Metacognitions and desire thinking in nicotine dependence: Results from a cross-sectional study.

Acknowledgments

The process of writing the graduate thesis can surely be said to appear somewhat intimidating. Throughout the years at the clinical psychology-program at NTNU, this final academic task always looms in the near-future, standing out as the last theoretical challenge. It is, therefore, a peculiar feeling to find ourselves at the end of this process. The two of us met the first year and quickly became friends. The idea of writing the thesis together was first brought into the day in the fall of 2018. We soon started searching for possible projects amongst the potential supervisors suggested by the institute and decided for Stian Solems project on metacognitions in nicotine-dependence – which turned into this thesis. We have both previously worked in institutions with patients suffering from addiction, which has undoubtedly added to our shared interest in this subject. We gathered data through recruitment at the campus and in social media, and had quite a lot of appeals in lectures, trying to communicate the concept of metacognitions in addiction, while encouraging students to answer our self-report. The breakthrough in data-collecting came though when we started recruiting through the facebook-page of the Norwegian Directorate of Health. While doing recruitment, we read the relevant literature and had discussions on the concepts which were new to us. After analyzing the data in cooperation with our supervisor Stian, we started writing. As quite a lot of the statistical analyses used were new to us, and metacognitions in nicotine dependence is a relatively new research-area, lacking a complete theoretical framework, the writing process has been challenging, yet intellectually stimulating. While writing the first parts of the thesis, we completed one subsection each before reviewing, discussing, and correcting each other's writings. While working with the discussion, we found it most useful to write together, paragraph for paragraph. We cannot understate the fact that we owe our gratitude to our supervisor Stian Solem throughout this process. Through emails and meetings at his office, he has provided thorough and effective guidance and invoked a feeling that no question is irrelevant or too simple. His helpfulness in aiding us with our thesis has been of great importance to the quality of the final product. We must also express our gratitude to our fellow-student Isak Joramo, who read through one of the last drafts and provided valuable language correction.

Abstract

Both metacognitions about smoking and desire thinking have been associated with nicotine dependence. Moreover, metacognitions have been suggested to contribute to the dysregulation of desire thinking and lead to a pathological increase in craving leading to nicotine dependence. The aim of this study was to further explore the role of both metacognitions about smoking and desire thinking in nicotine dependence. The sample consisted of 446 (293 women) self-declared smokers and snus (a moist smokeless snuff) users. Path analysis supported a slightly modified version of the original model to have a good fit to the data. This model proposes that positive metacognitive beliefs about snus or smoking are associated with the activation of desire thinking, which leads to a conscious allocation of attentional resources towards snus- or smoking-related information (imaginal prefiguration) and prolonged self-talk regarding reasons to engage in snus or smoking behavior (verbal perseveration). This is then associated with nicotine dependence and negative metacognitive beliefs about snus or smoking. Lastly, there was a direct association between positive metacognitions and nicotine dependence. These findings further support the application of metacognitive theory to better understand and develop potential interventions regarding nicotine dependence.

Keywords: nicotine, metacognition, desire thinking, snus, smoking

Introduction

It has long been acknowledged that nicotine dependence is the main reason why people use tobacco products that put them at greater risk of adverse health effects (Fagerström, Heatherton, & Kozlowsky, 1990). The most common modes of nicotine deliverance in Norway are cigarettes and snus, a type of moist smokeless snuff. In 2018 12% of Norwegians identified themselves as daily smokers, while another 12% identified themselves as daily snus users (Statistisk sentralbyrå [SSB], 2019). While smoking is on the decline, snus use in younger generations is on the rise, and Statistics Norway (SSB) estimates that if current trends continue, the percentage of total daily tobacco users in Norway will stabilize at approximately 35% for men, and 25% for women (SSB, 2017).

The adverse health effects of smoking are well documented and many people struggle to quit, even in situations where quitting seems to be highly favorable. In the sixth survey of the Tromsø Study (Tromsø 6) in 2007-2008, approximately half of the participants continued to smoke after being diagnosed with chronic obstructive pulmonary disease or angina pectoris, or after suffering a heart attack (Danielsen, Løchen, Medbø, Vold, & Melbye, 2016). The total cost of tobacco use in society is undoubtedly a complex question and not just an economic issue. A report by the Norwegian directorate of health (Sælendsminde & Torkilseng, 2010) estimated the direct health effects of smoking alone to be between 6.3 to 7.7 percent of total national spending on health services. The research on the exact adverse health effects and costs of snus use is difficult to interpret and some even advocate promoting snus if it leads to an overall decrease in smoking (Lund 2013). However, the Norwegian Institute of Public Health (2019) concludes that snus has several potentially harmful effects in their newest report on the matter. Taken together, there should not be any doubt that assisting individuals that want to, but struggle to quit using nicotine products will contribute to better public health. Thus, a better understanding of nicotine dependence and effective interventions assisting cessation is warranted.

Cognitive theories of nicotine dependence have emphasized outcome expectancies and emotional regulation when trying to explain why people engage in addictive behavior (Rash & Copeland,

2008, Leventhal & Zvolensky, 2015). Outcome expectancies are the conscious, anticipated consequences following the use of a substance (Rash & Copeland, 2008). Positive outcome expectancies motivate an individual to use, while negative outcome expectancies motivate absence. Outcome expectancies in smoking have typically been measured with the Smoking consequences questionnaire (Rash & Copeland, 2008), where the anticipated consequences of smoking include expectations of mood- and weight regulation, long- and short-term health effects, and potential positive and negative social implications. These measures have predicted smoking behavior in both adult**s** (Brandon & Baker, 1991; Copeland, Brandon, & Quinn, 1995; Rash & Copeland, 2008) and adolescents (Lewis-Esquerre, Rodrigue, & Kahler, 2005; Hine, Honan, Marks, & Brettschneider, 2007)**.** Parallel to this research, and the emergence and recognition of the "third wave" of behavioral therapies, more and more research suggest that metacognitive beliefs may also play a role in addiction (Hamonniere & Varescon, 2018), and it has therefore been hypothesized that nicotine dependence may be better understood through a metacognitive, rather than a cognitive perspective (Spada, Caselli, Nikcevic, Wells, 2015).

Metacognitions in addiction

Metacognition as a theoretical construct emerged in the 1970s in the area of developmental psychology, drawing on the work of John Flavell. Studying children's growing understanding of the nature of their own cognition, Flavell and colleagues coined metacognition in its broadest form as "thinking about thinking" (Miller, Kessel & Flavell, 1970). Subsequently, metacognition has been studied within memory, aging, and neuropsychology (Brown, 1978; Flavell, 1979; Metcalfe & Shimamura, 1994; Wells, 2009). Even though the cognitive phenomena of "thinking about thinking" has been subject to investigation within philosophy and psychology for decades, metacognition has only been studied empirically for the past four decades (Rhodes, 2019).

