime (Berg et al., 2013), which suggests that addiction mindset might have different patterns and consequences than in daily smokers. E-cigarettes are an emerging form of nicotine use that is rising, especially among youth (U.S. Department of Health and Human Services., 2016) and tend to be perceived as less addictive and harmful than traditional combustible cigarettes (Cooper, Loukas, Harrell, & Perry, 2017). As 21% of the Study 3 sample were e-cigarette users, future work should explore if addiction mindset has similar effects and consequences among e-cigarette users or dual-users.

The measure developed in Study 1 can also be used for testing different types of addictions by changing the wording in the instructions from nicotine to alcohol, marijuana, or any other substance that researchers are interested in. Since different addictions are likely associated with varying levels of perceived addictiveness or risk, the findings from these studies on cigarette smokers might or might not generalize to other substances (Berg et al., 2015). It is therefore, important to study beliefs about addiction in other substances to examine whether the results generalize across other types of substance use and if the perceived addictiveness of the substance is related to the types of beliefs that people have about addiction to other substances.

Since addictive behavior tends to disproportionately affect certain subgroups in society (U.S. Department of Health and Human Services, 2014), it is also important to test whether these findings differ in groups with different race, ethnicity and socioeconomic status. Although targeted recruitment was employed in all the studies, most of the data collected was from

Caucasian participants, which may limit generalizability of results among other groups in the population. The available data suggests that mindset does not vary by race and ethnicity, but the data sets may not have enough variability to detect differences.

Relations to models of addiction

The findings from this research should be taken into consideration when framing the discourse around addiction. When addiction is believed to be as an internal and permanent aspect of a person's life, it may influence someone's motivation to quit, persistence in quit attempts and likelihood of cessation. Although the disease model of addiction, which exemplifies this fixed view of addiction, was intended to reduce stigma and help people in their recovery efforts, this research supports other work which suggests it may be counterproductive for people trying to change their behavior (Hall, Carter, & Forlini, 2015; Satel & Lilienfeld, 2014; Wiens & Walker, 2015). Conversely, this research shows that endorsing a belief that addiction can change may be more helpful for smokers to quit smoking. This is similar to research supporting a choice model of addiction (Heyman, 2013).

It is important to note that this work is not intended to explore whether the disease vs. choice model of addiction is an accurate representation of behavior. Rather, this work provides important insight on how current smokers' efforts to change their behavior is related to their *beliefs* about addiction. To address these beliefs in a growth mindset intervention, the content used in the growth mindset intervention in study 3 followed a model of addiction that is not deterministic (Henden, Melberg, & Røgeberg, 2013). While acknowledging that some features of addiction (cravings, withdrawal, etc.) are involuntary, the focus of the intervention was to show evidence that addiction can be overcome. An illustration of this model of addiction would be to

say that while some genes are associated with increased risk of addiction, they are not causal or deterministic of addictive behavior. Evidence from Study 3 shows that presenting evidence for the malleability of addiction in this way has the potential to influence successful cessation.

In summary, three studies applied the theory of mindset to addictive behaviors and has yielded novel insights about how smokers' beliefs about the permanence of addiction can be measured, how they relate to motivational factors and attributions for failure, and how changing mindset may be a path to changing behavior. Given the increasing public health burden of addiction, this work provides a new perspective on how targeting people's beliefs about addiction may be beneficial for reducing addictive behavior.

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Table 1

Factor Analysis and Descriptive Statistics of Addiction Mindset Scale Items from Study 1

Scale items	Factor Loadings	Mean (SD)
A person's addiction can never fully leave them.	.77	3.74 (1.40)
People can change how addicted they are.	-.74	2.78 (1.26)
Some people will always be addicted, and there's not much they can do about it.	.76	3.93 (1.40)
You can't really change how addicted you are.	.74	4.40 (1.26)
Anyone can always overcome an addiction.	-.75	2.94 (1.38)
If they keep trying despite setbacks, people can get over an addiction.	-.77	2.31 (1.03)

Note. All six items load heavily on a single factor, designated as fixed vs. growth mindset of addiction.

Table 2

This table shows AMS scores among different demographic subgroups in the sample recruited for in Study 1.

Demographic Group	**N**	***M* (AMS)**	**SD**	***t***	***p***
Smoking status				3.69	<.001
Smoking	300	3.99	0.99		
Not smoking	300	4.28	0.94		
Gender				2.42	.01
Male	302	4.23	1.02		
Female	298	4.03	0.92		
Race				1.65	.09
White	506	4.10	0.96		
Non-White/minority	94	4.28	1.05		
Ethnicity				0.16	.87
Hispanic	63	4.11	0.93		
Non-Hispanic	537	4.13	0.98		
Education				1.65	.10
High school or less	81	4.30	1.13		
Greater than High School	519	4.11	0.95		
Employment status				-1.05	.29
Employed	503	4.03	0.95		
Unemployed	97	4.15	0.98		

AMS = Addiction Mindset Scale

Table 3

Bivariate correlations between measures used in Study 2

	AMS	CPD	FTND	Quit attempts	Motivation	Commitment	Self-efficacy	Perceived barriers
AMS								
CPD	.07							
FTND	-.02	.38**						
Quit attempts	.04	-.09	-.05					
Motivation	.18*	-.07	-.05	.30**				
Commitment	.37*	-.14	-.10	.20**	.52**			
Self-efficacy	.36**	-.17*	-.20**	.26**	.36**	.60**		
Perceived barriers	-.28**	.32**	.15*	-.14*	-.10	-.38**	-.42**	

Note. AMS Addiction Mindset Scale, CPD Cigarettes per day, FTND Fagerstrom Test of Nicotine Dependence
*$p < .05$. **$p < .01$

Table 4

Regression analysis from Study 2 predicting smoking related variables from AMS score, age, cigarettes per day and quit attempts.

Variables	Adj. R^2	β	Weight (B)	95% CI for B	*t*-value	*p*-value
DV: Motivation	0.10					
AMS		0.17	0.37	0.07-0.68	2.42	.02
Age		0.01	0.01	-0.03-0.03	0.17	.87
CPD		-0.07	-0.01	-0.04-0.01	0.90	.37
Quit attempts		0.28	0.09	0.05-0.14	4.12	<.001
DV: Commitment	0.17					
AMS		0.37	0.32	0.20-0.43	5.50	<.001
Age		0.01	0.00	-0.01-0.01	0.13	.10
CPD		-0.15	-0.01	-0.02-0.00	-2.18	.03
Quit attempts		0.16	0.02	0.00-0.04	2.35	.02
DV: Self-efficacy	0.18					
AMS		0.33	0.33	0.86-2.18	5.05	<.001
Age		-0.13	-0.01	0.20-0.45	-1.94	.05
CPD		-0.13	-0.01	-0.03-0.01	-1.87	.06
Quit attempts		0.22	0.03	0.01-0.05	3.30	.001
DV: Perceived barriers	0.19					
AMS		-0.29	-0.11	-0.17- -0.06	-4.41	<.001
Age		-0.11	-0.01	-0.01-0.00	-1.68	.09
CPD		0.36	0.01	0.01-0.02	5.34	<.001
Quit attempts		-0.09	-0.01	-0.01-0.00	-1.40	.16
DV: Ability attribution	0.04					
AMS		-0.13	-0.12	-0.26-0.03	-1.63	.11
Age		0.20	0.02	0.01-0.04	0.20	.01
CPD		0.02	0.00	-0.01-0.1	0.02	.75
Quit attempts		0.05	0.01	-0.01-0.03	0.05	.45
DV: Effort attribution	0.01					
AMS		0.17	0.19	0.03-0.36	2.30	.02
Age		0.04	0.01	-0.01-0.02	0.57	.57
CPD		0.01	0.00	-0.01-0.01	0.11	.91
Quit attempts		0.05	0.01	-0.02-0.03	0.64	.52

Note. AMS – Addiction Mindset Scale. Higher scores indicate more growth mindset. CPD Cigarettes per day.

Table 5

Baseline demographics, self-reported mental health, smoking history and behavior in the Study 3.

	Total (N=398)	Control (N=199)	Intervention (N=199)	*p*-value
Demographics				
Age mean (SD)	42.0 (12.3)	42.0 (12.5)	42.1 (12.0)	.88
Male	165 (41%)	84 (42%)	81 (41%)	.84
Caucasian	309 (79%)	157 (79%)	152 (78%)	.99
African American	60 (15%)	32 (16%)	28 (14%)	.75
Asian	1 (<1%)	1 (<1%)	0 (0%)	>0.99
Native American or Alaska Native	3 (1%)	1 (<1%)	2 (1%	.98
Native Hawaiian or Pacific Islander	1 (<1%)	0 (0%)	1 (<1%)	.99
More than one race	19 (5%)	8 (4%)	11 (6%)	.60
Hispanic	45 (11%)	20 (10%)	25 (13%)	.53
Married	125 (31%)	57 (29%)	68 (34%)	.28
Working	195 (49%)	99 (50%)	96 (48%)	.84
HS or less education	156 (39%)	78 (39%)	78 (39%)	>.99
LGB	68 (17%)	39 (20%)	29 (15%)	.23
Self-Reported Mental Health				
Anxiety disorder	146 (37%)	77 (39%)	69 (35%)	.47
Depression	144 (36%)	76 (38%)	68 (34%)	.47
Bipolar disorder	56 (14%)	30 (15%)	26 (13%)	.67
Schizophrenia	9 (2%)	3 (2%)	6 (3%)	.50
Alcohol abuse	16 (4%)	7 (4%)	9 (5%)	.80
Drug abuse	24 (6%)	9 (5%)	15 (8%)	.29
No mental health conditions	199 (50%)	94 (47%)	105 (53%)	.32
Smoking Behavior				
FTND score, mean (SD)	5.84 (2.09)	5.87 (2.11)	5.82 (2.08)	.81
High nicotine dependence	234 (59%)	117 (59%)	117 (59%)	>0.99
Cigarettes per day, mean (SD)	19.0 (16.2)	19.0 (16.5)	19.1 (15.9)	.94
Smokes more than half pack per day	279 (70%)	137 (69%)	142 (71%)	.66
Smokes more than one pack per day	84 (12%)	43 (22%)	41 (21%)	.90

Used e-cigarettes at least once in past month	85 (21%)	37 (19%)	48 (24%)	.22
Quit attempts in past 12M, mean (SD)	1.0 (2.5)	0.8 (2.0)	1.1 (2.9)	.33
Self-efficacy	71.6 (22.6)	75.2 (21.2)	68.0 (23.4)	.002
Commitment to quitting	4.00 (0.71)	4.04 (0.71)	3.96 (0.71)	.31
Friend & Partner Smoking				
Close friends who smoke, mean (SD)	2.5 (1.8)	2.5 (1.8)	2.4 (1.8)	.48
Number of adults in home who smoke, mean (SD)	1.5 (0.8)	1.6 (0.9)	1.5 (0.8)	.27
Living with partner who smokes	136 (34%)	63 (32%)	73 (37%)	.34
Theory-Based Measures				
AMS score, mean (SD)	3.33 (0.86)	3.31 (0.86)	3.35 (0.87)	.69
AIS score, mean (SD)	2.86 (0.38)	2.87 (0.35)	2.85 (0.40)	.52

Note. SD = standard deviation, LGB = Lesbian, Gay or Bisexual, FTND = Fagerstrom Test for Nicotine Dependence, AMS = Addiction Mindset Scale, AIS = Avoidance and Inflexibility Scale. P-values are reported for t-tests (for continuous variables) and Fisher's exact tests (for categorical variables) comparing demographics across groups.

