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Modelling the contribution of negative affect, outcome expectancies and metacognitions to cigarette use and nicotine dependence

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Abstract

Background: Both positive smoking outcome expectancies and metacognitions about smoking have been found to be positively associated with cigarette use and nicotine dependence. The goal of this study was to test a model including nicotine dependence and number of daily cigarettes as dependent variables, anxiety and depression as independent variables, and smoking outcome expectancies and metacognitions about smoking as mediators between the independents and dependents. **Methods:** The sample consisted of 524 self-declared smokers who scored 3 or above on the Fagerstrom Test for Nicotine Dependence (FTND: Uysal et al., 2004). **Results:** Anxiety was not associated with either cigarette use or nicotine dependence but was positively associated with all mediators with the exception of stimulation state enhancement and social facilitation. Depression, on the other hand, was found to be positively associated with nicotine dependence (and very weakly to cigarette use) but was not associated with either smoking outcome expectancies or metacognitions about smoking. Only one smoking outcome expectancy (negative affect reduction) was found to be positively associated with nicotine dependence but not cigarette use. Furthermore one smoking outcome expectancy (negative social impression) was found to be positively associated with cigarette use (but not to nicotine dependence). All metacognitions about smoking were found to be positively associated with nicotine dependence. Moreover, negative metacognitions about uncontrollability were found to be positively associated with cigarette use. **Conclusions:** Metacognitions about smoking appear to be a stronger mediator than smoking outcome expectancies in the relationship between negative affect and cigarette use/nicotine dependence. The implications of these findings are discussed.

Key words: cigarette use; metacognitions about smoking; negative affect; nicotine dependence; smoking outcome expectancies.

1. Introduction

1.1. Anxiety, depression and nicotine use

Research has shown that nicotine users have significantly higher rates of psychiatric comorbidity compared to non-users (Buckley et al., 2005; John, Meyer, Rumpf, & Hapke, 2004; Lasser et al., 2000). In a large study involving over 43,000 computerized personal interviews, Grant and colleagues (2004) reported that the odds ratio of nicotine dependence with a comorbid anxiety disorder ranged between 2.6 for a specific phobia to 4.6 for panic disorder with agoraphobia compared to the general population. Similarly, major depression and dysthymia both demonstrated an odds ratio of 3.3 compared to the general population, with findings slightly higher in individuals who experienced episodes of mania and hypomania.

Leventhal and colleagues (2009) found that specific depressive symptoms, including low mood, hopelessness, decreased appetite and psychomotor agitation were associated with nicotine dependence in psychiatric outpatients and that these associations varied as a function of remission status. With regards to the association between depression and cigarette use, past research has yielded conflicting results. Breslau et al. (2004), for example, reported a significant relationship between the rate of daily cigarette use and the onset of major depression. When looking specifically at the role of anhedonia as a symptom of depression, though, past research has concluded that there is a non-significant correlation with cigarette use (Cook, Spring, & McChargue, 2004; Leventhal, Waters et al., 2009). Without knowing the specific symptoms reported by the participants of this study, it is uncertain whether low mood or anhedonia were more prominent, and this is supported by the very small effect size found in this relationship.

Evidence on the association between anxiety, cigarette use and nicotine dependence is unclear. For example, Moylan and colleagues (2012), who recently conducted a systematic review of the link between anxiety and nicotine dependence, concluded that there appears to be a link between forms of anxiety disorder (panic disorder and generalized anxiety disorder) and nicotine dependence, although this has not been a consistent finding across studies.

Leventhal and Zvolensky (2015) attempted to explain the link between negative affect (anxiety and depression) and nicotine use by formulating a transdiagnostic model based on underlying emotional vulnerabilities implicated in using nicotine. These vulnerabilities include anhedonia, anxiety sensitivity and distress tolerance and collectively appear to underpin negative affect, as well as promote and amplify nicotine use. Furthermore, they claim that the relationship between nicotine use and negative affect becomes self-reinforcing, as nicotine heightens the risk of developing symptoms of emotional disorders (Breslau, Novak, & Kessler, 2004; Kahler, Spillane, Busch, & Leventhal, 2011; Khalid et al., 2012; Leventhal & Zvolensky, 2015).

1.2. Smoking outcome expectancies

Outcome expectancies refer to the anticipated reinforcing and punishing consequences related to using a substance, in both the short and long-term (Rash & Copeland, 2008). Several studies have demonstrated that smoking outcome expectancies predict smoking-related behaviors in both adults (Brandon & Baker, 1991; Copeland, Brandon, & Quinn, 1995) and adolescents (Anderson, Pollak, & Wetter, 2002; Hine, Honan, Marks, & Brettschneider, 2007; Lewis-Esquerre, Rodrigue, & Kahler, 2005; Wahl, Turner, Mermelstein, & Flay, 2005). Although the development of these smoking outcome expectancies is not well understood, parental behavior, interaction with peers, and media representation of smoking might direct and reinforce their formation (Flay et al., 1994; Khoddam & Doran, 2013; Tickle et al., 2006).