Metacognition is a rather broad term, referring to any knowledge, process, or strategy that appraise, monitor, or control cognition (Flavell, 1979; Moses and Baird, 1999; Wells, 2000). Wells and Matthews (1994) outlined a metacognitive model of psychological disorders termed the Self-Regulatory Executive Model (S-REF). S-REF incorporates elements of cognition such as attention, regulation of cognition, levels of control of processing, and interaction between

different dimensions of cognition. The S-REF- model consists of three interacting levels of cognitive processing, involving automatic and reflexive low-level processing, conscious cognitive style, and lastly, a metasystem holding metacognitive knowledge and beliefs (Wells & Matthews, 1994; Wells & Matthews, 1996). According to the model, the activation of a particular cognitive style called the cognitive attentional syndrome (CAS) is central to psychological distress. The CAS is theorized to be transdiagnostic and features unhelpful coping mechanisms, such as repetitive rumination, worry, threat monitoring, thought control strategies, and avoidance. These processes are activated as a means for dealing with threats, self-discrepancies, and emotional distress, but have a paradoxical effect as the CAS leads to the persistence of negative thoughts and emotions, locks attention towards threats, and fails to modify erroneous beliefs (Wells, 2009).

The CAS is activated and maintained by metacognitive beliefs about thinking regarding the usefulness, significance, and meaning of thoughts and internal events. There are two main types of metacognitive beliefs: Positive and negative. The former is beliefs about the usefulness of the thinking styles which constitute the CAS, while the latter concern the uncontrollability, significance, and danger of thoughts. Positive metacognitive beliefs can lead to the activation of inadequate coping styles by motivating the individual to engage in activities such as ruminating and worrying. Negative metacognitive beliefs can cause an escalation of the faulty coping mechanisms and add to its preservation (Wells, 2009). The S-REF model is the theoretical foundation for metacognitive therapy (MCT; Wells, 2009), which features disorder-specific formulations for multiple disorders, including depression (Papageorgiou & Wells, 2004), generalized anxiety disorder (Wells, 1995), post-traumatic stress disorder (Wells & Sembi, 2004), and obsessive-compulsive disorder (Fisher & Wells, 2008). MCT has shown promising results as a treatment for anxiety and depression when compared with traditional CBT (Normann & Morina, 2018).

According to the S-REF model, metacognitions give rise to the CAS, which in turn causes sustained and prolonged thinking and maladaptive coping. Furthermore, it posits these mechanisms to be transdiagnostic and involved in all psychological distress (Wells, 2009). As

with other disorders conceptualized within the framework of the S-REF model, also addiction seems to be associated with the activation of the CAS and related metacognitive beliefs (Spada, Caselli, Nikčević & Wells, 2015). The presence of elevated endorsement of generic metacognitive beliefs, as measured by the MCQ (Cartwright-Hatton & Wells, 1997), and its short form MCQ-30 (Wells & Cartwright-Hatton, 2004) has been demonstrated across several addictive behaviors (Spada, Caselli, Nikčević & Wells, 2015), including alcohol use (Spada, Caselli & Wells, 2009), problematic internet use (Spada, Langston, Nikčević & Moneta, 2008), nicotine use (Spada, Nikčević, Moneta & Wells, 2007), and gambling (Lindberg, Fernie & Spada, 2011). A review of studies exploring metacognitive beliefs in addiction (Hamonniere & Varescon, 2018) found that the five dimensions in the MCQ-30 were positively correlated with the severity of the aforementioned addictions. Moreover, the need to control thoughts was identified as the strongest predictor.

The MCQ was originally developed for the assessment of metacognitive beliefs associated with generalized anxiety-disorder (Cartwright-Hatton & Wells, 1997). Although the utility of the measure has been demonstrated across different psychological disorders, it is assumed that disorder-specific models capture unique processes and content most accurately (Wells, 2009), which entails specific metacognitive measures for specific disorders. The presence of addiction specific positive and negative metacognitions about addictive behavior has been identified in alcohol use, nicotine use, and gambling (Nikčević & Spada, 2010; Spada, Giustina, Rolandi, Fernie & Caselli, 2015; Spada & Wells, 2006, 2008).

Positive and negative metacognitive beliefs give rise to addictive behavior as a coping strategy aimed at regulating cognition and affect. Positive metacognitive beliefs reflect the benefits of addictive behavior on the control and regulation of cognition and affect. (e.g. "Smoking helps me control my thoughts", "Gambling will improve my mood", "Alcohol helps me with my anxiety"). Negative metacognitive beliefs concern the lack of executive control over the addictive behavior, the uncontrollability of thoughts related to the addiction, thought-action fusion, and the potential negative consequences of the addictive behavior on cognitive function. (Nikčević et al, 2017). Positive beliefs are theorized to be involved in the initiation of the

addictive behavior, whereas the negative beliefs are theorized to follow after the addictive behavior, and over time adding to its preservation (Spada, Caselli, Nikčević & Wells, 2015).

Metacognitions in nicotine dependence.

In a preliminary study on the relationship between metacognitions, emotion, and nicotine dependence, Spada, Nikčević, Moneta, & Wells (2007) found three general dimensions of the MCQ-30 to be positively and significantly correlated with smoking dependence, namely: Positive beliefs about worry, negative beliefs about worry concerning uncontrollability and danger, and beliefs about cognitive confidence. Through structural equation modeling, the results also showed that the relationship between emotion and smoking dependence was partially mediated by the identified three dimensions of metacognitions. This supported the idea that smoking may be conceptualized as a strategy for regulating negative affect which is guided by metacognitive beliefs. Nikčević & Spada (2008) added to these findings in a study investigating metacognitions in non-smokers, low-dependency smokers and high-dependency smokers. The results indicated that low-dependency smokers were lower on positive beliefs about worry than high dependency smokers. Furthermore, that high-dependency smokers and low dependency smokers were higher on the need to control thoughts than non-smokers, and this particular dimension of beliefs was also found to be the only one predicting category-membership as a smoker. Nikcevic & Spada (2008) argue that these results underline the notion that metacognitions are influential in smoking behavior, and advance their previous findings by differentiating smokers from non-smokers using metacognitions, in addition to demonstrating specific metacognitions for both low- and high-dependency smokers.