Table 6

Baseline characteristics and their association with number of MIND tips viewed (pages as well as tips).

	Num. MIND Tip Pages Viewed (max = 58)		Num. MIND Tips Viewed (max = 8)	
Demographics	Estimate	*p* value	Estimate	*p* value
Age	0.52	<.001	0.07	<.001
Male	-4.39	0.21	-0.65	0.19
Caucasian	2.04	0.64	0.36	0.65
Hispanic	4.50	0.38	0.64	0.38
Married	2.46	0.50	0.36	0.48
Working	-3.42	0.32	-0.45	0.35
HS or less education	3.92	0.26	0.64	0.20
LGB	-0.36	0.94	-0.01	0.99
Addiction Mindset				
AMS score	0.68	0.73	0.12	0.66
Mental Health				
Self-report anxiety disorder	-8.37	0.02	-1.16	0.02
Self-report depression	-8.15	0.02	-1.09	0.03
Self-report bipolar disorder	-11.4	0.02	-1.87	0.008
Self-report schizophrenia	-19.5	0.05	-2.92	0.04
Self-report alcohol abuse	2.16	0.79	0.30	0.80
Self-report drug abuse	-13.61	0.03	-1.83	0.04
Self-report no mental health conditions	10.32	0.002	1.4	0.003
Smoking Behavior				
Nicotine dependence score	-2.33	0.004	-0.33	0.004
High nicotine dependence	-10.51	0.002	-1.47	0.002
Cigarettes per day	-0.43	0.03	-0.06	0.03
Smokes more than half pack per day	-7.58	0.04	-1	0.06
Smokes more than one pack per day	-3.92	0.35	-0.51	0.39
Smoked for 10 or more years	2.84	0.57	0.40	0.57
Used e-cigarettes at least once in past month	-0.15	0.97	0.06	0.91

Quit attempts in past 12M	0.04	0.95	0	0.99
At least one quit attempt in past 12M	1.99	0.59	0.50	0.34
self-efficacy (confidence)	0	1	0	0.81
Commitment to quitting	2.46	0.31	0.33	0.33
Friend & Partner Smoking				
Close friends who smoke	-2.40	0.01	-0.33	0.01
Number of adults in home who smoke	-4.15	0.06	-0.61	0.05
Living with partner who smokes	1.07	0.57	0.17	0.50
ACT Theory-Based Measure				
Acceptance of thoughts	7.07	0.09	0.98	0.10
Acceptance of feelings	6.89	0.07	0.90	0.09
Acceptance of physical triggers	1.21	0.70	0.12	0.77
AIS Scale	6.61	0.13	0.86	0.16
Alcohol Use				
Any alcohol use in past month	-4.05	0.24	-0.55	0.25
Heavy drinker	-4.63	0.42	-0.58	0.78

Note. Estimates reported are regression coefficients from models estimating associations between viewing of MIND tips and baseline characteristics. Each characteristic was entered in a separate equation. ACT = Acceptance and Commitment Therapy, AIS = Avoidance and Inflexibility Scale, LGB = self-identified Lesbian, Gay or Bisexual, AMS = Addiction Mindset Scale.

Table 7

Smoking cessation and engagement with cessation program at 2-month follow up in Study 3.

Outcome variable	Overall (n = 398)	Control (n = 199)	Intervention (n = 199)	OR/IRR/Estimate (95% CI)[a]	*p*-value
Cessation					
30-day PPA, complete case	56 (15%)	25 (13%)	31(17 %)	1.64 (0.90, 3.00)	.10
30-day PPA, missing=smoking	56 (14%)	25 (12%)	31(16%)	1.54 (0.86, 2.76)	.15
Change in CPD	-3.81 (7.88)	-3.01 (8.37)	-4.66(7.27)	-1.90 (-4.00, 0.18)	.07
Number of quit attempts	4.36 (8.49)	4.11 (7.60)	4.62(9.35)	1.20 (0.86, 1.67)	.28
Change in FTND	-1.33 (1.92)	-1.11 (1.73)	-1.55(2.08)	-0.53 (-1.07, 0.01)	.05
Engagement with app					
At least 1 login	287 (72%)	151 (76%)	136 (68%)	0.69 (0.44, 1.07)	.10
Number of logins	20.54 (34.16)	21.61 (37.74)	19.46 (30.20)	0.90 (0.61, 1.21)	.38
Number of days used	11.96 (16.90)	11.73 (16.14)	12.19 (17.64)	1.00 (0.72, 1.37)	.97
Completion certificate	119 (30%)	58 (30%)	61 (31%)	1.08 (0.70, 1.65)	.74
Number of ACT exercises completed	11.92 (19.93)	11.74 (17.03)	12.12 (22.50)	0.95 (0.69, 1.32)	.77

Note. [a]OR indicates odds ratio in logistic regression for binary variables, IRR indicates incident rate ratio in negative binomial regression for count variables (i.e. number of times logged in and length of use of website) and point estimate indicates difference between arms for continuous variables. Numbers presented in first three columns represent mean (SD) for continuous variables, or n (percentage) for categorical variables. Results are adjusted for two stratification factors (heavy smoking, education). Cessation results are adjusted for baseline self-efficacy. FTND = Fagerstrom Test for Nicotine Dependence, CPD = Cigarettes Per Day, ACT = Acceptance and Commitment Therapy (modules inside SmartQuit).

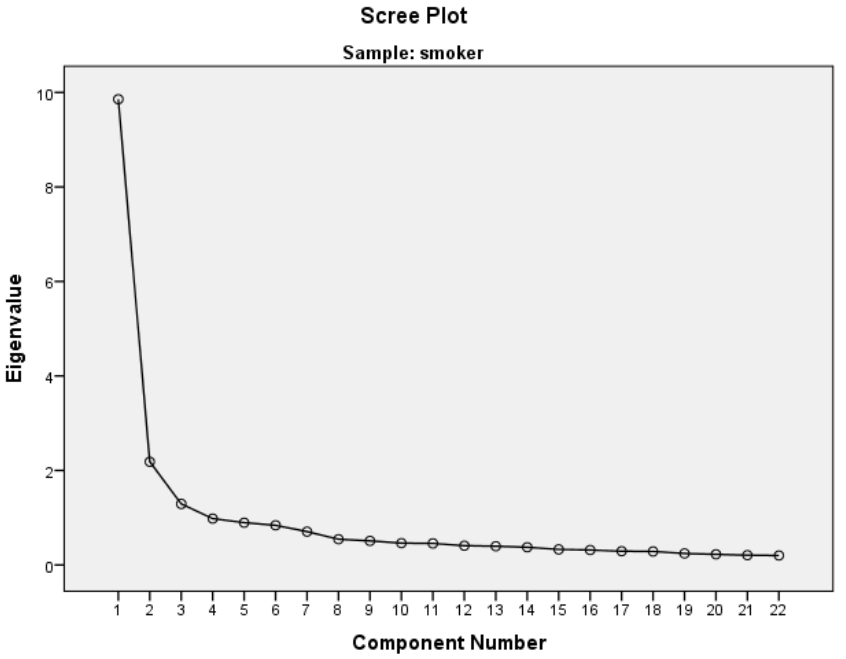
Table 8

Modified Intent-to-treat analysis in Study 3: Smoking cessation and engagement with cessation program at 2-month follow up among participants with at least 1 login to their respective interventions.

Outcome variable	Overall (n = 266)	Control (n = 151)	Intervention (n = 115)	OR/IRR/Estimate (95% CI)[a]	*p*-value
Cessation					
30-day PPA, complete case	42 (17%)	19 (13%)	23 (21%)	2.13 (1.06, 4.27)	.03
30-day PPA, missing=smoking	42 (16%)	19 (13%)	23 (20%)	2.10 (1.45, 4.19)	.03
Change in CPD	-4.15 (7.74)	-3.53 (7.57)	-4.96 (7.96)	-1.26 (-3.97, 1.27)	.33
Number of quit attempts	5.25 (9.75)	4.66 (8.38)	6.02 (11.30)	1.33 (0.88, 1.91)	.18
Change in FTND	-1.48 (1.91)	-1.18 (1.69)	-1.88 (2.12)	-0.78 (-1.45, -0.11)	.02
Engagement with app					
Number of logins	30.14 (38.13)	28.48 (41.13)	32.31 (34.00)	1.08 (0 .83, 1.42)	.55
Number of days used	17.46 (18.10)	15.46 (16.91)	20.1 (19.31)	4.14 (-0.23, 8.50)	.06
Completion certificate	116 (44%)	58 (38%)	58 (50%)	1.58 (0.86, 2.59)	.07
Number of ACT exercises completed	17.41 (22.32)	15.48 (18.02)	19.96 (26.82)	3.72 (-1.66, 9.11)	.18

Note. [a]OR indicates odds ratio in logistic regression for binary variables, IRR indicates incident rate ratio in negative binomial regression for count variables (i.e. number of times logged in and length of use of website) and point estimate indicates difference between arms for continuous variables. Numbers presented in first three columns represent mean (SD) for continuous variables, or n (percentage) for categorical variables. Results are adjusted for two stratification factors (heavy smoking, education). Cessation results are adjusted for baseline self-efficacy. FTND = Fagerstrom Test for Nicotine Dependence, CPD = Cigarettes Per Day, ACT = Acceptance and Commitment Therapy (modules inside SmartQuit).

Figure 1. Scree plots showing factor analysis solutions for smokers and non-smokers separately.