The broad spectrum of smoking outcome expectancies has been captured by the Smoking Consequences Questionnaire (SCQ; Brandon & Baker, 1991) which focuses on the ‘subjective expected utility’ of smoking. The SCQ has undergone several iterations that have been used to measure smoking outcome expectancies in adults in the general and clinical populations (Buckley et al. 2005; Copeland et al., 1995; Rash & Copeland, 2008). Current versions suggest 10 different factors used in formulating outcome expectations, including the impact that smoking can have on mood, health, and social engagement. A distinction has been made between positive smoking outcome expectancies, such as the stimulation that smoking provides and the taste of the cigarette that one might enjoy, and negative smoking outcome expectancies, such as the risk to health and potential dependence. The former smoking outcome expectancies are typically linked to use, whilst the latter are typically linked to non use.

Prior research has that found university students and young adults with history of major depression versus no history of depression and higher dispositional negative affect report stronger positive and negative smoking outcome expectancies predicting current smoking status (McChargue et al., 2004; Morrell et al., 2010). In addition, both depression symptoms and proneness have been found to be positively correlated with greater smoking reinforcement expectancies (Friedman-Wheeler et al., 2007). Evidence also suggests that anxiety and anxiety sensitivity may be linked to smoking outcome expectancies (e.g. McNally, 2002; Kirsten et al., 2008).

1.3. Metacognitions about smoking

Metacognitions are defined as the information individuals hold about inner cognitive-affective experiences and coping strategies involved in regulating these experiences (Wells, 1995; 2000). Wells (2000) delineates between two broad categories of metacognitions: positive and negative. Positive metacognitions are conceptualized as beliefs about the benefits of specific coping strategies in helping to regulate cognition and affect (e.g. “Worry will help me to prepare” or “If I ruminate I will understand”). Negative metacognitions, on the other hand, reflect the perceived inability to

control cognitive-affective states and associated coping strategies and the potential dangers that might ensue without this control (e.g., “If I could not control my thoughts, I would not be able to function” or “When I start worrying, I cannot stop”). Research has demonstrated that metacognitions play a key role in the development and maintenance of psychological and behavioral problems including depression, generalised anxiety disorder, obsessive compulsive disorder, post-traumatic stress disorder and social anxiety disorder (for a review see: Wells, 2009; 2013).

Over the last fifteen years there has been a growing interest in the role of metacognitions in addictive behaviours (for a review Spada, Caselli, Nikčević, & Wells, 2015). Positive and negative metacognitions about engagement in addictive behaviors have been identified in alcohol misuse, nicotine dependence and gambling. Positive metacognitions relate to the effects of engaging in addictive behavior as a means of controlling and regulating cognition (e.g. “Smoking helps me to control my thoughts”) and affect (e.g. “Gambling will improve my mood”) (Nikčević & Spada, 2010; Spada, Giustina, Rolandi, Fernie & Caselli, 2014; Spada & Wells, 2006, 2008; Toneatto, 1999). Negative metacognitions concern the perception of lack of executive control over the engagement in the addictive behavior (e.g., “My smoking persists no matter how I try to control it”), uncontrollability of thoughts related to the addictive behavior (“The thought of gambling is stronger than my will”), thought-action fusion (“Thinking about using alcohol can make me drink”), and the negative impact of the engagement in the addictive behavior on cognitive functioning (“Drinking will damage my mind”) (Hoyer, Hacker, & Lindenmeyer, 2007; Nikčević & Spada, 2010; Spada, Giustina, Rolandi, Fernie & Caselli, 2014; Spada & Wells, 2006, 2008; Toneatto, 1999). Table 1 presents findings linking metacognitions with different forms of addictive behaviours, highlighting key studies undertaken in the area of smoking and nicotine dependence. These show that metacognitions about smoking have been found to be predictors of both cigarette use and nicotine dependence. In addition, both anxiety and depression have been found to be directly associated with metacognitions about smoking in several studies (e.g. Nikčević & Spada, 2008; 2010).