In a study aimed at identifying specific metacognitions related to smoking-behavior, Nikčević & Spada (2010) did a series of semi-structured interviews of 12 smokers. The data collected revealed specific positive and negative beliefs about smoking; the positive beliefs were related to the regulation of negative affect and improvement of cognitive function, while the negative beliefs regarded the uncontrollability of smoking urges. Building on these findings Nikčević, Caselli, Wells, & Spada (2015) developed and tested the MSQ (the Metacognitions about

Smoking Questionnaire), by running explanatory and confirmatory factor analysis on three samples of smokers. The results suggested that the MSQ presented good psychometric properties, and predicted smoking behavior above outcome expectancies, which indicated that clinical interventions aimed at the metacognitive level may be more beneficial than interventions focused at cognitive level content. These findings were proceeded in a study testing a model where metacognitions and outcome expectancies were tested as possible mediators between anxiety and depression as independent variables, and nicotine dependence and daily cigarette use as dependent variables (Nikčević et al., 2017). The results mirrored Nikčević et al., (2015) finding that metacognitions about smoking explained more variance in smoking behavior than outcome expectancies, and went beyond the scope of the previous study by demonstrating that metacognitions acted as a significant mediator between anxiety and smoking behavior (Nikčević et al., 2017).

Similar results as those of the aforementioned studies have also been demonstrated in a non-English speaking population in a study aimed at validating a Turkish version of the MSQ (Alma et al., 2018). In addition to demonstrate that the Turkish version presented adequate psychometric properties, it was found that metacognitions predicted smoking behavior independently of outcome expectancies, as well as demographic variables, negative affect, and duration of smoking habit supporting the transdiagnostic utility of the metacognitive model. Interestingly, the results revealed younger smokers to be more likely to endorse positive metacognitions about smoking, as opposed to older smokers who were more likely to endorse stronger negative metacognitions. Although the study did not measure the duration of the participants' smoking habit, this may indicate that the endorsement of negative metacognitive beliefs develops gradually with nicotine dependence and may, as suggested by the metacognitive model, contribute to its preservation. Taken together these results support the metacognitive model of addiction and the involvement of generic and specific metacognitions in nicotine dependence.

Desire thinking, craving, and its dysregulation
Another focus of prior addiction research has been craving and the dysregulation of craving.

Craving is often conceptualized as a powerful subjective experience that motivates individuals to seek out and achieve a target, or practice an activity, in order to reach its desired effects (Marlatt, 1987). It is a strong predictor for relapse in addiction treatment (Anton, 1999; Breese, Sinha, & Heilig, 2011; Drummond, 2001; Marlatt, 1978; Shadel et al., 2011), and managing, reducing and stopping the escalation of craving has thus been seen as a crucial therapeutic target in addiction treatment (Oei, Raylu, & Casey, 2010; O'Malley, Krishnan-Sarin, Farren, Sinha, & Kreek, 2002; Paille et al., 1995).

The elaborated intrusion theory of desire (EI) suggests that desire, or craving, is the product of both associative- and higher-level elaborate processes (Kavanagh, Andrade, & May, 2005). Both internal and external triggers can activate associative information about the desired target, giving rise to intrusive thoughts, perceived as spontaneous, containing the targets positive consequences or giving rise to a feeling of deprivation which further can induce craving (Bywaters, Andrade, & Turpin, 2004; Witvliet, & Vrana, 1995). EI suggests that this feeling of craving sequentially activates more voluntary cognitive processes, conceptualized by Caselli and Spada (2010; 2011) as "desire thinking". Desire thinking has two components and is defined as voluntary thoughts in the form of positive images, imagining hypothetical positive outcomes (imaginal prefiguration), and verbal thoughts containing reasons to engage with the desired target (verbal preservation).

Several studies have now suggested that desire thinking plays a role in a variety of addictive behaviors. Experimental manipulation of desire thinking led to an increase in the urge to drink in patients seeking treatment (Caselli, Gemelli, & Spada, 2017), and the urge to engage in a self-chosen desired activity in a community sample (Caselli, Soliani, & Spada, 2013). Desire thinking increases with the severity of drinking behavior (Caselli, Ferla, Mezzaluna, Rovetto, & Spada, 2012), appears to be a risk factor for binge eating- and binge drinking episodes (Spada et al., 2015; Martino et al., 2017), is associated with problematic internet- and Facebook use (Spada, Caselli, Slaifer, Nikcevic, & Sassaroli, 2014; Marino et al., 2019), predicts problem drinking in patients seeking treatment independently of emotional intolerance (Caselli et al., 2015), and is a better predictor of gambling than negative affect and craving (Fernie et al., 2014).

Caselli and Spada (2010; 2011) argue that although desire thinking is a functional strategy in the short term, by reducing the negative sensations associated with craving, it leads to a preservation and escalation of craving in the long term by continuing to focus on the desired target without achieving it. This in turn gives rise to even more associative information about the target, resulting in an increase of a negative feeling of deprivation where engagement with the desired target is the only solution**.** They also point out that desire thinking does not need to be maladaptive per se, as it may help keep individuals motivated when gratification is delayed, or when faced with obstacles. Desire thinking is maladaptive only when poorly regulated, and if the desired target is conflicting with personal goals, for example when the desired target is cigarettes when one wants to quit smoking. It has been suggested that maladaptive metacognitive beliefs may play a role in this dysregulation (Caselli & Spada, 2010; 2013). And, from a metacognitive perspective, desire thinking may be considered as a coping strategy similar to rumination and worry and thus a central part of the CAS in addictive behaviors with maladaptive consequences including: (1) increased levels of craving and perception of being out of control; (2) increased accessibility of target-related information; and (3) interference with the regulation of craving (Caselli & Spada, 2015, p. 72). Consequently, Caselli and Spada (2016) have therefore suggested desire thinking and its regulation (by maladaptive metacognitions) to be a more appropriate focus for treatment than craving itself.

Desire thinking in nicotine dependence

To our knowledge*,* only two studies have examined the role of desire thinking in nicotine dependence (Caselli, Nikcevic, Fiore, Mezzaluna, & Spada, 2012; Caselli & Spada, 2015). The first study divided a sample of smokers from the general population into three sub-groups based on their reported nicotine dependence: low, moderate, and high, and compared their tendency to engage in desire thinking with smoking as their desired target. Individuals higher in nicotine dependence reported higher scores on both components of desire thinking. Caselli and colleagues (2012) also found that imaginal prefiguration and verbal preservation accounted for 5% and 12% of the total variance in nicotine dependence, over and above demographic variables, negative affect, and smoking urges. The other study explored the relationships between metacognitions, desire thinking, and craving. Caselli and Spada (2015) tested a model where positive

metacognitions were hypothesized to be associated with desire thinking, which in turn would be associated with craving and negative metacognitions. An increase in both craving and negative metacognitions would then lead to a pathological escalation in desire thinking, and indirectly increase craving. Their model had good statistical fit with their data which suggests a possible mechanism on how desire thinking is dysregulated, how craving escalates, and leads to nicotine dependence. As these two studies have relatively small samples, 156 and 140 respectively, and because no other studies have examined the role of desire thinking and its relationship with nicotine dependence, more research is needed before a clear picture of this relationship emerges.

