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Effects of depressive symptoms on antecedents of lapses during a smoking cessation attempt:

An ecological momentary assessment study

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Running head: DEPRESSION AND SMOKING CESSATION

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ABSTRACT

Aims: To investigate pathways through which momentary negative affect and depressive symptoms affect lapse risk. **Design:** Ecological Momentary Assessment was carried out during two weeks after an unassisted smoking cessation attempt. A three-month follow-up measured smoking frequency. **Setting:** Data were collected via mobile devices in German-speaking Switzerland. **Participants:** A total of 242 individuals (age 20-40, 67% men) reported 7,112 observations. **Measurements:** Online surveys assessed baseline depressive symptoms and nicotine dependence. Real-time data on negative affect, physical withdrawal symptoms, urge to smoke, abstinence-related self-efficacy, and lapses. **Findings:** Two-level structural equation model suggested that on the situational level, negative affect increased the urge to smoke and decreased self-efficacy ($\beta = .20$; $\beta = -.12$, respectively), but had no direct effect on lapse risk. A higher urge to smoke ($\beta = .09$) and lower self-efficacy ($\beta = -.11$) were confirmed as situational antecedents of lapses. Depressive symptoms at baseline were a strong predictor of a person's average negative affect ($\beta = .35$, all $p < .001$). However, the baseline characteristics influenced smoking frequency three months later only indirectly, through influences of average states on the number of lapses during the quit attempt. **Conclusions:** Controlling for nicotine dependence, higher depressive symptoms at baseline were strongly associated with higher average negative affect during the smoking cessation attempt, which in turn were associated with a worse longer-term outcome. Negative affect experienced during the quit attempt was the only pathway through which the baseline depressive symptoms were associated with a reduced self-efficacy and increased urges to smoke, all leading to the increased probability of lapses.

KEYWORDS smoking, relapse, lapse, depression, ecological momentary assessment

INTRODUCTION

Recent and past depressive symptomatology is a robust predictor of poor smoking cessation outcomes [1-7]. Factors linking depression and relapse include higher levels of physical withdrawal symptoms [8,9], a lower self-efficacy to refrain from smoking [10,11] or higher levels of cravings [9,12]. These factors are all established predictors of lapses and relapses on the state as well as the trait level [13-23]. Yet, to date, these predictors have not been integrated into a common framework and it is not well understood to what extent and through which pathways depressive symptoms affect proximal antecedents of lapses and increase the lapse risk.

The cognitive-behavioural relapse model by Marlatt and Gordon [24-27] posits that momentary internal and external conditions such as negative affect, low self-efficacy, social pressure, or substance-related cues can create high-risk situations with a strong urge to smoke or even a lapse, defined as a one-time consumption of tobacco. Distal background variables on the person level such as personality traits or psychological distress are thought to influence momentary internal conditions in high-risk situations as well as how an individual deals with lapses and whether a lapse leads to the abandonment of the abstinence goal [24-27].

The present study examined how momentary negative affect, physical withdrawal symptoms, the urge to smoke, and abstinence-related self-efficacy influenced subsequent lapse risk on the situational level. On the person level, we analysed how and to what extent depressive symptoms as more enduring characteristics of an individual influenced a person's average situational states and the frequency of lapses during the first two weeks of an unassisted smoking cessation attempt. Furthermore, we investigated whether depressive symptoms at baseline would predict smoking frequency three months later.

On the situational level, we first expected that negative affect would reduce abstinence-related self-efficacy, which in turn would render individuals more vulnerable for lapses [16,18,28,29]. Abstinence-related self-efficacy is the confidence that one is capable of

remaining abstinent and operates through cognitive, motivational, affective and decisional processes [30-34]. Self-efficacy is thought to foster motivation and perseverance in the face of high-risk situations. Negative affect as well as a higher urge to smoke may challenge the belief of being able to remain abstinent and may thus reduce self-efficacy [24-27,34]. Second, we expected that negative affect as well as physical withdrawal symptoms would increase the urge to smoke [35]. This is in line with the negative reinforcement model of substance use [36], which assumes that addicted smokers use tobacco to escape or avoid negative affect or withdrawal symptoms. Higher urge levels in turn would increase lapse risk directly [17,23,37-39] as well as through reducing self-efficacy. Frequent elevated urges to smoke are thought to deplete one's self-control to resist smoking and can thus lead to smoking lapse [40-42]. Third, we tested whether negative affect would have an additional direct effect on lapse risk, for example as conditioned stimuli that elicit a conditioned response or by negative reinforcement [36]. The proposed model of interplay between momentary states and subsequent lapses at the situational level is illustrated in Figure 1 (top panel).