Aims of the study

In light of the above research, the goal of this study was to gain a better understanding of the roles that both smoking outcome expectancies and metacognitions about smoking may play in mediating the relationship between negative affect (anxiety and depression) and cigarette use (numbers of cigarettes smoked per day) and nicotine dependence (as measured by the Fagerstrom Test for Nicotine Dependence, Uysal et al., 2004). The central reason why we wanted to pursue this line of investigation is that it has been argued that these constructs are, to a degree, distinct. Indeed, as advocated by Nikčević and colleagues (Nikčević et al., 2015) there is an overlap between smoking outcome expectancies and metacognitions about smoking in that the positive dimensions of both constructs capture what are essentially motivations for smoking. A crucial difference, however, is that positive smoking outcome expectancies do not explicitly distinguish between cognitive and metacognitive belief domains. This is an important distinction because according to the metacognitive model of psychopathology, and burgeoning research evidence, the key markers of psychopathology are beliefs pertaining to the metacognitive rather than cognitive domain (Wells, 2009). In addition, with respect to the negative dimensions of both scales, whereas negative smoking outcome expectancies mainly measure general negative outcomes arising from smoking, negative metacognitions about smoking tap into the perception of lack of executive control and presumed cognitive interference of smoking and smoking-related thoughts. From a metacognitive standpoint, high scores on negative metacognitions about smoking should be a key marker of the perseveration in use as they are presumed to play a key role in propagating negative affect and hence prevent the discontinuation of maladaptive coping behaviour (Nosen & Woody, 2014; Wells, 2009). Preliminary evidence has suggested that metacognitions about smoking do predict smoking behaviour over and above smoking outcome expectancies (Nikčević et al., 2015); however no study to date has modelled the relative contribution of these constructs accounting for negative affect.

In the current study, we tested a mediation model in which negative affect is hypothesized to predict both smoking outcome expectancies and metacognitions about smoking, which in turn predict cigarette use and nicotine dependence. Since different patterns of smoking outcome expectancies and metacognitions about smoking may be consistent with different patterns of cigarette use and nicotine dependence we explored whether all or a subset of these are actually implicated in the mediation hypothesis. It is important to highlight that this study was testing a between-person paradigm (Moolenaar & Campbell, 2009). The broad assumption being that individuals high in negative affect should also endorse high (positive) smoking outcome expectancies and metacognitions about smoking and present with high cigarette use and nicotine dependence.

2. Method

2.1. Participants

The sample consisted of 524 self-declared smokers (261 female) living in Turkey and aged between 18 and 68 years (mean = 28.5; SD = 7.8) who scored 3 or above (3 being the cut off for the presence of low/moderate nicotine dependence) on the Fagerstrom Test for Nicotine Dependence (FTND; Uysal et al., 2004). The average number of cigarettes smoked per day was 18.8 (SD = 8.6) with most participants stating that they started smoking by the age 20 (range = 6 – 37 years). With respect to smoking cessation, only 6.7% of the sample reported that they had engaged in treatment to stop smoking.

Just over half the participants were currently employed (56.1%) and most perceived their socio-economic status to be at least ‘moderately high’ (47.1%). Participants tended to live in metropolitan areas (440), whilst fewer inhabited urban (68) and rural regions (16). Nearly all participants had been taught at tertiary educational level (491 were either current or former higher education students).

2.2. Procedure

After gaining ethical permission from Department of Psychology, Dokuz Eylül University, İzmir, Turkey, the study was administered to an unrestricted self-selected survey sampling (Couper, 2000) by using web-survey methods via e-mailing Dokuz Eylül University staff and sharing details of the study through varied social media services. Only participants who scored 3 or above on the Fagerstrom Test for Nicotine Dependence (FTND: Uysal et al., 2004) were included in the sample for the current study as this score is the minimum threshold for indicating the presence of nicotine dependence.

2.3. Measurement of key variables

Cigarette use. This was assessed by asking the following question: “How many cigarettes do you smoke on an average per day?”

Nicotine dependence. The Turkish version of the Fagerstrom Test for Nicotine Dependence (FTND: Uysal et al., 2004) was used in order to measure nicotine dependence. The questionnaire consists of six items that contribute to a single factor designed to measure nicotine dependence. The translated FTND has been reported to possess good test-retest reliability (Uysal et al., 2004).

Anxiety and depression. The Turkish version of the 14-item Hospital Anxiety and Depression Scale (HADS; Aydemir, Guvenir, Kuey, & Kultur, 1997) was used to assess anxiety and depression. The scale has been shown to possess good psychometric properties (Aydemir, Guvenir, Kuey, & Kultur, 1997).