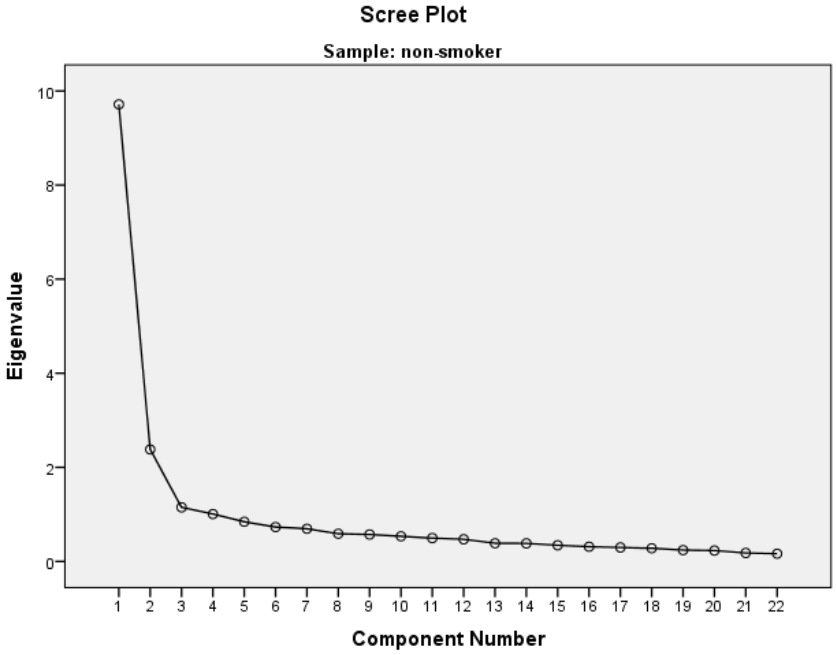
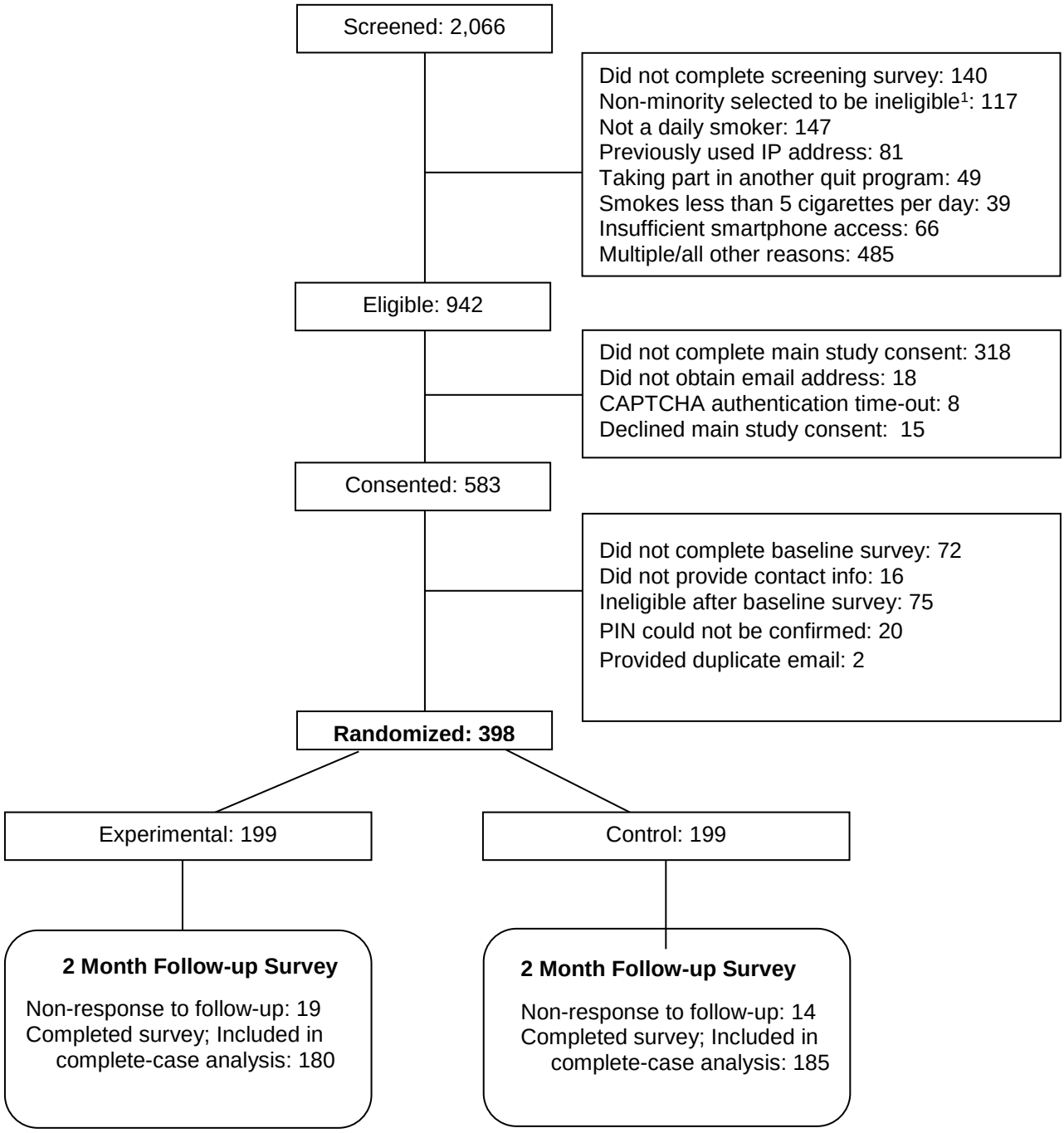


Figure 2. Participant Flow Diagram



[1] In order to increase enrollment of racial and ethnic minorities, some non-minorities who were otherwise eligible for study enrollment were randomly selected to be excluded.

Figure 3a. Histogram of number of MIND Tips viewed by participants in the experimental group.

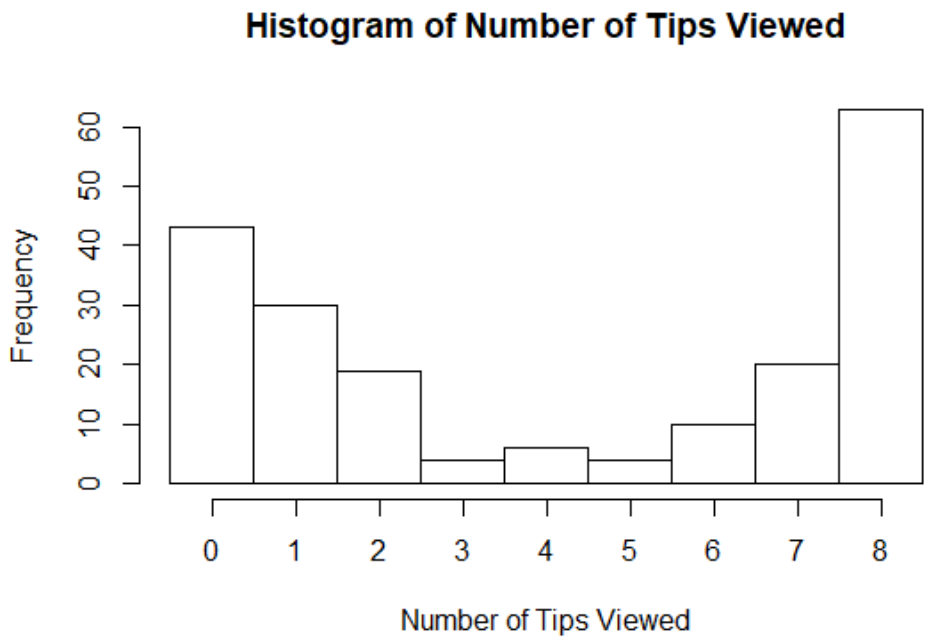


Figure 3b. Histogram of number of days SmartQuit was used among participants with 1 login. A total of 111 people had 0 logins.