Insert Figure 1 about here

On the person-level, we tested whether the situational level pathways would be confirmed as more stable patterns of relationships between a person's average states during the first two weeks of a quit attempt, and whether depressive symptoms and nicotine dependence at baseline predicted these average states. Pervasive and persistent negative affect is a core symptom of depression [43]. Furthermore, depression-specific biases in information processing, such as a pessimistic explanatory style and increased elaboration of negative material can increase negative affect and decrease self-efficacy [44]. Thus, we expected that depressive symptoms would increase average negative affect during the smoking cessation attempt in addition to the effects of nicotine dependence and withdrawal symptoms. Furthermore, we assumed that baseline depressive symptoms would directly decrease average abstinence-related self-efficacy independent from the increase in negative

affect for example due to depression-specific cognitive biases [44] or learned helplessness [45]. Then, we assumed that depressive symptoms would increase the average reported intensity of physical withdrawal [8,9,12], possibly due to an increased internal focus on somatic symptoms or difficulties disengaging from physical withdrawal symptoms [44]. Finally, we expected that depressive symptoms would have a direct effect on lapse risk as well as on smoking frequency at the three month follow-up, for example in rendering individuals more vulnerable to social pressure [46]. In order to disentangle the effects of depressive symptoms and nicotine dependence, we controlled the analyses for the level of nicotine dependence at baseline.

METHODS

Participants and procedure

As described elsewhere [47], participants aged 20-40 years were recruited via mass media and the internet in Switzerland. The inclusion criteria were the desire to give up smoking within the next month without using smoking cessation methods and the possession of an internet-enabled mobile phone. Furthermore, participants reported the average smoking frequency during the previous year in a screening question. Only participants were invited to take part in study who smoked at least 10 cigarettes per day. After enrolling for the study, participants completed an online questionnaire for the baseline measures.

On the day they started the smoking quit attempt, they were instructed to request the EMA questionnaires. Participants were then prompted to complete a short questionnaire at three random times throughout the day between 9:00 am and 9:00 pm. The measurements took place over a four-week period. A follow-up was conducted three months after the beginning of the quit attempt. All participants received a monetary incentive of 100 Swiss Francs (around \$110) after having filled out the follow-up assessments. The study was approved by the local Ethics Committee.

A total of 370 interested volunteers filled out the baseline questionnaires and 270 participated in the EMA study (73%). The overall response rate for the EMA prompts was 54.7%. A total of 189 participants took part in the three-month follow-up (70% of those who took part in the EMA study). Due to the increasing non-compliance with the sampling scheme protocol towards the end of the four-week period, we analysed the first 14 days after smoking cessation only. Participants with only one or two observations ($n = 27$) and one multivariate outlier were excluded from the analysis.

Around two-thirds of the remaining participants were men, mean age was 28 years. The analysis sample consisted of 7,112 observations (measuring momentary emotional states, physical withdrawal symptoms, self-efficacy, urge to smoke and lapses) nested in 242 participants. The average number of observations per participant was 29 (range 3-45). The response rate for all EMA questionnaires for the analysis sample was 69%; an average of 72.4% completed at least one EMA questionnaire per day (range 97.8% at day one to 60.3% at day 13). Forty percent of the participants reported a first lapse on the first day of the quit attempt, 66% had lapsed at least once after the sixth day. A description of lapse trajectories can be found elsewhere [48]. During the first two weeks of the smoking cessation attempt, the average number of days on which participants lapsed was 5.61 ($SD = 5.52$) per participant. More detailed sample characteristics are given in Table 1.