Smoking outcome expectancies. The Turkish version of the Brief Smoking Consequences Questionnaire for Adults (BSCQ-A; Süsen & Yalçınkaya-Alkar, 2016) was used to assess smoking outcome expectancies. The BSCQ-A consists of 25-items that describe 10 factors, labelled: (1) ‘Negative Affect Reduction’; (2) ‘Stimulation State Enhancement’; (3) ‘Health Risks’; (4) ‘Taste and Sensory Motor Manipulation’; (5) ‘Social Facilitation’; (6) ‘Weight Control’; (7) ‘Craving Addiction’; (8) ‘Negative Physical Feelings’; (9) ‘Boredom Reduction’; and (10) ‘Negative Social

Impression'. Respondents indicate the strength of their endorsement of these expectancies by rating them using a 10-point Likert-type format. The Turkish BSCQ-A has been reported to possess good psychometric properties (Süsen & Yalçınkaya-Alkar, 2016).

Metacognitions. The Turkish version of Metacognitions about Smoking Questionnaire (MSQ; Alma, Spada, Fernie, Yılmaz-Samancı, Caselli & Nikčević, in revision) was used. The MSQ consists of four-factors designed to measure metacognitions that specifically pertain to smoking. The factors are 'Positive Metacognitions about Cognitive Regulation', 'Positive Metacognitions about Emotional Regulation', 'Negative Metacognitions about Uncontrollability', and 'Negative Metacognitions about Cognitive Interference'. The endorsement of metacognitions is indicated on a four-point Likert-type scale. The Turkish version of the MSQ has been shown to possess good internal reliability, predictive validity and convergent validity (Alma, Spada, Fernie, Yılmaz-Samancı, Caselli & Nikčević, in revision).

2.4. Data analyses

Correlation analyses were conducted in order to test the associations between the variables of interest. The pattern of relationships specified by our theoretical model (Figure 1) was examined through path analysis (i.e. structural equation modelling for observed variables), using the package Lavaan (Rosseel, 2012) of the software R (R Development Core Team 2012) and utilizing a single observed score for each construct included in the model. In particular, the covariance matrix of the observed variable was analyzed with Maximum Likelihood method estimator and a bootstrap approach (1000 bootstrap samples) was used to calculate bootstrapped confidence intervals to test for mediation. To evaluate the goodness of fit of the model we considered the R^2 of each endogenous variable and the total coefficient of determination (TCD; Bollen, 1989; Jöreskog & Sörbom, 1996). In the tested model, cigarette use and nicotine dependence were the dependent variables, anxiety and depression were the independent

variables, and smoking outcome expectancies and metacognitions about smoking were the mediators between the independent and dependent variables (Figure 1).

3. Results

Tables 2 and 3 show the means, standard deviations and bivariate correlations between the variables included in the study. Specifically, the positive association observed between cigarettes use and nicotine dependence suggested that the two outcomes are strongly linked but not overlapping concepts. Moreover, as expected, most of the mediator variables were correlated with each other. Overall, however, the associations indicated that smoking outcome expectancies and metacognitions about smoking are related but not overlapping constructs. Specifically, the strongest association was observed between negative affect reduction and positive metacognitions about emotional regulation, whereas some bivariate associations were found to be weak or non-significant (as an example, negative social impression was non-significantly associated with both positive metacognitions about smoking factors).

A first version of the theoretical model (Figure 1) was tested with all the variables of interest, including age and gender as control variables. Several path coefficients did not reach statistical significance and were characterized by a small effect size: the association between depression and three metacognitions about smoking (positive metacognitions about cognitive regulation, positive metacognitions about emotional regulation, and negative metacognitions about uncontrollability), and all the smoking outcome expectancies variables; the association between anxiety with smoking outcome expectancies (health risks, taste and sensory motor manipulation, craving addiction), and between anxiety and the two outcomes; the association between two metacognitions about smoking (positive metacognitions about cognitive regulation and negative metacognitions about cognitive interference) and cigarette use; the association between gender and nicotine dependence; the associations between most of the smoking

outcome expectancies and both outcomes, with the exception of the significant association between negative affect reduction and nicotine dependence, and the association between negative social impression and both outcomes.

Therefore, these non-significant associations were removed and a second version of the model was evaluated. In this model, all path coefficients were significant at least at the $p < .05$ level, with the exception of the association between anxiety and two outcomes expectancies (stimulation state enhancement, and social facilitation); the association between negative social impression and nicotine dependence; and the association between positive metacognitions about emotional regulation and cigarette use. As shown in the Figure 2, positive and direct associations were observed between all metacognitions about smoking and nicotine dependence, and between one smoking outcome expectancy and nicotine dependence. Positive associations were also observed between negative metacognitions about uncontrollability and cigarette use. Moreover, depression appeared to be significantly associated with nicotine dependence but very weakly to cigarette use. Overall, negative metacognitions about uncontrollability appeared to be the strongest direct predictor for both cigarette use and nicotine dependence.