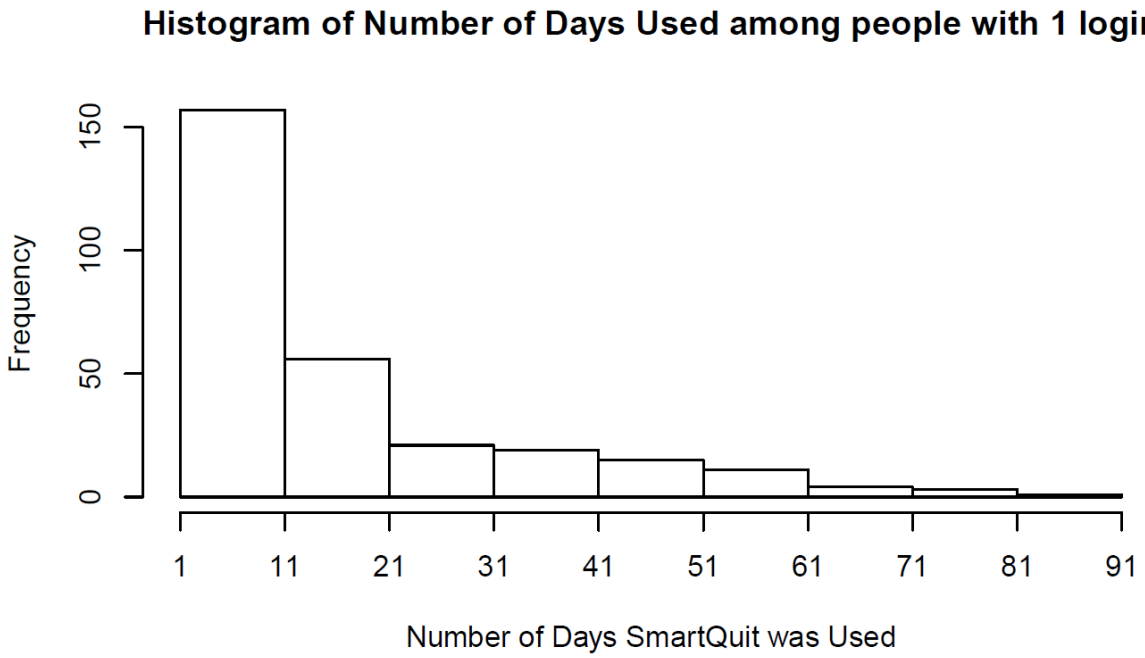
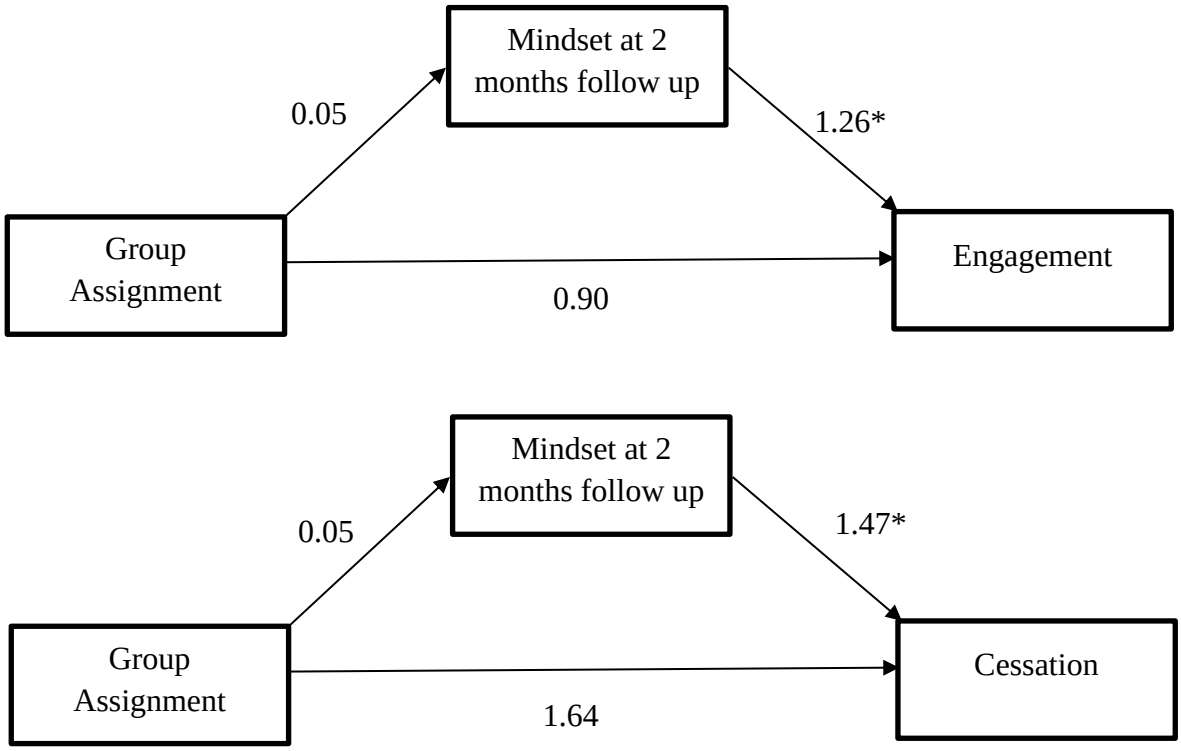
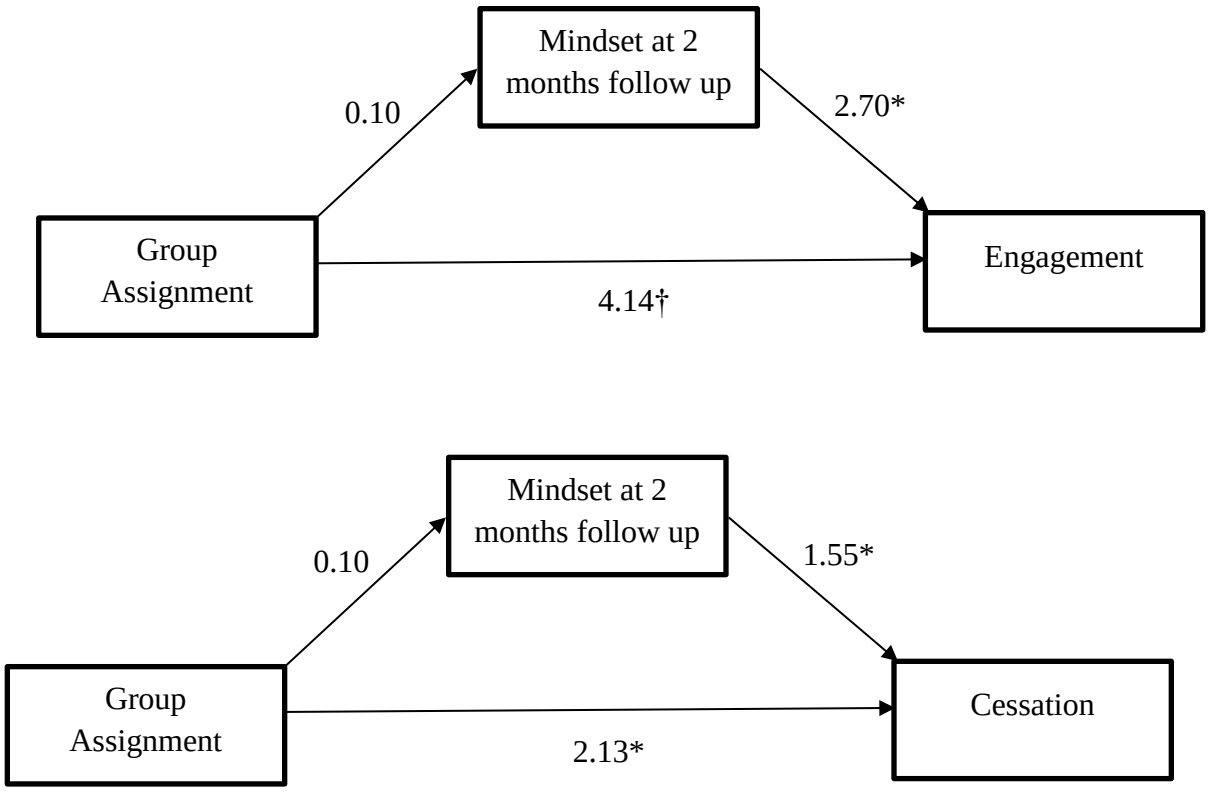


Figure 4. Mediation Models for Intent-to-treat group



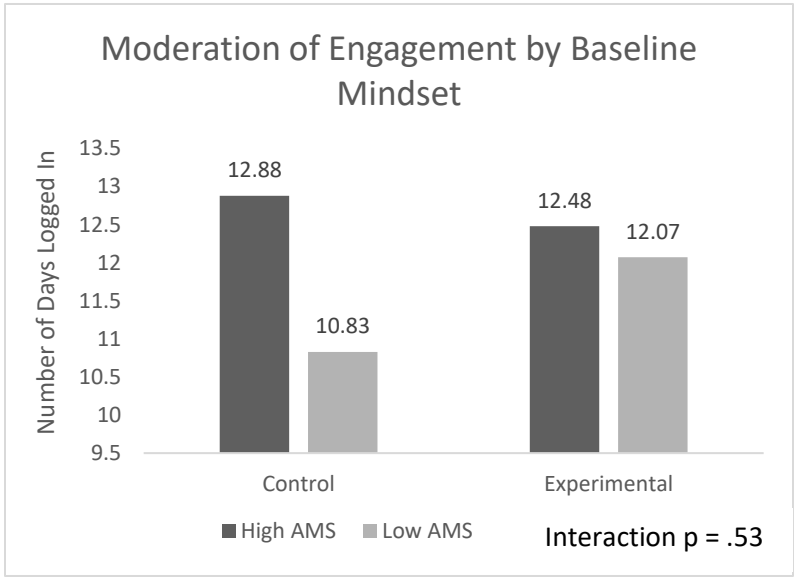
Note. *$p<.05$

Figure 5. Mediation Models for Per-Protocol Subgroup



Note. †p<.10 **p*<.05

Figure 6. Moderation tests with baseline mindset score in intent-to-treat group.



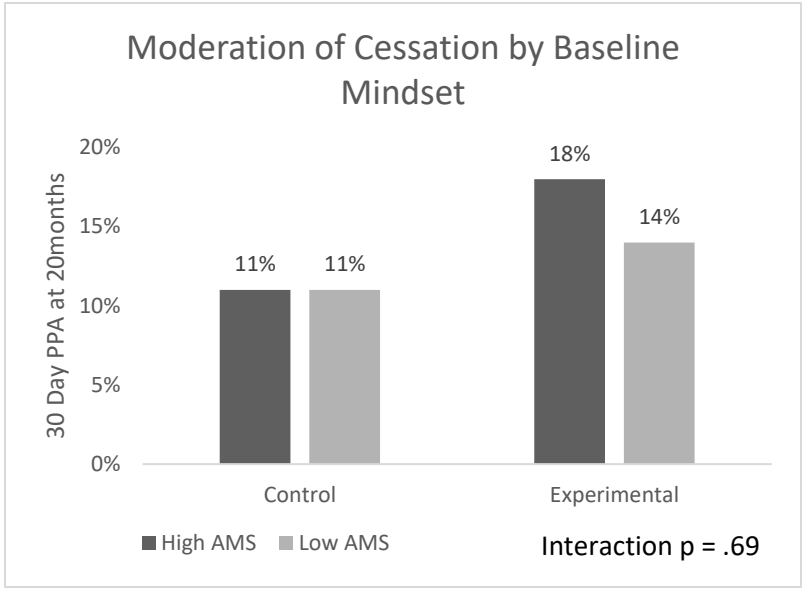
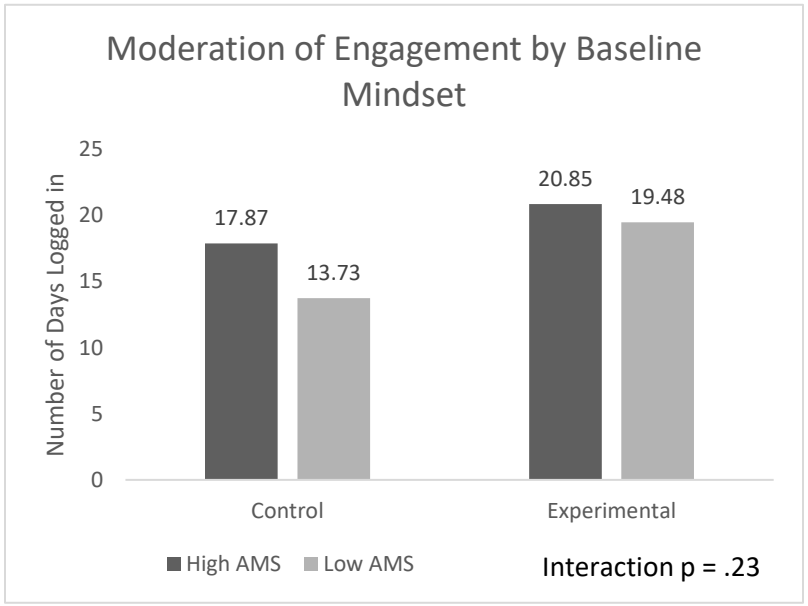


Figure 7. Moderation tests with baseline mindset score in modified intent-to-treat group.