Figure 1 outlines a suggested model of desire thinking and nicotine dependence based on earlier work by Caselli and Spada (2015). In this model positive metacognitive beliefs about snus or smoking are associated with a conscious allocation of attentional resources towards snus- or smoking-related information (imaginal prefiguration) and prolonged self-talk regarding reasons to engage in snus or smoking behavior (verbal perseveration). This is then associated with nicotine dependence and negative metacognitive beliefs about snus or smoking. Lastly, there is an association between positive and negative metacognitions. This connection marks instances where the activation of snus or smoking-related beliefs lead to an increasing experience of losing control without an actual increase in dependence severity. Caselli and Spada (2015) tested a similar metacognitive model, but of desire thinking and craving. Although craving is highly associated with addictive behaviors, it is theoretically possible to crave something without acting on it, and to engage in addictive behavior without craving, especially if the behavior has become habituated (Spada, Caselli, Nikcevic, & Wells, 2015). It's therefore important to test a model on the possible relationship between desire thinking, metacognitions, and actual nicotine use behavior and addiction. No other studies have explored this relationship or included snus users in their samples.

The goal of this study was, therefore, to further explore the presence of metacognitions and desire thinking in nicotine dependence and test the statistical fit of the model outlined in Figure 1. Our hypotheses included (1) both measures of desire thinking and metacognitions are positively correlated with nicotine dependence, and (2) That the metacognitive model presented

in Figure 1 will have a good statistical fit to our data. A potential theoretical model on how nicotine dependence develops and is maintained may not only contribute to the understanding of the phenomenon itself, but it may also contribute to the development of clinical interventions assisting people to quit their nicotine use.
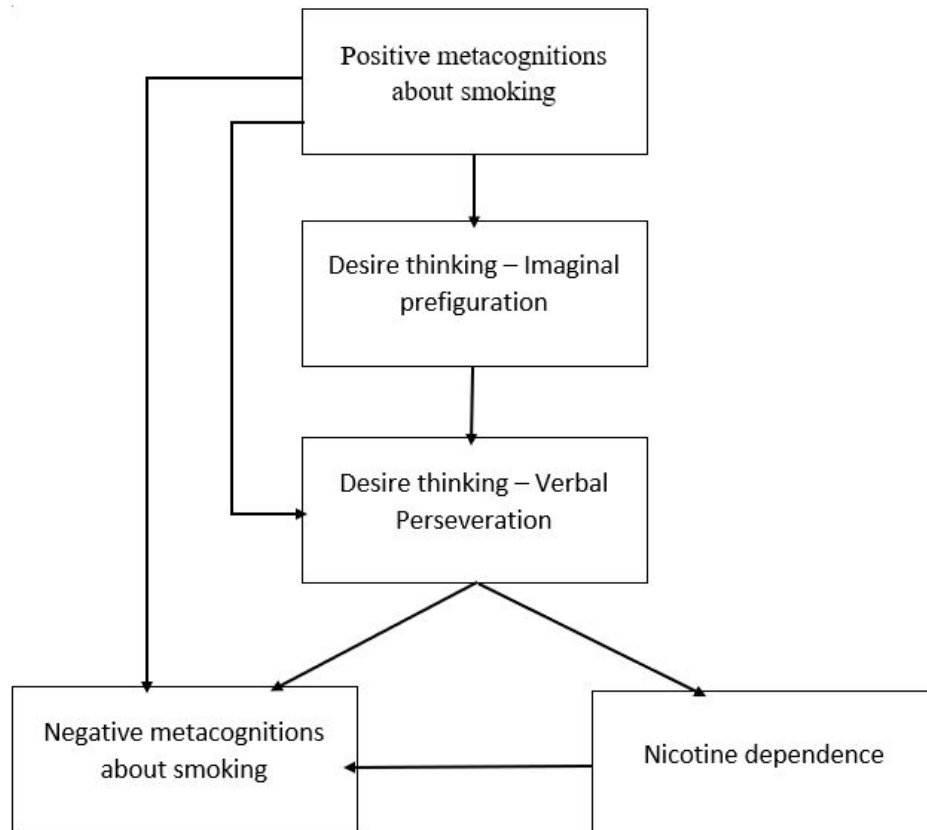

Fig. 1. Structure of a metacognitive model of desire thinking and nicotine dependence, based on work by Caselli and Spada (2015).

Method

Participants and procedure

This study has been approved by the Norwegian data protection services (NSD; reference number 53698). No approval from The Regional Committee for Medical and Health Research

Ethics (REC) was necessary as the survey was answered anonymously online, without direct contact between informants and the researchers.

Participants were invited through a hyperlink spread on social media, where it was shared on a Facebook-page managed by the Norwegian Directorate of Health (Direktoratet for e-helse, 2019) which offers guidance to people that wish to quit smoking or quit using snus. The link was also shared directly with students during on-campus lectures.

The hyperlink was presented as an opportunity to participate in a scientific study where the aim was to test a new psychological model of nicotine dependence. By clicking the link the participants were brought to a web page containing information about the survey and the survey itself. The information stated once again the aim of the study, that participation in the study is voluntary and that the information gathered would be anonymized and handled in a secure manner. The order of presentation of the measures was the same as presented in this paper (Fagerström Test of Nicotine Dependence first and Metacognitions about Smoking Questionnaire last). Questions about demographic information were listed first, before the Fagerstøm test of nicotine dependence. The participants did not get any compensation or payment for completing the survey.

Participants were required to: (1) be 18 years or older; (2) consent to being part of the study; (3) understand written Norwegian; and (4) answer at least 75% of the items constituting each measure. No partially answered surveys were included as participants were required to click a button at the end of the survey to confirm the completion.

As Table 1 shows, 293 of the 446 participants were women (65.7%). Hundred and ninety-two identified as single (43.0%). Sixty-eight reported being without work (15.2%), while 378 (84.8%) reported either studying or working. The mean age of the sample was 35.4 years ($SD =$ 13.8) and the average duration of nicotine usage was 17.0 years ($SD = 14.3$). Thirty of the included participants reported that they didn't use nicotine at all (6.7%), while the rest (93.7%) identified themselves as either smokers (38.8%), snus users (48.9%), or both (5.6%). About one-third of the participants (33.9%) had never tried to stop their nicotine use. The mean score

on the Fagerström Test of Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991) was 3.9 (*SD* = 2.4), which is considered as a moderate nicotine dependency.

Table 1

Summary of participants characteristics.

	N	%		M (SD)	Alpha
Female sex	293	65.7	Age	35.4 (13.8)	
			Years using	17.0 (14.3)	
Single	192	43.0			
Working or studying	378	84.8	FTND	3.9 (2.4)	.69
Without work	68	15.2	NB	18.7 (6.4)	.89
			PB	24.3 (7.7)	.92
Snus	218	48.9	IP	9.1 (3.2)	.77
Smoking	173	38.8	VP	11.4 (4.2)	.89
Both	25	5.6	PHQ	3.4 (3.0)	.87
No snus/smoking	30	6.7			
Methods tried to assist cessation					
"Slutta" mobile app	231	51.8			
Nicotine gum	125	28.0			
Telephone	14	3.1			
General practitioner	53	11.9			
Other	66	14.8			
Never tried to quit	151	33.9			

Note. FND = Fagerström Test of Nicotine Dependence; PB = Positive metacognitive beliefs; NB = Negative metacognitive beliefs; IP = Imaginal Prefiguration; VP = Verbal Preservation; PHQ = The Patient Health Questionnaire-4.