Along with the direct paths, as shown in Table 4, four indirect relationships were found to be significant at the $p < .05$ level. These were the indirect associations between anxiety and nicotine dependence via three metacognitions about smoking (positive metacognitions about emotion regulation, negative metacognitions about uncontrollability, and negative metacognitions about cognitive interference); and the indirect associations between anxiety and cigarette use via one metacognition about smoking (negative metacognitions about uncontrollability).

The squared multiple correlations for the endogenous variables indicated that the model accounted for 16% of the variance in cigarette use and for 20% of the variance in nicotine dependence. Lower explained variance was observed for mediators (e.g. 6% for negative metacognitions about uncontrollability and 4% for negative affect reduction). Finally, the total amount variance explained by the model (Total Coefficient of

Determination, $TCD = .34$) indicated a good fit to the observed data. In terms of effect size, $TCD = .34$ corresponds to a correlation of $r = .58$. According to the Cohen's (1988) traditional criteria, this is a large effect size.

4. Discussion

The goal of this study was to test a mediation model in which anxiety and depression predict both smoking outcome expectancies and metacognitions about smoking, which in turn predict cigarette use and nicotine dependence. Since we assumed that different patterns of smoking outcome expectancies and metacognitions about smoking could be consistent with different patterns of cigarette use and nicotine dependence we explored whether all or a subset of these were implicated in the mediation hypothesis.

Our final mediation model revealed that anxiety was not associated with either cigarette use or nicotine dependence but was positively associated with all mediators with the exception of stimulation state enhancement and social facilitation. Depression, on the other hand, was found to be positively associated with nicotine dependence (and very weakly to cigarette use) but was not associated with either smoking outcome expectancies or metacognitions about smoking. Only one smoking outcome expectancy (negative affect reduction) was found to be positively associated with nicotine dependence but not cigarette use. Another smoking outcome expectancy (negative social impression), was found to be positively associated with cigarette use (but not to nicotine dependence). All metacognitions about smoking were found to be positively associated with nicotine dependence. Moreover, negative metacognitions about uncontrollability were found to be positively associated with cigarette use.

Our findings on the positive association between depression and both nicotine dependence and cigarette use echo, to an extent, existing literature in the area (e.g. Breslau et al., 2004; Leventhal et al., 2009). However, when looking specifically at the role of anhedonia as a symptom of depression, past research has concluded that there is a non-significant correlation with cigarette use (Cook, Spring, & McChargue, 2004; Leventhal,

Waters et al., 2009). Without knowing the specific symptoms reported by the participants of this study, it is uncertain whether low mood or anhedonia were more prominent, and this is supported by the very small effect size found in this relationship. Our findings also indicated the lack of an association between anxiety and the outcome variables. This finding aligns itself to recent research which indicates that specific forms of anxiety (e.g. panic disorder and generalized anxiety disorder) rather than generic anxiety may be linked to nicotine dependence (Moylan et al., 2012), although this has not been a consistent finding across studies.

Nevertheless, anxiety appeared to be indirectly linked to the two outcome variables via metacognitions about smoking. This means that individuals high on anxiety also endorse positive metacognitions (“I need to smoke in order to think clearly/gain mental control”) and negative metacognitions about smoking (“My thoughts about smoking are overwhelming me) which, in turn, may lead to cigarette use and nicotine dependence.

Only two of the ten smoking outcome expectancies (negative affect reduction and negative social impression) we investigated were found to have a direct effect on one of the two outcome measures whilst all metacognitions about smoking were associated to nicotine dependence and one metacognition about smoking (negative metacognitions about uncontrollability) to cigarette use. Taken together, these findings align themselves with those of Nikčević and colleagues (2015) who observed, in the first study comparing smoking outcome expectancies and metacognitions about smoking, that metacognitions about smoking explained incremental variance in smoking behaviour above smoking outcome expectancies.

A closer look at the coefficients in the model indicates that negative metacognitions about uncontrollability are a much stronger predictor than the positive dimensions of both smoking outcome expectancies and metacognitions about smoking (which capture, fundamentally, positive expectancies about using) of both cigarette use and nicotine dependence. Why would this be the case? From a metacognitive standpoint, high scores

on negative metacognitions about uncontrollability would indicate the lack of belief in the controllability of the behaviour (smoking) and of intrusions associated with such behaviour (e.g. craving). These beliefs are likely to limit attempts at engaging in self-control as well lead to a propagation of negative affect and hence prevent quitting cigarette use, leading to nicotine dependence (Nikčević et al., 2015; Nosen & Woody, 2014; Spada et al. 2015; Wells, 2009).