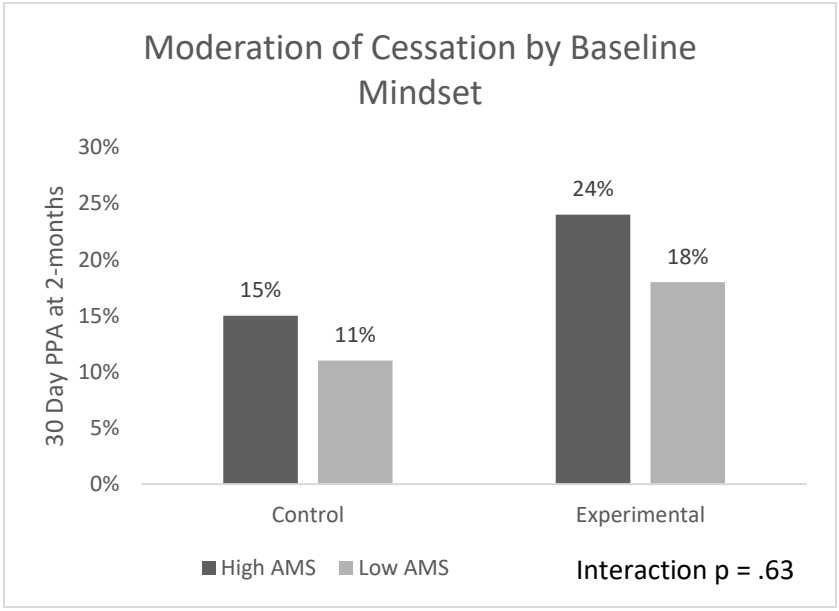
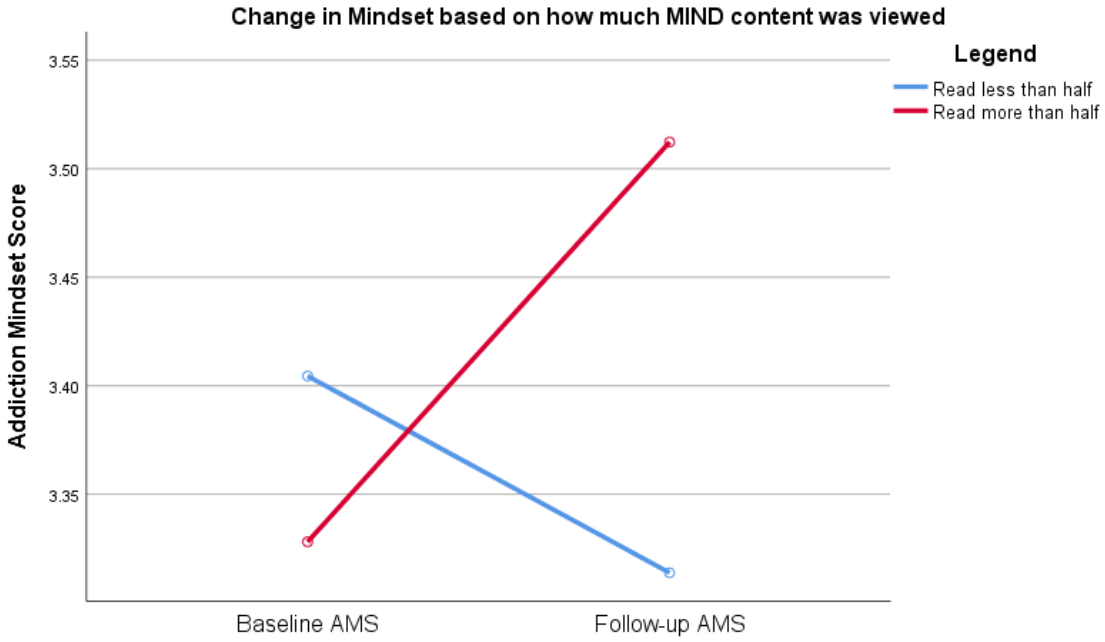


Figure 8. Change in mindset scores within the intervention group as a function of how much MIND content participants viewed.



$F\,(1,175) = 3.64, p = .058$

Appendix – A. Addiction Mindset Scale

Below are some statements that people make about addiction, please choose whether you agree or disagree with each of them. In this survey, we are only referring to addiction to nicotine, i.e., from cigarette smoking. Please keep this in mind while reading the statements.

The options are coded (1) – (5). Items #3, #4 and #5, the growth mindset items, are reverse coded. The average is used as an AMS score, where higher scores indicate more growth mindset.

	Strongly Agree	**Agree**	**Mostly Agree**	**Mostly Disagree**	**Disagree**	**Strongly Disagree**
1. A person's addiction can never fully leave them.	❍	❍	❍	❍	❍	❍
2. Some people will always be addicted, and there's not much they can do about it.	❍	❍	❍	❍	❍	❍
3. People can change how addicted they are.	❍	❍	❍	❍	❍	❍
4. Anyone can always overcome an addiction.	❍	❍	❍	❍	❍	❍
5. If they keep trying despite setbacks, people can get over their addiction.	❍	❍	❍	❍	❍	❍
6. You can't really change how addicted you are.	❍	❍	❍	❍	❍	❍

Appendix – B. All 22 items used in Study 1 and percent of participants who agreed/disagreed with clarity.

	Agreement with "was the meaning of this statement very clear?"	
	Smoker	Non-smoker
Fixed Items		
"The extent to which a person is addicted is something basic about them and it can't be changed very much."	95%	96%
"A person can learn new ways to break a habit, but they can't really change their basic addiction."	98%	98%
"Whether a person is addicted or not is deeply ingrained in that person. It cannot be changed very much"	98%	98%
"Even with great effort, some people are not able to change their addiction."	99%	100%
"Once you get addicted, the addiction is always a part of you that won't ever change even if you manage to stop using the substance."	98%	99%
"People who are addicted will always be addicted to some extent, and they can't really do much to change it."	99%	98%
"Once an addict, always an addict"	100%	99%
*"You can't really change how addicted you are."	99%	99%
*"A person's addiction can never fully leave them"	100%	98%
*"Some people will always be addicted, and there's not much they can do about it."	100%	99%
"Addiction is something you either have or don't have."	100%	98%
Growth items		
"Addiction is a series of choices, and people can end their addiction by making different choices."	97%	99%
"With effort, people can get over their addiction."	98%	99%
"No matter how addicted you are, you can always change quite a bit."	98%	99%
*"People can always substantially change how addicted they are."	97%	99%

"People do get addicted, but they can recover from the addiction with effort."	98%	99%
"If an addicted person gets help, they will be able to change."	99%	99%
"You can be addicted a little or a lot, and that can change."	98%	96%
"People who learn from their addiction can overcome it."	99%	97%
"People can learn to control their addictions."	100%	100%
*"Anyone can always overcome an addiction."	98%	99%
*"If they keep trying despite setbacks, people can get over their addiction."	99%	99%

Note. *items that were included in the final scale are marked.

Appendix – C. Shows goodness of fit indices for a confirmatory factory analysis of all six items used to measure AMS from Study 2 data (N = 200).

Fit Index Type	Observed Value	Acceptable Value	Fit Level
cmin/df	9.30	<5	Bad fit
Comparative Fit Index (CFI)	.860	>.90	Bad fit
Tucker-Lewis Index (TLI)	.767	>.95	Bad fit
SRMR	.069	<.09	Good fit
RMSEA	.204	<.10	Bad fit

Appendix- D. Baseline characteristics and their association with cessation, number of logins to SmartQuit, and number of days SmartQuit was used in Study 3.

	Cessation: 30-day PPA[a]		Number of Logins to SmartQuit		Number of days SmartQuit was used	
Demographics	OR (95% CI)	*p*	IRR (95% CI)	*p*	IRR (95% CI)	*p*
Age	0.98 (0.96, 1.01)	0.26	1.03 (1.01, 1.04)	<.001	1.03 (1.01, 1.03)	<.001
Male	1.29 (0.72, 2.28)	0.39	0.91 (0.64, 1.30)	0.61	0.94 (0.67, 1.30)	0.69
Caucasian	0.74 (0.38, 1.44)	0.37	1.40 (0.90, 2.17)	0.14	1.30 (0.87, 1.95)	0.21
Hispanic	0.97 (0.39, 2.43)	0.95	0.99 (0.57, 1.72)	0.97	1.10 (0.66, 1.82)	0.73
Married	0.91 (0.49, 1.72)	0.78	1.00 (0.69, 1.46)	0.99	1.06 (0.74, 1.50)	0.77
Working	1.31 (0.73, 2.30)	0.36	0.95 (0.67, 1.35)	0.77	0.96 (0.69, 1.32)	0.78
HS or less education	0.72 (0.41, 1.29)	0.27	1.47 (1.03, 2.10)	0.03	1.46 (1.05, 2.03)	0.02
LGB	0.65 (0.33, 1.30)	0.23	1.28 (0.81, 2.05)	0.29	1.28 (0.83, 1.97)	0.26
Addiction Mindset						
AMS score	1.21 (0.86, 1.70)	0.27	0.99 (0.80, 1.21)	0.93	1.04 (0.86, 1.26)	0.67
Mental Health						
Self-report anxiety disorder	0.42 (0.21, 0.82)	0.01	0.82 (0.57, 1.18)	0.29	0.81 (0.58, 1.13)	0.22
Self-report depression	0.33 (0.16, 0.68)	0.003	0.52 (0.36, 0.75)	0.004	0.61 (0.44, 0.85)	0.003
Self-report bipolar disorder	1.22 (0.55, 2.66)	0.62	0.82 (0.49, 1.36)	0.44	0.73 (0.46, 1.16)	0.19
Self-report schizophrena	0.68 (0.08, 5.58)	0.72	0.19 (0.05, 0.65)	0.008	0.27 (0.08, 0.84)	0.02
Self-report alcohol abuse	0.91 (0.20, 4.20)	0.91	0.55 (0.22, 1.34)	0.19	0.58 (0.25, 1.33)	0.20
Self-report drug abuse	0.26 (0.03, 2.00)	0.20	0.40 (0.19, 0.84)	0.02	0.44 (0.22, 0.87)	0.02
Self-report no mental health conditions	2.36 (1.29, 4.31)	0.005	1.40 (0.99, 1.98)	0.06	1.36 (0.98, 1.87)	0.06
Smoking Behavior						
Nicotine dependence score	1.07 (0.92, 1.22)	0.36	0.97 (0.89, 1.05)	0.46	0.96 (0.89, 1.04)	0.38
High nicotine dependence	1.45 (0.80, 2.62)	0.22	0.92 (0.65, 1.31)	0.66	0.88 (0.63, 1.22)	0.45
Cigarettes per day	1.01 (0.97, 1.05)	0.55	1.00 (0.98, 1.02)	0.76	0.99 (0.98, 1.02)	0.96
Smokes more than half pack per day	0.98 (0.53, 1.80)	0.95	1.00 (0.68, 1.46)	0.99	0.95 (0.67, 1.35)	0.79