Measures

Fagerström Test of Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991)

To measure nicotine dependence the FTND was used. It consists of six items added to a single factor, with scores ranging from 0 to 10, where higher scores indicate higher nicotine dependence. The FTND includes questions concerning both nicotine craving (Do you find it difficult to refrain from smoking in places where it is forbidden e.g. in church, at the library, in cinema, etc.?) and behavior (How many cigarettes/day do you smoke?), or both (How soon after you wake up do you smoke your first cigarette?). Two questions have four potential answers

(coded 0-3) and the rest have two options (coded 0-1). Earlier research have used cut-off values of 3 and 5 to indicate moderate and high nicotine dependence (Caselli, Ferla, Mezzaluna, Rovetto & Spada, 2012).

Regarding psychometric properties, The FTND has shown good test-retest reliability (Pomerleau, Carton, Lutzke, Flessland and Pomerleau, 1994). It is also closely related to biochemical indices of the heaviness of smoking, such as cotinine-levels in salvia (Heatherton, Kozlowski, Frecker and Fagerström, 1991). Earlier investigations of the measure's internal consistency have found somewhat "questionable" (DeVille, 2016) alpha values but have deemed its internal consistency satisfactory (Heatherton, et al., 1991; Pomerleau, et al., 1994; with coefficient alpha values .61 and .64 respectively).

The Desire Thinking Questionnaire (DTQ; Spada & Caselli, 2011)
The DTQ was used to measure the tendency the participants had to engage in the activity of desire thinking. It consists of 10 items divided into two factors, with five items each. The first factor, Imaginal prefiguration (IP) relates to the tendency to imagine oneself doing the desired activity, or what doing the desired activity would feel like. The second factor, verbal preservation (VP) relates to the preservation of verbal thoughts or self-talk regarding reasons to engage in the desired activity. The respondents are asked to answer the questions on a four-point scale ranging from "almost never" (coded 1) to "almost always" (coded 4), where higher scores indicate a higher tendency to be engaged in desire thinking. Giving a possible score from 5 to 20 for IP and VP respectively. In this study, all questions were modified to refer to smoking or snus use as the desired activity. Both the DTQ total score and factor scores have shown good factor structure, it has shown good internal consistency with coefficient alpha values of .78 and .80 for VP and IP respectively (Caselli & Spada, 2011). Very weak correlations were found between the DTQ and existing measures of other types of perseverative thinking (rumination and worry), and although the DTQ moderately correlated with existing craving measures, the two constructs do not seem to overlap (Caselli & Spada, 2011), which in turn suggests good divergent validity. It has also shown good temporal stability and good predictive validity by predicting craving in a sample of alcohol abusers (Caselli & Spada, 2011).

Metacognitions about smoking questionnaire (MSQ; Nikcevic, Caselli, Wells & Spada, 2015)

The MSQ consists of 4 factors with 5 items each, using a four-point Likert scale to measure endorsement of different metacognitions specifically related to smoking. The version used in this study was also modified to include snus use. Two factors measure the endorsement of positive metacognitions, while two factors measure the endorsement of negative metacognitions. Only these two overarching factors of positive- and negative metacognitions were used in this study. All factors of the MSQ include: (1) Positive metacognitions about cognitive regulation (PM-CR; e.g. "smoking/snus helps me think more clearly"); (2) Positive metacognitions about emotional regulation (PM-ER; e.g. "Smoking/snus helps me to relax when I am agitated"); (3) Negative metacognitions about uncontrollability (NM-U; e.g. "It is hard to control my desire for cigarettes/snus"); and (4) Negative metacognitions about cognitive interference (NM-CI; e.g. "Thinking so much about smoking/snus interferes with me seeing things clearly"). The MSQ has been shown to have good internal consistency, with an alpha coefficient of 0.90 for the total score, 0.93 for PM-CR, 0.76 for PM-ER, 0.81 for NM-U, and 0.86 for NM-CL. It has also shown good predictive and divergent validity by predicting nicotine dependence and daily cigarette use over and above, while indicating moderate overlap with measures of smoking outcome expectancies (Nikcevic et al., 2015; Nikcevic et al., 2017).

The patient health questionnaire-4 (PHQ-4; Kroenke, Spitzer & Williams, 2003; Kroenke, Spitzer, Williams, Monahan & Löwe, 2007)

To measure negative affect the PHQ-4 was used, which consists of two subscales (PHQ-2, GAD-2), each containing two items. All items are introduced by "over the last two weeks, how often have you been bothered by:". The first two measure the severity of depression symptoms (PHQ-2) by addressing general depressed feelings, and anhedonia. The last two measure the severity of anxiety symptoms by addressing a feeling of anxiousness, and uncontrollable worry. The response options are: "Not at all", "several days", "More than half of the days", and "Almost every day". The scores are coded from 0 to 3, and added together for each subscale respectively, giving a severity score of 0 to 6 for both anxiety and depression, with a cutoff of 3 or higher for potential clinical cases. Total scores of 6 or greater should be seen as"yellow flags" and total scores of 9 or above should be seen as "red flags" with regard to the presence of an anxiety or

depression disorder (Löwe, et al., 2010). The PHQ-4 has shown specificity and sensitivity in screening anxiety and depression in clinical samples, and to be a reliable and valid measure of anxiety and depression symptoms in the general population (Kroenke et al., 2003; Kroenke et al., 2007; Löwe et al., 2010)**.** It has also shown good internal consistency with alpha coefficients of .78 for the depression subscale, .75 for the anxiety subscale, and .82 for its total score (Löwe et al., 2010).

Data analysis

Four hundred and sixty-three participants completed the survey in total. Seventeen of these cases had more than 25% missing items in one of the measures and were excluded from further analysis. additionally, a single item was missing in eight of the cases. Imputation using the mean item value of the subscale in question was therefore used for these missing items. This rendered 446 participants with complete data.

Examination of skewness and kurtosis values revealed that the scores for the PHQ-4, and the negative metacognitive beliefs and imaginal prefiguration subscales were positively skewed. A log10-transformation (Field, 2013) was used on all three scales. The transformed scores showed adequate normality and were used in all further analyses.

An independent t-test we used to check for differences in nicotine dependency between smokers and snus users. No significant difference between smokers (M = 4.40, SD = 2.36) and snus users (M = 4.09, SD = 2.21) were found; t(389) = 1.303, p = .193. On this basis, we merged the two groups in all further analyses.