Overall, these findings indicate that metacognitions about smoking may constitute an important factor in cigarette use and nicotine dependence. Hence techniques and principles of metacognitive therapy (Wells, 2009) which have been found to be very effective in the treatment of anxiety and mood disorders (Normann, van Emmerik & Nexhmedin, 2014) could potentially be applied to quitting cigarette use and consequently reduction in nicotine dependence. These could include the direct re-structuring of both positive and metacognitions about smoking using Socratic dialogue techniques as well as experiential interventions aimed at questioning the validity of metacognitions such as postponement of use experiments, detached mindfulness and attention training (Spada et al. 2015).

The confirmation that metacognitions about smoking are a better predictor of both cigarette use and nicotine dependence than smoking outcome expectancies highlights that possibility that smoking cessation may be more closely dependent on changing metacognitions than on changing smoking outcome expectancies.

The present study has limitations that need to be highlighted. First, the sample was not randomly selected and thus may be subject to a selection bias. Second, the use of data from a self-report questionnaires may be influenced by recall bias and answer accuracy. Third, the cross-sectional design adopted does not allow definitive statements about causality. Fourth, it should be highlighted that findings from our study emerge

from a between-person perspective and hence potential applications and inferences to within-person paradigms (such as metacognitive therapy) such be considered with caution.

Future studies should therefore employ intensive longitudinal designs, particularly to test predictions about smoking uptake amongst those identified to be high risk of doing so and to disaggregate within- and between-person sources of information as suggested by Curran and Bauer (2011). Despite these limitations, results of this study have potentially important implications for developing prevention and intervention programmes for individuals who would like to quit smoking, which focus on metacognitive change.

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Figure 1: The theoretical model developed for testing in the study.

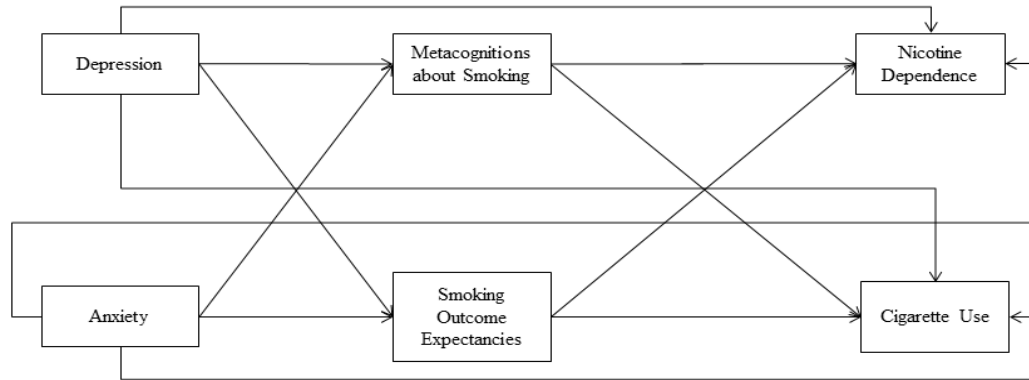
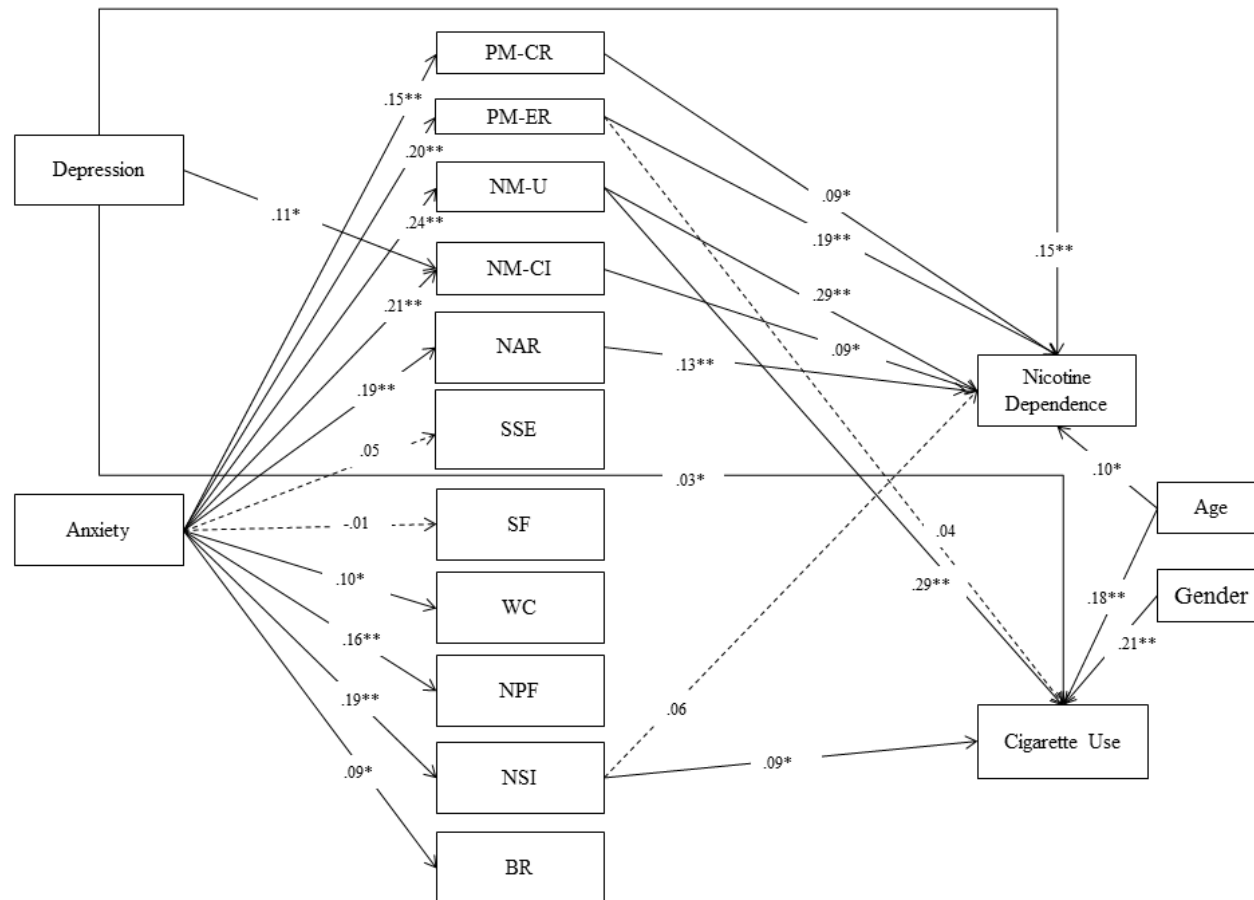