Smokes more than one pack per day	1.23 (0.62, 2.43)	0.55	1.00 (0.65, 1.54)	>.99	0.96 (0.65, 1.43)	0.86
Smoked for 10 or more years	0.70 (0.33, 1.50)	0.36	1.42 (0.86, 2.37)	0.17	1.30 (0.82, 2.09)	0.26
Used e-cigarettes at least once in past month	1.13 (0.58, 2.23)	0.72	1.09 (0.71, 1.67)	0.70	1.20 (0.81, 1.78)	0.37
Quit attempts in past 12M	0.95 (0.70, 1.28)	0.74	0.99 (0.91, 1.08)	0.88	0.99 (0.92, 1.07)	0.90
At least one quit attempt in past 12M	0.74 (0.38, 1.45)	0.38	1.20 (0.81, 1.76)	0.37	1.27 (0.89, 1.81)	0.19
Self-efficacy (confidence)	1.03 (1.01, 1.05)	<.001	0.99 (0.99, 1.00)	0.90	1.00 (0.99, 1.00)	0.63
Commitment to quitting	1.74 (1.10, 2.76)	0.02	1.05 (0.82, 1.34)	0.71	1.07 (0.85, 1.34)	0.58
Friend & Partner Smoking						
Close friends who smoke	0.90 (0.76, 1.06)	0.20	0.93 (0.84, 1.03)	0.15	0.95 (0.86, 1.04)	0.24
Number of adults in home who smoke	0.78 (0.53, 1.15)	0.21	0.95 (0.85, 1.07)	0.40	0.95 (0.85, 1.06)	0.33
Living with partner who smokes	1.13 (0.83, 1.53)	0.43	1.24 (1.02, 1.50)	0.02	1.19 (1.00, 1.41)	0.05
ACT Theory-Based Measure						
Acceptance of thoughts	1.07 (0.54, 2.13)	0.84	0.97 (0.63, 1.48)	0.87	1.10 (0.74, 1.63)	0.63
Acceptance of feelings	0.94 (0.49, 1.80)	0.86	0.96 (0.64, 1.43)	0.84	1.02 (0.71, 1.49)	0.89
Acceptance of physical triggers	1.16 (0.67, 2.00)	0.59	1.14 (0.82, 1.59)	0.44	1.13 (0.83, 1.53)	0.44
AIS Score	1.10 (0.51, 2.37)	0.81	1.06 (0.66, 1.69)	0.82	1.15 (0.74, 1.77)	0.54
Alcohol Use						
Any alcohol use in past month	0.70 (0.39, 1.26)	0.23	0.76 (0.53, 1.07)	0.12	0.71 (0.51, 0.98)	0.04
Heavy drinker	0.65 (0.18, 2.37)	0.52	0.94 (0.50, 1.80)	0.86	0.93 (0.51, 1.68)	0.81

Appendix – E. Growth Mindset Intervention content.

Introduction

Sarah, a mother of two in Tennessee, had been smoking for 25 years.

"I wanted to quit smoking so I could be there for my kids, but it seemed impossible. I know people say 'once a smoker, always a smoker.' But is there really no way to kick this for good?"

Sarah is not alone. Research shows that most smokers want to know more about addiction to cigarettes: is addiction permanent? Or can it be overcome?

Smokers' Top 5 Questions about Addiction

1. Does smoking change our brains permanently?
2. Do some people have an addictive personality?
3. How long does withdrawal last?
4. Does addiction run in the family?
5. Can you do anything about urges to smoke even after you quit?

We have the answers

Every 3 days, you will receive an email with a new tip answering these questions.

Complete with the latest science and featuring stories of people who have quit like Sarah, this program will explore what it means to be addicted and how to free your body and mind from it.

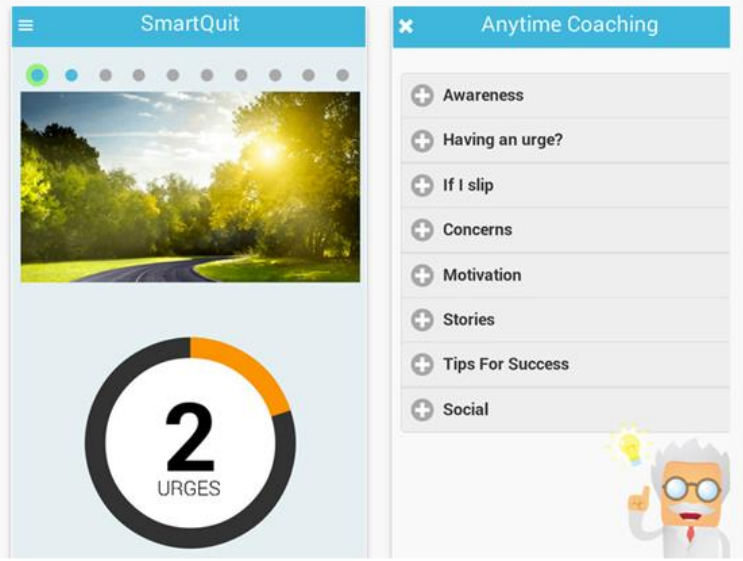
This program is made to go hand in hand with SmartQuit, by helping you stay committed on your journey.

SmartQuit is here to help.

SmartQuit has exercises that are scientifically proven to help you quit smoking.

At the end of each emailed exercise, you'll get a SmartQuit tip. These tips have been specifically picked for you by previous program participants. Good luck!

In a scientific study, people who completed the SmartQuit program were 4 times more likely to quit!



From someone who has quit: Sarah

"Quitting is the hardest thing I've had to do. I couldn't have done it without the support from this program. SmartQuit helps with the urges and the emails make you open your eyes and look at addiction for what it is. It was nice to have this kind of support right there in my pocket as I went about my busy day."

(Sarah, 42 years old, a program user is now completely smoke-free.)

MIND TIP #2: Managing withdrawal

Withdrawal symptoms

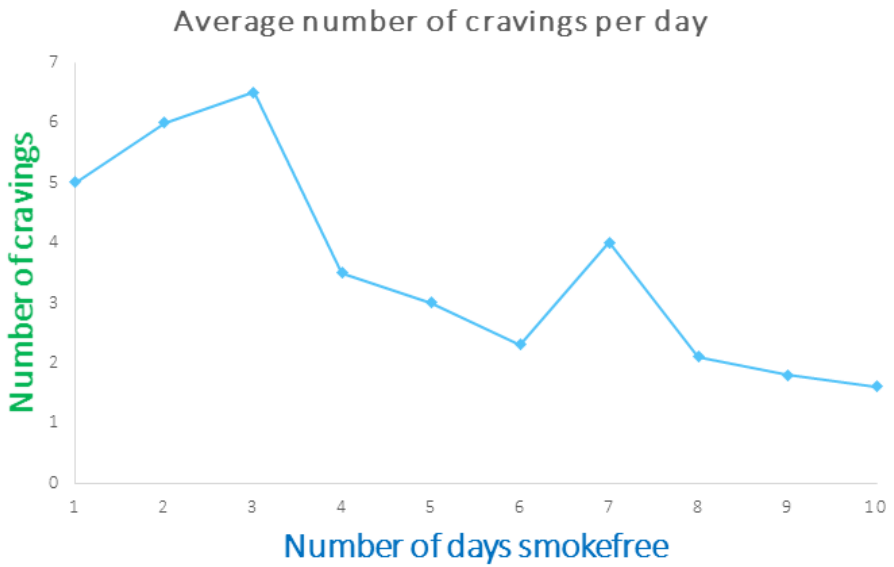
When you quit smoking, you may have withdrawal symptoms such as:

- Cravings for cigarettes,
- Feeling irritable, anxious or depressed
- Headaches
- Feeling like eating more
- Difficulty sleeping or concentrating on your work

Here's how withdrawal progresses:

After quitting smoking	What happens
4 hours after your last cigarette	Withdrawal symptoms begin 
3 – 5 days later	Withdrawal is usually strongest 
2 weeks later	Withdrawal tends to ease up and eventually disappear 

Cravings tend to decrease as you stay quit



From someone who has quit: Rachel

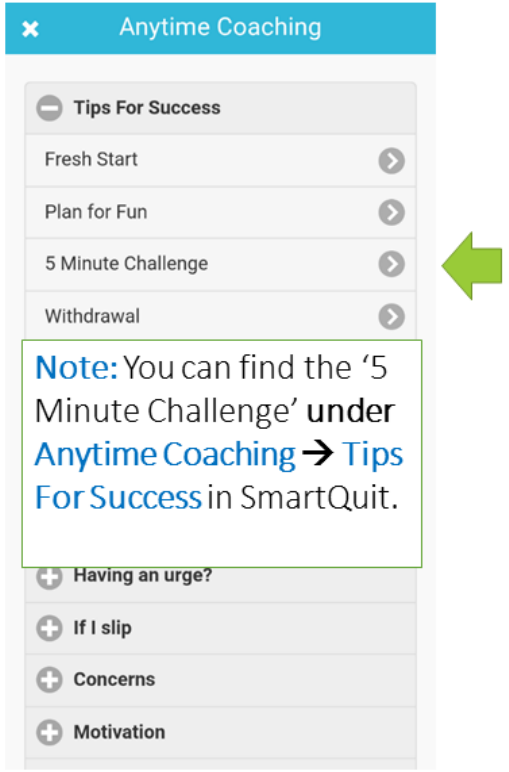
"I finally quit after nearly 20 years of smoking. At first the cravings were pretty bad and I had really bad headaches. It was hard to wake up and not have that morning cigarette. I felt like it would never get better. It was slow, but over the first couple of weeks and then months, I got my life back."

(Rachel is 41 years old and works in a restaurant in Pennsylvania. She used to smoke over half a pack a day for years. She is now celebrating her fourth year smoke-free.)

SmartQuit Tip!

Rachel's Tip:

"When I had cravings, even a few minutes felt like a long time. There was this tip called 5 minute challenge that helps you see how long cravings actually take. It was pretty helpful."

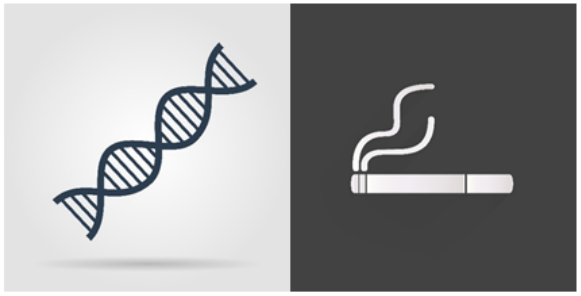


MIND TIP #3:
Is addiction in your genes?