A series of two-tailed Pearson correlations were run to determine the relationship between the variables. The strength of the correlations is presented as classified by Evans (1996) where < .20 is very weak, .21- .39 is weak, .40-.59 is moderate, .60-.79 is strong, and $0.8 \leq r$ is very strong.

To examine the relative unique contribution of the study's variables, a six-step hierarchical regression analysis was run with nicotine dependence as the outcome variable. The first step consisted of the demographic variables work, civil status, sex, and years of use. Negative affect was entered as step two. The order of the four remaining steps was decided in light of the

theoretical causal chain from smoking cues to nicotine dependence suggested by (Caselli & Spada, 2015), and by our hypothesis, which resulted in the following order: Positive metacognitive beliefs → imaginal prefiguration → verbal preservation → negative metacognitive beliefs. To check for multicollinearity the correlation-matrix provided by the two-tailed Pearson correlations, the variance inflation factor (VIF) and the tolerance statistic were examined. No variables should correlate more than .8 with each other (Field, 2013), the largest VIF should not exceed 10 and the average VIF should not be substantially larger than 1 (Bowerman & O'Connel, 1990), a tolerance of less than .2 indicates a potential problem (Menard, 1995).

To test the hypothesized model outlined above in Figure 1, and propose a possible causal relationship between the variables, a path analysis was run in the AMOS application for SSPS (Arbuckle, 2014). Theoretical justification and relevant empirical findings showing the models plausibility have already been outlined in the introduction. The technique applies a series of regression analyses to calculate the relationships between the variables while at the same time estimating the coefficients of the whole system - testing the entire model's probability and fit to the data.

Stage, Carter, and Nora (2004) recommend using at least two fit indices when judging the goodness of fit of a model. As the chi-square measure is considered a reasonable measure when dealing with sample sizes between 75-200 cases (Kenny, 2015), and considering our sample size of 446, the root mean square error approximation (RMSEA), the Tucker Lewis index (TLI), and the standardized root mean square residual (SRMR) were considered when evaluating the fit of this model. Cut-off recommendations that represent a good fit are TLI >.90, RMSEA<.06, and SRMR<.08 respectively (Hu & Bentler, 1999).

Results

Internal consistency

Because we used translated versions of the measures Cronbach's alpha was calculated to ensure the internal consistency of the measures and the reliability of the test scores. According to

DeVille's (2016) guidelines for interpreting alpha values, the positive metacognitive beliefs subscale (PB) displayed excellent internal consistency; the negative metacognitive beliefs (NB) and Verbal preservation (VP) subscales, and the PHQ-4 displayed good internal consistency, while the imaginal prefiguration sub-scale displayed acceptable internal consistency. The FTND displayed a borderline questionable/acceptable internal consistency. All alpha values are presented above, in Table 1.

The relationship between the variables

Both metacognitive variables showed moderate correlations with nicotine dependence. Of the two desire thinking variables, Verbal perseveration had the strongest correlation with nicotine dependence, with moderate strength, while imaginal prefiguration had a weak correlation. Years of use correlated weakly with dependence, while negative affect had a very weak correlation with nicotine dependence. Years of use had the strongest relationship with negative metacognitive beliefs which showed a moderate correlation, and it had no significant correlation with imaginal prefiguration. A strong relationship was found between negative metacognitive beliefs and verbal perseveration. All correlations are presented in Table 2.

Table 2
Inter-correlations of variables in all samples.

	PB	NB	IP	VP	PHQ	FTND
Years using	.29**	.47**	.05	.31**	.10*	.35**
PB		.51**	.40**	.54**	.17**	.46**
NB			.44**	.64**	.29**	.53**
IP				.57**	.21**	.37**
VP					.14**	.58**
PHQ						.14**

Note. PB = Positive metacognitive beliefs; NB = Negative metacognitive beliefs; IP = Imaginal prefiguration; VP = Verbal prefiguration; PHQ = The patient health questionnaire-4; FTND = Fagerström test of nicotine dependence.
* $p < .05$
** $p < .01$

A hierarchical regression analysis was used to examine the relative contribution of the variables to nicotine dependence. As none of the variables were strongly correlated (over .80), our highest

VIF was equal to 2.3 with the average VIF not substantially larger than 1, and our lowest tolerance statistic was .44, the assumption of no multicollinearity was deemed to have been met.

The demographic variables contributed significantly to the model and accounted for 12% of the variation in nicotine dependence, negative affect added 1.6%. After these variables were controlled for 13.7% was added by including positive metacognitive beliefs in the model. Adding imaginal prefiguration explained another 4.1%, then verbal preservation added 7.9%. Finally, negative metacognitive beliefs explained an additional 1.1%. All steps added significantly to the regression model and explained a total of 39.9% of the variation in nicotine dependence, 26.3% over and beyond demographic variables and negative affect. In the final step of the equation, the strongest sole predictor of nicotine dependence was verbal preservation (β = .33). Civil status, work situation, negative affect, and imaginal prefiguration did not contribute significantly to the model in the final step of the equation. In terms of sex differences, our finding suggests being male is a risk factor for nicotine dependence, as sex contributed significantly in the final step. All regression statistics are presented in Table 3.

Table 3
Hierarchical regression with FTND as the outcome variable.

						Final step of the equation	
		R^2	ΔR^2	ΔF	p	β	p
Step 1	Work status					-.036	.938
	Civil status					-.024	.521
	Sex					-.091	.019
	Years of use					.162	.001
		.120	.128	16.1	<.001		
Step 2	PHQ	.134	.016	8.1	.005	.014	.735
Step 3	PB	.270	.137	82.9	<.001	.153	.001
Step 4	IP	.311	.041	26.5	<.001	.036	.449
Step 5	VP	.389	.079	57.2	<.001	.334	<.001
Step 6	NB	.399	.011	8.0	.005	.156	.005

Note. PHQ = The patient health questionaire-4; PB = Positive metacognitive beliefs; NB = Negative metacognitive beliefs; IP = Imaginal prefiguration; VP = Verbal preservation.

Path analysis

The model outlined in Figure 1 did not turn out to have a satisfactory fit to the data, because the path directly from positive metacognitions to negative metacognitions was not significant. Because we were interested in exploring additional paths that could improve the fit of the model, we examined the modification indices. A path directly from positive metacognitions to nicotine dependence was suggested. Thus, we decided to remove the path from positive metacognitions to negative metacognitions and add the path from positive metacognitions to nicotine dependence, and then test this model's fit to the data. The full model is presented in Figure 2. This metacognitive model of desire thinking and nicotine dependence resulted in a non-significant chi-square ($x^2 = 3.103$, $df = 2$, $p = .212$), an RMSEA of 0.032, an SRMR of .0140, and a TLI of .993, and was considered a good fit to the data. The model explained a total of 36% of the measured variance in nicotine dependence.