Figure 2: The final model of showing the interrelationships between the study variables.



Notes: * $p < 0.05$, ** $p < 0.001$; $N = 524$; PM-CR= Positive Metacognitions about Cognitive Regulation, PM-ER= Positive Metacognitions about Emotional Regulation, NM-U= Negative Metacognitions about Uncontrollability, NM-CI= Negative Metacognitions about Cognitive Interference, NAR= Negative Affect Reduction, SSE= Stimulation State Enhancement, SF= Social Facilitation, WC= Weight Control, NPF= Negative Physical Feelings, NSI= Negative Social Impression, BR= Boredom Reduction.

Table 1: Metacognitions across addictive behaviours: Key studies.

Addictive behaviour	Key finding	Reference
Alcohol use and misuse	Generic metacognitions are elevated in alcohol use and problem drinking	Spada, Caselli, & Wells, 2009; Spada & Wells, 2005; Spada, Zandvoort, & Wells, 2007
	Positive and negative metacognitions about alcohol use predict the severity of alcohol use in binge drinking university students	Clark, Tran, Weiss, Caselli, Nikčević, & Spada, 2012
	Positive and negative metacognitions about alcohol use predict problem drinking in clinical and non-clinical samples	Spada & Wells, 2006, 2008, 2009, 2010
	Positive and negative metacognitions about alcohol use predict drinking behaviour independently of alcohol outcome expectancies in non-clinical samples	Spada, Moneta, & Wells, 2007
Cigarette use and nicotine dependence	Generic metacognitions predict cigarette use and nicotine dependence independently of negative affect	Nikčević & Spada, 2008; Spada, Nikčević, Moneta, & Wells, 2007
	Smokers endorse both positive and negative metacognitions about smoking	Nikčević, Caselli, Wells, & Spada, 2015; Nikčević & Spada, 2010
Gambling	Generic metacognitions predict gambling independently of negative affect	Lindberg, Fernie, & Spada, 2011; Spada & Roarty, 2015;
	Gamblers endorse both positive and negative metacognitions about gambling	Spada, Giustina, Rolandi, Fernie, & Caselli, 2015

Table 2: Correlation matrix for the independent and dependent variables: nicotine dependence, cigarette use, anxiety, depression, and gender and age.

	M	SD	Range of scores	1	2	3	4	5
1. Nicotine dependence	5.36	1.90	3-10	1				
2. Cigarette use	18.82	8.61	1-75	.58**	1			
3. Anxiety	9.56	4.24	0-20	.15**	-.05	1		
4. Depression	7.20	4.07	0-21	.21**	.05	.61**	1	
5. Gender	-	-	-	.09*	.26**	-.13**	-.004	1
6. Age	28.52	7.80	18-68	.11*	.20**	-.18**	-.12**	-.10*

Notes: * $p < 0.05$, ** $p < 0.01$; N=524.