Is addiction genetic?

A lot of people wonder if addiction is genetic.

Currently, we know that genes do have a complicated role in addiction. But we can say this for sure: unlike popular belief, there is no “addiction gene”.



Here's what the science says

Scientists have long been searching for a connection between genes and addiction.

In one recent study, researchers recently looked at over 140,000 gene types across 75,000 people to see if they could find a definite link between genes and addiction.

After looking at the data closely, scientists from the Society for the Study of Addiction concluded that having specific genes does not guarantee that a person will be addicted.

From someone who has quit: Carlos

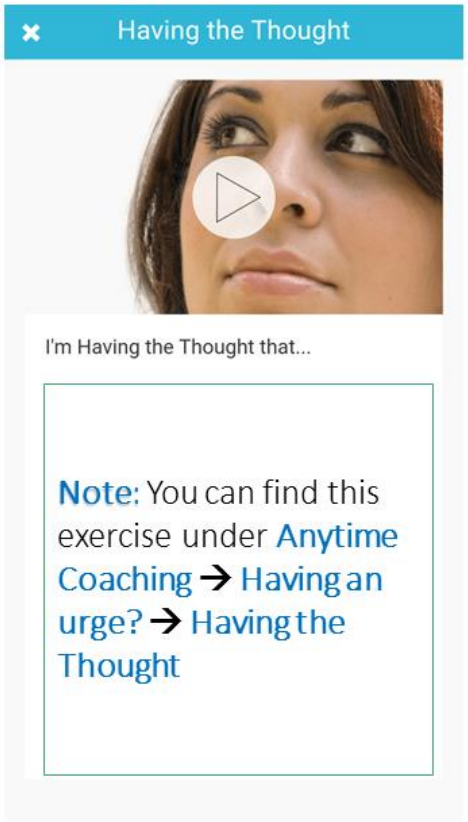
"Most everybody smoked at home. It felt natural for me to smoke. When I couldn't quit smoking I wondered if I would be smoking till I die. But my sister quit smoking. And that's when I figured, the whole "it runs in the family" thing you know, it's not your story. You get to write your own story. So I chose to quit. It wasn't easy, but I did it."

(Carlos, a 51 year old veteran from Texas, used to smoke heavily for over 35 years. He has now quit smoking for good.)

SmartQuit Tip!

Carlos' Tip:

"Worrying about addictive genes used to hold me back from quitting. To deal with these worrying thoughts, I was recommended this exercise from SmartQuit. It helped me learn that I didn't have to smoke just because of my thoughts."

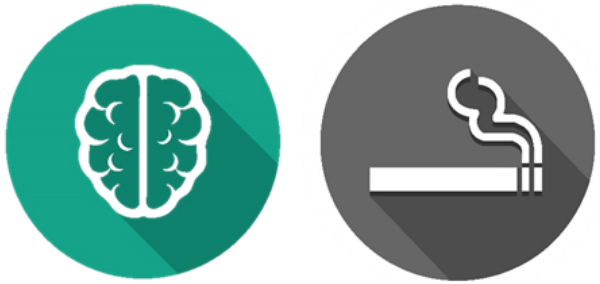


MIND TIP #4:
Does addiction damage the brain?

Addiction's effects on the brain

One concern that many smokers have is whether addiction causes permanent damage to the brain.

We asked experts to explain if addiction causes permanent damage, or whether recovery is possible. To fully understand what happens, we first need to get familiar with how nicotine addiction works.

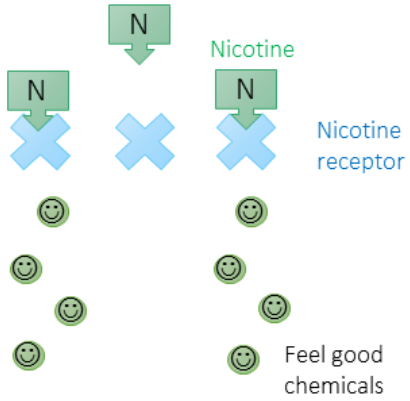


What happens when you smoke?

When you smoke, nicotine goes into your brain and clicks into special cells called receptors. It then releases chemicals that make you feel good.

Not only that, as you smoke more, your brain makes more receptors. But these receptors also cause cravings when you don't smoke. So you smoke more.

Then the whole thing begins all over again: more feel-good chemicals when you smoke but more cravings when you don't. This is how you get addicted.



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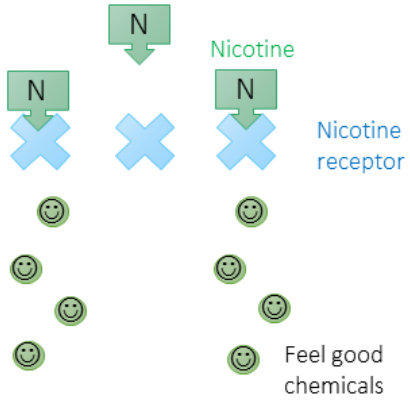
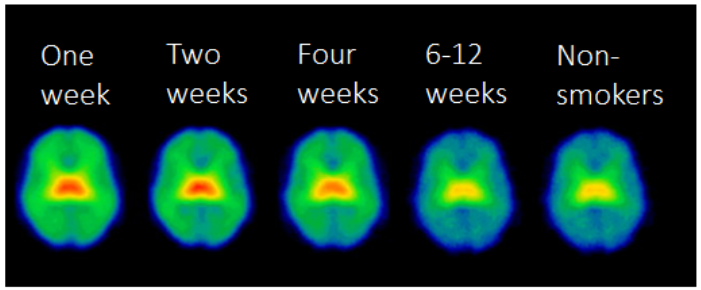


Your brain can recover fully

Research from Yale University shows us that when you continue to stay smoke-free, your brain starts to get rid of all the empty receptors that are causing cravings. You can see this in the brain scan below.

- One week after quitting: the brain is getting rid of the receptors.
- 6-12 weeks after quitting: all the extra receptors are gone. You are now the same as a non-smoker.



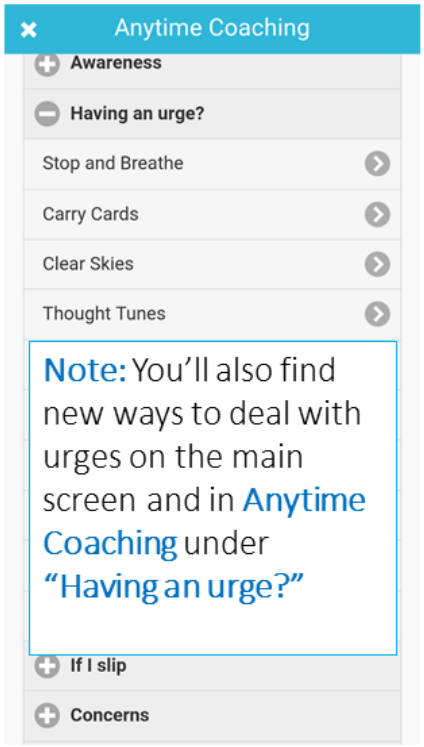
Extra nicotine receptors (shown in green) decrease over time.

SmartQuit Tip!

It takes time for your brain to reset and heal. How do you deal with urges while your brain is recovering?

Jessica's Tip:

"SmartQuit showed me how to deal with urges in a new way – it was different from anything I'd tried before."



From someone who has quit: Jessica

"I smoked since I was in high school and after 24 years, I was struggling to quit. You hear people talk about how addiction has ruined you for good. But this was the first time I heard about recovery. And it gave me hope."

(Jessica, 40 years old, used to smoke about a pack of cigarettes a day for years. She now works for an advertising agency in Michigan and is celebrating her first year smoke-free)

MIND TIP #5:
Addictive Personality

From someone who has quit: Lisa

Lisa, a former smoker from Massachusetts, talks about her struggles with addiction.

"I've always liked trying new things just for the experience. Unfortunately, the one thing I tried and could not stop was cigarettes. When I struggled to quit, my mom said I've always had an addictive personality and it just made sense to me that I couldn't quit."

What do you think?

Is Lisa's mom right? Do some people just have an addictive personality? Does personality play a role in addiction?

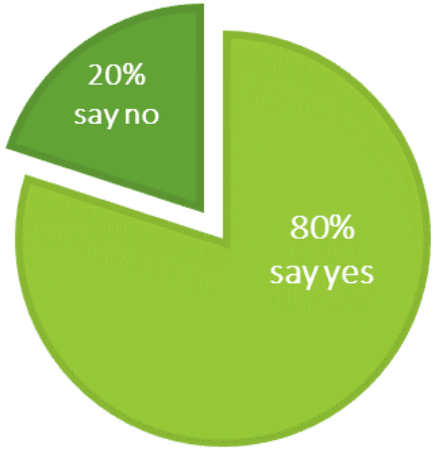
Let's find out what experts think.

The truth about addictive personality

Experts say that "addictive personality" does not guarantee being addicted at all. There's just no way to say for sure that someone will get addicted because of their personality.

For example, take self-control. Sure, there are a lot of people with poor self-control who get addicted. But the majority of people with low self-control don't get addicted.

Does addictive personality discourage you from quitting?



Surveys show that 80% of current smokers believe that an addictive personality makes it difficult for them to quit smoking.

But the truth is, it doesn't have to. As you have just read, experts say that anyone can get addicted, and anyone can overcome addiction too. Yes, no matter what type of personality they have.

From someone who has quit: Lisa

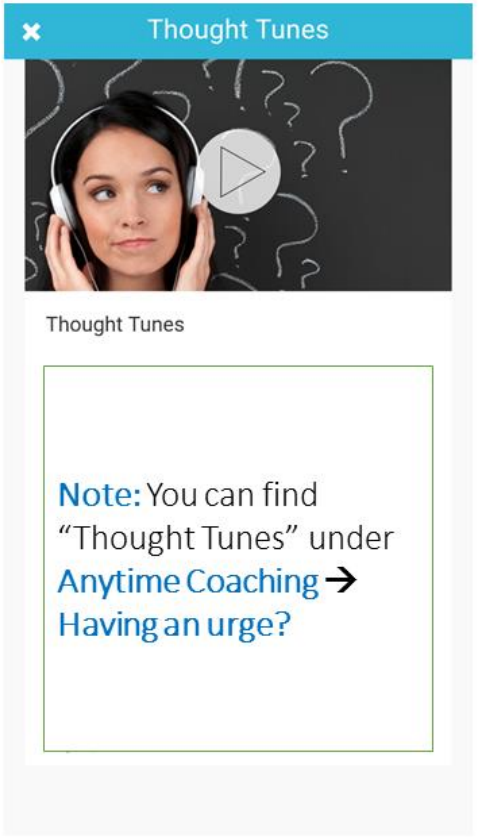
"Thinking that I've an addictive personality and I can't help it was just holding me back. After learning that personality does not matter for quitting, I was able to kick the habit for good. It wasn't easy, but it was worth all the effort because it feels so good to be free at last."