Discussion

The goal of this study was to further explore the presence of metacognitions and desire thinking in nicotine dependence. All of our translated measures displayed satisfactory internal reliability and correlated positively with nicotine dependence. Positive metacognitive beliefs, negative metacognitive beliefs, and verbal perseveration were moderately correlated with nicotine dependence, with verbal preservation having the strongest correlation and uniquely explaining the most variation in the hierarchical regression analysis. Negative affect and imaginal prefiguration correlated weakly with nicotine dependence. Our results also supported a metacognitive model of desire thinking and nicotine dependence. In this model, an internal or external trigger activates positive metacognitive beliefs about snus or smoking that are associated with a conscious allocation of attentional resources towards snus- or smoking-related information (imaginal prefiguration) and prolonged self-talk regarding reasons to engage in snus or smoking behavior (verbal perseveration). This is then associated with nicotine dependence and negative metacognitive beliefs about snus or smoking. Lastly, there is a direct association between positive metacognitions and nicotine dependence. All paths in the model were

significant except the suggested connection between positive- and negative metacognitions about smoking or snus. This path was removed and an additional path from positive metacognitions about smoking or snus directly to nicotine dependence emerged (see Figure 2).
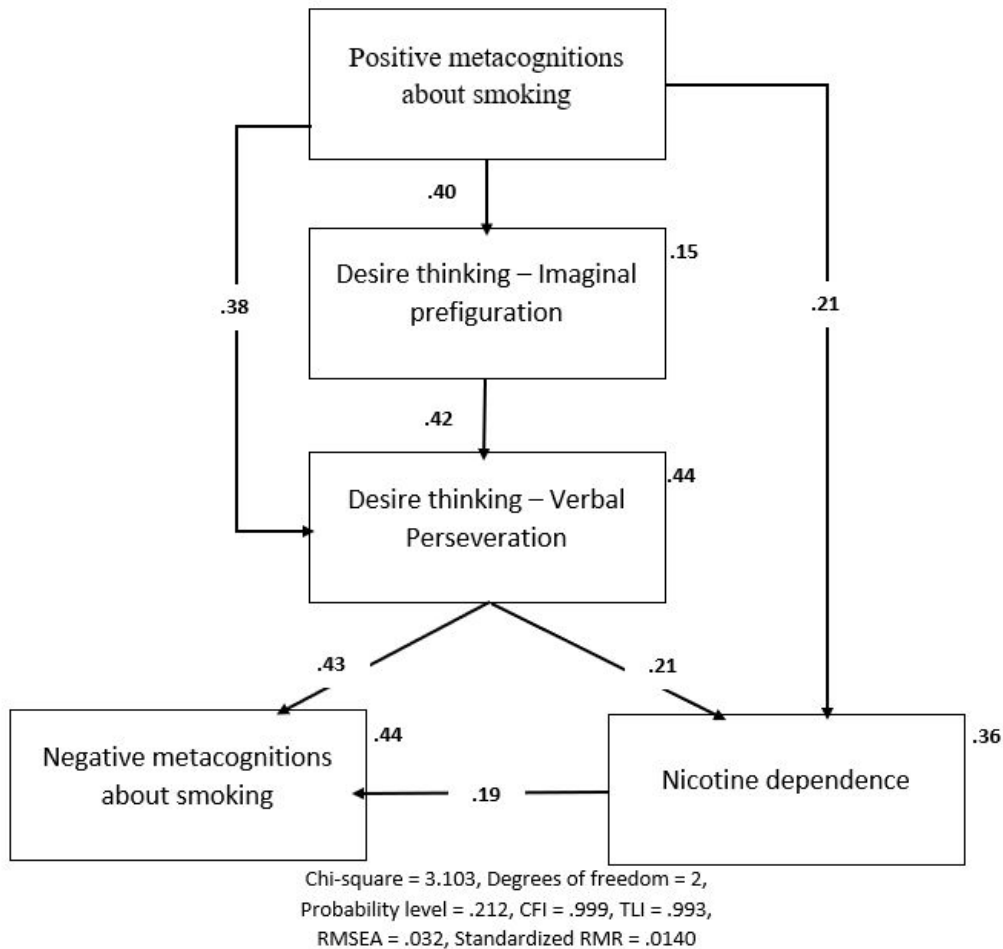

Fig. 2. Path analysis of Metacognitions, Desire Thinking, and Nicotine dependence.

The non-significant hypothesized path from positive metacognitions directly to negative metacognitions may indicate that the activation of smoking and snus-related beliefs do not contribute to the experience of losing control over one's nicotine use by itself, but only insofar as it indirectly leads to preservative self-talk, increased craving or actual smoking or snus use behavior. In the new model, only verbal preservation and nicotine dependence directly influence negative beliefs, which may indicate that verbal preservation is an important factor for addictive

behavior to be clinically relevant. This has also been suggested by research on a nonclinical population (Caselli & Spada, 2015).

The added path (positive metacognitive beliefs → nicotine dependence) may represent situations where individuals engage in smoking or snus use as cognitive-affective regulation, motivated by positive metacognitions, without the activation of desire thinking, as in automatic habitual use and/or in situations where nicotine products are readily available. This is in accordance with Spada, Caselli, Nikčević, and Wells (2015) which hypothesize desire thinking to be activated either (1) in new contexts; (2) when habitual behavior is interrupted or nicotine products are unavailable; or (3) through conscious attempts at refraining from snus or cigarettes.

A prior study (Caselli & Spada, 2015) found support for a similar metacognitive model of desire thinking and (cigarette) craving. Both models have the same core-structure, where an external or internal trigger activates positive metacognitions which in turn activates both dimensions of desire thinking which then leads to a higher endorsement of negative metacognitive beliefs and an increase in craving (or in the case of this study, nicotine dependence). The models differ however, in the connection between positive and negative metacognitions in the model proposed by Caselli and Spada, which did not turn out statistically significant in this study, and the connection added to our model between positive metacognition and nicotine dependence. We propose a few potential reasons for this difference: Firstly, the two studies measure metacognitive beliefs differently. In our study we used the MSQ, which measures behavior-specific beliefs about smoking/snus use, whereas Caselli and Spada (2015) used the Metacognitions about Desire Thinking Questionnaire (MDTQ; Caselli & Spada, 2013), which measures specific beliefs about desire thinking. According to Nikcevic et al., (2015, p.103) "Positive metacognitions about smoking have been conceptualized as a specific form of outcome expectancy likely to play a central role in motivating individuals to engage in smoking as a means of cognitive-emotional regulation." This means that positive metacognitions about desire thinking should not necessarily have the same direct association with snus or smoking behavior as positive metacognitions about snus or smoking.