Table 3: Correlation matrix for the mediator variables: smoking metacognitions and smoking outcome expectancies.

	M	SD	Range of scores	1	2	3	4	5	6	7	8	9	10	11	12	13
1. PM-CR ^a	2.34	.90	1-4	1												
2. PM-ER ^a	2.90	.86	1-4	.67**	1											
3. NM-U ^a	2.25	.85	1-4	.16**	.19**	1										
4. NM-CI ^a	1.81	.79	1-4	.08	.11**	.73**	1									
5. NAR ^b	19.38	6.73	0-27	.54**	.77**	.12**	.10*	1								
6. SSE ^b	7.36	5.18	0-18	.45**	.35**	-.004	.02	.45**	1							
7. HR ^b	15.91	3.44	0-18	-.09*	.003	.17**	.17**	-.02	-.15**	1						
8. TSMM ^b	13.32	8.13	0-27	.32**	.27**	-.11*	-.06	.28**	.36**	-.14**	1					
9. SF ^b	12.64	7.29	0-27	.37**	.34**	.22**	.25**	.36**	.33**	-.06	.23**	1				
10. WC ^b	10.23	8.49	0-27	.26**	.22**	.19**	.17**	.21**	.28**	.12**	.16**	.29**	1			
11. CA ^b	12.47	4.78	0-18	.25**	.23**	.34**	.30**	.31**	.16**	.10*	.07	.19**	.19**	1		
12. NPF ^b	9.27	4.88	0-18	-.09*	.003	.23**	.25**	.009	-.14**	.19**	-.23**	.06	.12**	.16**	1	
13. BR ^b	13.81	4.29	0-18	.27**	.39**	.22**	.19**	.41**	.29**	.08	.13**	.37**	.16**	.25**	.07	1
14. NSI ^b	9.86	6.60	0-27	-.06	-.05	.31**	.38**	.01	-.02	.19**	-.24**	.15**	.23**	.07	.31**	.03

Notes: * $p < 0.05$, ** $p < 0.01$; N=524; ^a = Smoking metacognitions: PM-CR= Positive Metacognitions about Cognitive Regulation, PM-ER= Positive Metacognitions about Emotional Regulation, NM-U= Negative Metacognitions about Uncontrollability, NM-CI=Negative Metacognitions about Cognitive Interference. ^b = Outcome Expectancies:

NAR=Negative Affect Reduction, SSE= Stimulation State Enhancement, HR= Health Risk, TSMM= Taste and Sensory Motor Manipulation, SF= Social Facilitation, WC= Weight Control, CA=Craving Addiction, NPF= Negative Physical Feelings, BR= Boredom Reduction, NSI= Negative Social Impression.

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Table 4: Standardized bootstrapped estimates of the indirect effects (with 95% confidence intervals) of independents (anxiety and depression) on the dependents (nicotine dependence and number of daily cigarettes) through the proposed mediators (smoking metacognitions and outcome expectancy) linked to the dependents.

Independent variables	Mediators	Dependent	Estimate	Confidence intervals	
				Lower bound	Upper bound
Anxiety		Nicotine dependence			
	<i>PM-CR^a</i>		.006	-.002	.014
	<i>PM-ER^a</i>		.017*	.003	.031
	<i>NM-U^a</i>		.032*	.012	.052
	<i>NM-CI^a</i>		.011*	.001	.021
	<i>NAR^b</i>		.011	-.001	.023
	<i>NSI^b</i>	-.006	-.014	.002	
Depression	<i>NM-CI^a</i>		.004	-.004	.012
Anxiety		Cigarette use (N)			
	<i>PM-ER^a</i>		.012	-.043	.019
	<i>NM-U^a</i>		.142*	.071	.213
	<i>NSI^b</i>		-.034	-.077	.009

Note: * Significant indirect relationships at 5% level; that is, their 95% confidence intervals did not include the zero value;

^a= Smoking metacognitions (PM-CR= Positive Metacognitions about Cognitive Regulation, PM-ER= Positive Metacognitions about Emotional Regulation, NM-U= Negative Metacognitions about Uncontrollability; ^b= Outcome Expectancies (NAR= Negative Affect Reduction, NSI=Negative Social Impression).

Author Disclosure**Contributors**

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

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Authors AN, LA, DK, AEY-S and GC have contributed the design of the paper and write-up of the paper. Author CM performed the statistical analysis of the data.

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Conflicts of Interest

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Highlights

- We investigated the contribution of negative affect, expectancies and metacognitions to cigarette use and nicotine dependence.
- Depression, but not anxiety, directly predicted cigarette use and nicotine dependence.
- Metacognitions were found to be a stronger predictor than outcome expectancies of both cigarette use and nicotine dependence.

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