(Lisa, 42, used to smoke about half a pack of cigarettes a day for over ten years. She has been smoke-free for 2 years and counting. She enjoys her job as a ski instructor and is living a healthier, happier life.)

SmartQuit Tip!

Lisa's Tip:

"When you want to quit, thoughts like "I have an addictive personality" or "I lack the willpower" can get in the way. SmartQuit has this one exercise called "Thought Tunes" - that was a really fun way to deal with those interfering thoughts."



MIND TIP #6:
What if I keep having the urge to smoke?

From someone who has quit

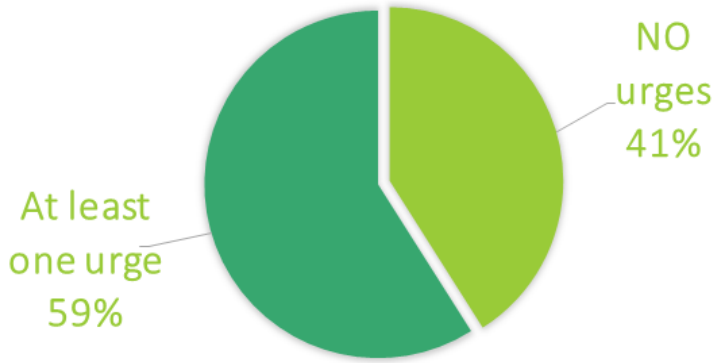
Jenn, a 53 year old homemaker from Arkansas, grew up in a family of smokers.

"I started smoking as a teenager. When I quit, I had been smoking about a pack a day. It was manageable for the most part – but that one cigarette after dinner was a ***real struggle to give up****. Every time I failed to quit smoking was because of the urge to smoke after dinner."*

Urges may still be there

The truth is that even after you quit, you may still have an urge to smoke once in a while. And if you do, you're not alone.

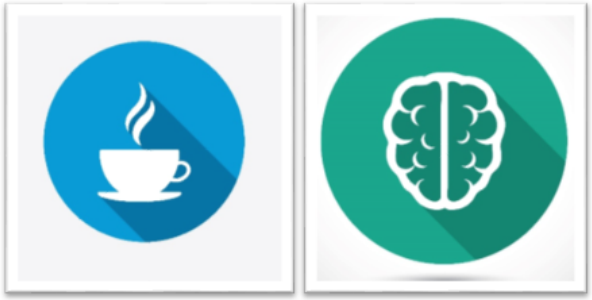
Research has found that more than half of former smokers reported having an urge to smoke, sometimes even years after staying quit.



Habitual urges

Like Jenn's after dinner cigarette, urges that keep coming up even after you quit smoking are usually because of habit. Research shows that habits like smoking with your morning coffee are the most common reason for having repeated urges. These urges can be persistent.

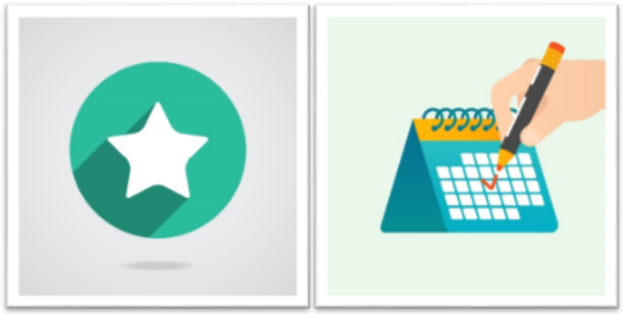
But this doesn't mean you're stuck being addicted. You can change your habits.



Practice is the key

For example, you might practice drinking your coffee or eating your dinner without smoking. “When the urge comes, take a deep breath and pause. Practice pausing and not reaching for your cigarette as you usually might”, suggests Dr. Jonathan Bricker, a behavioral scientist at Fred Hutchinson Cancer Research Center.

“It might sound simple, but we know from research that this practice is helping you change your habit, one day at a time.”



From someone who has quit

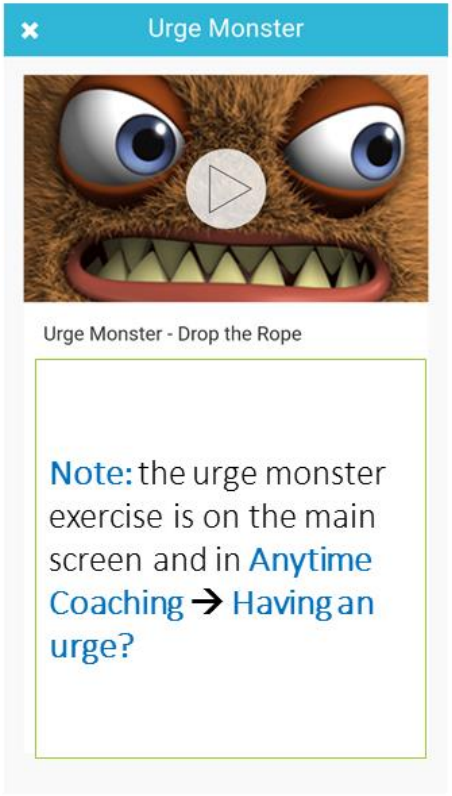
"It took me many months of sitting through dinner and practicing breathing and letting that urge go. But I can now let it pass. Many months of practicing breathing and letting that urge go has paid off."

(Jenn, 53, is now smoke-free after 40 years of smoking.)

SmartQuit Tip!

Jenn's Tip:

"My all time favorite exercise was the urge monster one. The idea of my urges being like monsters is fun and it made me feel better to think of them that way. Maybe it'll help you too."



MIND TIP #7:
What if I slip?

Learning skills takes practice

In this program, you are learning a lot of new skills to help you quit smoking for good. Learning to use these tools is just like learning anything new.

You may not get everything perfect right away. Maybe something doesn't work for you and maybe you slip. You may have to try something new, and that's okay. In fact, did you know over half of all smokers have to try many times before they quit for good?

Trying again leads to success

And the good news: all of that effort is not going wasted at all. Research shows that the more you try, the more likely you are to quit for good.

According to the US Department of Health and Human Services, there are now more people who have quit smoking than people who smoke. Thanks to them, we know this: overcoming addiction is not easy, but it is definitely possible.

Finding a way forward

Even if you slip and smoke a little bit, it does not mean you're addicted for life. Perhaps you could think it is an opportunity to plan and practice.

What are some things that you could do? You could identify your triggers. You could bookmark and use your favorite tip to help with your triggers. By making a plan and sticking with it, you are moving forward to becoming addiction free.

From someone who has quit

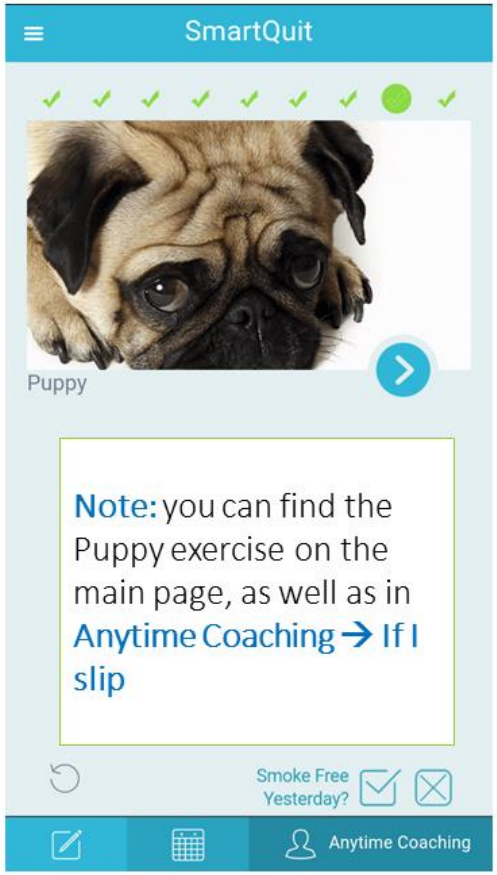
"I had smoked for over 25 years, and I had quit a few times too. Every time I started smoking again, I was really hard on myself, but when I think about it I only smoked more because of it. Last year, I decided to give it my all. When I had an urge to smoke and reached for the cigarette, I would practice one exercise. And if that didn't work, I'd practice another one. I just kept going until I could finally quit."

(Kyle, 47 years old, a security guard in South Carolina, used to smoke more than a pack a day when he quit. Now, he hasn't smoked at all for almost a year.)

SmartQuit Tip

Kyle's Tip:

"I did not quit smoking perfectly – I took a few puffs in the middle when the urge got really bad. Usually I would have given up there, but I looked for help and found this tip about a puppy. It helped me keep on going and not go back to smoking."



MIND TIP #8:
Program highlights

The brain and body can recover

As you smoke, your brain makes extra nicotine receptors that cause cravings when you quit. In about 6-12 weeks after you quit smoking, your brain can clear away the receptors to look just like a non-smoker's.

Withdrawal symptoms like headaches, cravings and insomnia can be difficult to handle, but they usually reduce and fade in about 2 weeks after you quit smoking.

Addiction is not part of who you are

Scientists have not found any one gene that causes addiction. Genes are not your destiny.

Experts say that the so called "addictive personality" is only a myth. It does not have to prevent anyone from quitting. While it is not easy, it is possible to overcome the addiction.

You will always have a way forward

Urges even after you quit smoking are common. Practicing new skills consistently will help you deal with those urges and become addiction free.

Learning new skills will take time and practice. You may not get it perfect right away, and you may slip. If you do, it doesn't mean you're addicted for life. Perhaps you could think of this as a chance to plan and practice.

From someone who has quit

"This was a very creative and innovative program. When it got tough to quit and felt like I'd never get there, I would come back and read some of the brochures to help me feel hopeful again. It made all the difference and I was able to quit for good this time."

(Adam, 56 years old, had smoked since he was 13. When he decided to quit when he was smoking over a pack of cigarettes a day. He is celebrating his 4th year smoke-free at his home in Florida)

Next steps

Getting over an addiction is challenging and there may be times when you're not motivated. That's okay. We're here to help.

Can you stick with it a little longer? Continuous practice of the skills in SmartQuit is scientifically proven to help you get there.

What to do next:

Even if you quit smoking, continue to use the app till you get to 1 month smoke-free. Even if you're just using it to track urges that you let pass, it will help.

Keep on going. We're rooting for you!

-The MIND STUDY team