Secondly, Caselli and Spada's (2015) model explained craving using the brief questionnaire of smoking urges (QSU-brief; Cox, Tiffany, & Christen, 2001), while our model explained nicotine dependence, using the FTND (Heatherton, Kozlowski, Frecker, & Fagerström, 1991). Different findings may therefore arise from the fact that the QSU-brief only measures craving, and the FTND measures both craving and behavior. The direct path between positive and negative beliefs, which was removed from our initial model, is explained by Caselli and Spada (2015) as those instances where target-achieving behavior and perceptions of low control occur without craving. These instances can, in turn, be explained by the added path in our model, from positive beliefs to nicotine dependence, since the FTND also assesses actual snus and smoking behavior.

Thirdly, we cannot rule out that the difference in these findings are due to different samples. About 49% of our participants reported snus as their main nicotine product. Norway has restrictive tobacco legislation, where smoking is banned in various public places and in all public buildings, whereas snus is not. It follows that the conditions for use are different for smokers as opposed to snus users, where the latter can use snus without any restrictions in most situations. This may have influenced the experiences of craving and cognitions in our sample. However, given the assumption of the generalizability of our sample, that we found no difference in nicotine dependence in smokers and snus users, and despite the measurement differences mentioned above, we argue the two models to be compatible with each other.

A secondary measure of nicotine dependence, years of nicotine use, was moderately correlated with negative metacognitive beliefs, but weakly correlated with positive beliefs about smoking or snus use. This dovetails earlier research (Alma et al., 2018), and suggest that negative metacognitive beliefs develop gradually as the addiction escalates. As Nikcevic et al. (2015) point out, negative metacognitive beliefs about smoking may mark the preservation of the addiction as they lead to negative affect that can trigger the activation of positive metacognitions, and prevent the discontinuation of maladaptive coping behavior such as desire thinking. This notion is further supported by our finding that negative metacognitions about smoking and snus use had the strongest correlation with negative affect in this study. An interesting finding was that imaginal prefiguration was not significantly correlated with years of nicotine use, and did

not contribute significantly to the final step of the hierarchical regression with nicotine dependence as the dependent variable. This may indicate that imaginal prefiguration does not add to the preservation or escalation of nicotine dependence, but rather represents a type of transient craving that is common in everyday desire, and further suggest, as mentioned above, that verbal preservation has to be activated as a habitual metacognition-driven response for cases to be clinically relevant (Caselli & Spada, 2015). Although, all this should be taken with consideration of the limitations of this variable as "years of use" do not encompass smoking frequency.

Also, a bi-directional relationship between smoking and metacognitive beliefs has been suggested (Nosen & Woody, 2014), which is compatible with our suggested model. Negative metacognitive beliefs propagate negative affect which in turn can trigger positive metacognitive beliefs and lead to craving and nicotine use. At the same time, a successful attempt at reducing smoking or snus use should lead to an increased feeling of control.

All in all, the results of this study further support the presence of behavior-specific metacognitions and desire thinking in nicotine dependence. That the dysregulation of desire thinking is driven by metacognitions, contributing to nicotine dependence. And moreover, that behavioral-specific metacognitions also contribute to nicotine dependence by motivating individuals to engage in smoking or snus use as a means of cognitive-emotional regulation without engaging in desire thinking. As desire thinking is likely to be dysregulated by metacognitions, it may be viewed as a type of extended thinking, a part of the CAS, and a central part of an S-REF model of addictive behavior (Spada et al., 2015).

Our findings imply a number of possible clinical implications. As suggested by Spada et al., (2015), a metacognitive conceptualization of addictive behavior indicates that central aspects of metacognitive therapy may be beneficial in the assessment, conceptualization, and treatment of addiction. In regard to assessment, information about desire thinking and related metacognitions could be gathered early on in a treatment-setting, in addition to other well-established measurements of addiction-related thoughts or craving (Caselli & Spada, 2015). Individual case-formulations which include idiosyncratic patterns of desire thinking and related

metacognitions can be formulated and communicated to the patient in order to highlight their dysfunctional interaction, and create concrete treatment goals. Therefore, helping patients to acquire tools for cognitive-affective regulation other than snus or cigarettes should only be one part of cessation treatment, and it may be helpful to use metacognitive therapy techniques in parallel to disrupt the escalation of craving, such as attention training technique (ATT), detached mindfulness, situational attentional refocusing, and the postponement of desire- and other types of extended thinking (Wells, 2009). Currently, no clinical studies have explored the interventional effects of MCT-techniques on nicotine-dependence, although a preliminary study has shown promising results using MCT as treatment for five patients diagnosed with alcohol-use disorder (Caselli, Martino, Spada & Wells, 2018),

Limitations and further research

The results of the study should be viewed in light of its limitations. First, the FTND showed questionable internal reliability, still, the alpha value was borderline questionable-acceptable, in accordance with earlier research, and the measure consists of relatively few items. All this considered, we interpreted the value as satisfactory. Second, self-report data were used in all analyses, which is prone to error in measurement. Third, our sample was not randomly selected. Most of the participants were recruited through the same social media-page which may have caused some bias. The type of person that follows a page about quitting smoking and snus may be somewhat different than a person who doesn't. Fourth, we did not explicitly explore the presence of psychological disorders in the sample, although controlling for anxiety and depression symptoms should resolve this to some degree. Fifth, we did not gather information about previous treatment or if participants had been exposed to metacognitive concepts before the study. Sixth, we did not compare our model to other established models of nicotine-dependence. Finally, because of the cross-sectional design of the study, any inference of causality should be done with certain reservations.

Several issues need to be addressed by future research. As Spada et al. (2015) have proposed, a metacognitive model of desire thinking and addictive behavior may be transdiagnostic, and similar models should therefore be tested for other addictive behaviors. Currently, the literature

of desire thinking research consists predominantly of cross-sectional studies. Longitudinal designs must be implemented to see if metacognitions and desire thinking can predict successful nicotine use cessation, which individuals in high-risk groups develop a "heavy" smoking or snus habit, whether these constructs can predict an escalation in use, and the effect of cessation on metacognitions and desire thinking. Longitudinal or experimental designs are also necessary to further test the causality-chain suggested by the model of this study. And as Caselli and Spada (2015) has already pointed out, the phenomenology of desire thinking, and its neurobiological basis also needs exploration. Here, the distinction between functional and dysfunctional desire thinking may be of special interest. With more and more data implying the role of metacognitions in addiction, we need more clinical studies where principles from metacognitive therapy are tested in the treatment of addictive behavior.

Conclusion

In conclusion, the findings of this study support a model were metacognitive beliefs play a role in the emergence and maintenance of nicotine addiction. An internal or external trigger activates positive metacognitive beliefs, either leading to smoking or snus use directly or through the escalation of craving through the dysregulation of desire thinking. This in turn leads to negative metacognitive beliefs which may mark the preservation of nicotine dependence through the propagation of negative affect, and by hindering the disruption of dysfunctional coping mechanisms.

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