Insert Table 1 here

Measures

At baseline, participants completed an online survey collecting socio-demographic information on gender, age, nationality, marital status, and smoking history. Depressive symptoms during the previous week were assessed using the German version of The Center for Epidemiologic Studies Depression Scale (CES-D) [49]. The questionnaire consists of 20 items rated on a four-point scale ranging from 0 ('rarely or none of the time') to 3 ('most or all of the time'). Nicotine dependence was measured with the German version of The

Fagerström Test of Nicotine Dependence (FTND) [50], a six-item self-report scale. At follow-up three months after the quit attempt, participants reported the frequency of smoking in the previous month with the response options 0 = never, 1 = 1-3 times a month, 2 = 1-6 times a week, and 3 = daily.

Using Ecological Momentary Assessment after the beginning of the quit attempt, we measured: a) momentary affect, using three items, i.e., ‘feeling content,’ ‘frustrated’ and ‘tense’ (response categories 1 = not at all to 4 = very much); b) intensity of physical withdrawal symptoms (“How severe are your current physical withdrawal symptoms on a scale of 0 to 10?”); c) intensity of the urge to smoke (“How intense is your current urge to smoke on a scale of 0 to 10?”); d) momentary abstinence-related self-efficacy (“At the present time, how confident are you that you succeed in giving up smoking on a scale from 0 to 10); and e) the occurrence of lapses since filling out the last questionnaire (0 = no/1 = yes).

Analysis

We used Stata 12 for the descriptive statistics of the baseline variables, and Mplus 7.11 [51] for the multilevel structural equation models. We applied the Diagonally Weighted Least Squares (DWLS) estimator with robust standard errors (denoted WLSMV in Mplus), which is appropriate for categorical data and provides absolute and comparative fit indices. Model fit was assessed through following different indices: the Comparative Fit Index (CFI), the Tucker Lewis Index (TLI), and the Root Mean Square Error of Approximation (RMSEA). An indication of a good model fit are indices over 0.95 for CFI and TLI [52-54] and approaching 0.05 for RMSEA [55].

EMA data were not sampled independently; rather, they were nested within the participants. Therefore, we fitted the two-level model depicted in Figure 1. The EMA data described associations at the situational level (level 1). The variable for lapses was treated as binary; the rest of situational variables were treated as continuous scales and were grand-mean

centred prior to analyses. To ensure the prospective nature of the analyses, the lapse indicator from the subsequent questionnaire ($t + 1$) was used as outcome of the current situation (t).

Personal average levels of all situational variables (negative affect, self-efficacy, withdrawal symptoms, urge to smoke and occurrence of lapses) were modelled as latent variables at the person level (level 2), as represented in Figure 1 by ovals. Person-level baseline characteristics, depressive symptoms and nicotine dependence, were introduced to explain inter-personal differences in average states across situations [56-58]. Smoking frequency at the follow up was included as an outcome variable at the person level.

RESULTS

Descriptive statistics for baseline characteristics and the EMA variables are presented in Table 1. Three months after the start of the quit attempt, 24% were abstinent and 41% had returned to daily smoking. Baseline depressive symptoms were correlated with nicotine dependence at baseline ($r = .22, p < .001$) and predicted frequency of smoking at the three-month follow-up ($\beta = -.19, p = .007$).

The two-level model

Intra-class correlations represent the proportion of the total variability in momentary states attributable to individual differences compared to situational circumstances. Person-level variation was generally smaller for momentary negative affect (.34) than for addiction-related variables (physical withdrawal symptoms .63; urge to smoke .49; abstinence-related self-efficacy .76; lapses .62). The hypothesised two-level model fitted the data well ($\chi^2 = 23.15, df = 18, p = .18, CFI = .999, TLI = .999, RMSEA = .006$). Figure 1 presents the standardised path coefficients for this model.

The situational level pathways

All the expected associations at the situational level were confirmed ($p < .001$), apart from the direct effect of negative affect on lapse risk ($\beta = -.02, p = .301$). However, due to

the very large number of sampled observations (7,112), statistical significance of even very small effects was expected. We therefore emphasise the effect sizes of estimated paths.

As expected, momentary negative affect was associated with a lower abstinence-related self-efficacy ($\beta = -.12$) and higher urge levels ($\beta = .20$). However, the urge to smoke was better predicted by physical withdrawal symptoms ($\beta = .46$) than by negative affect. Finally, higher subsequent lapse risk was predicted by the direct effect of decreased self-efficacy and the influence of increased urge to smoke, both direct ($\beta = .09$) and indirect through reduced self-efficacy (path from urge to smoke to self-efficacy $\beta = -.20$; path from self-efficacy to lapses $\beta = -.11$).

The effect of baseline depressive symptoms on a person's average states and smoking cessation outcomes

At the person level (N= 242), most relationships were significant at the $p < .001$ level. In what follows, the $p < .001$ significance level is assumed unless otherwise stated. Depressive symptoms at baseline were associated with a higher personal average of negative affect ($\beta = .35$) but not physical withdrawal symptoms ($\beta = .11$; $p = .058$) during the first two weeks of an unassisted smoking cessation attempt. Furthermore, the situational level pathways were confirmed as more stable patterns relating to individual differences. Specifically, the person's average negative affect was associated with a lower average self-efficacy ($\beta = -.31$) and higher urge levels ($\beta = .19$). Even to a greater extent than at the situational level, the average urge to smoke was predicted by average withdrawal symptoms ($\beta = .75$). Higher occurrence of lapses was predicted by higher average urge to smoke ($\beta = .32$) as well as reduced self-efficacy ($\beta = -.42$). It can be seen that the person's average states are highly predictive of the number of lapses; much more so than momentary states are predictive of situation-specific lapses.

Finally, the number of lapses during the first two weeks of the quit attempt was the only direct predictor of frequency of smoking in the three-month follow-up ($\beta = .54$). Baseline depressive symptoms and average states influenced the frequency of smoking at the follow up indirectly, through the occurrence of lapses. The hypothesised direct effects of baseline depressive symptoms on average self-efficacy ($\beta = -.09$, $p = .096$), the urge to smoke ($\beta = -.02$, $p = .607$), number of lapses ($\beta = .07$, $p = .260$) and smoking frequency at the three-month follow-up ($\beta = .02$, $p = .761$) were not confirmed.

DISCUSSION

This study aimed at providing a better understanding through which mechanisms negative affect at the situational level and depressive symptoms as more enduring person characteristics increased lapse risk during the first two weeks of an unassisted smoking cessation attempt. At the situational level, negative affect predicted lower abstinence-related self-efficacy and elevated urge levels, which in turn were direct antecedents of subsequent lapses. At the person level, these situational level pathways were confirmed as more stable patterns. While the associations at the level of situation-specific lapses were mainly weak, a person's average states were highly predictive of the frequency of lapses during the first two weeks of the quit attempt. Specifically the associations between negative affect and abstinence-related self-efficacy, self-efficacy and frequency of lapses as well as urge to smoke and lapses were stronger at the person level. Depressive symptoms at baseline, controlling for the effects of nicotine dependence, were strongly associated with higher average negative affect experienced by a person during the quit attempt. However, we did not find direct effects of depressive symptoms on average self-efficacy, urge to smoke, the frequency of lapses, and smoking frequency at follow-up.

Overall, our results corroborate previous evidence that on the situational level, negative affect, lower self-efficacy, higher levels of withdrawal symptoms, and higher levels of the urge to smoke directly or indirectly contribute to a higher lapse risk. Additionally, our

ecological momentary assessment study elucidated associations between these states.

Negative affect was associated with decreased self-efficacy and increased urge to smoke.

Thus, negative affect seemed to undermine one's confidence in being able to remain abstinent directly as well as indirectly via an increased urge. Both pathways might stimulate motivational and decisional processes leading to lapses [30-34]. Negative affect and withdrawal were only indirectly associated with lapse risk via decreased self-efficacy and increased urge to smoke. Against our hypothesis, momentary negative affect did not have an additional direct association with subsequent lapse risk. Therefore, our findings did not support models which assume that negative affect directly triggers a lapse or operates as conditioned stimulus that elicits a conditioned response. This concurs with some previous EMA studies [22,23,59], which did not find an effect of negative affect when taking levels of craving into account. One explanation is that negative affect is too volatile to predict subsequent lapses that in our design may occur hours later or even the next day [22].

At the person level, our results suggest that the link between baseline depressive symptoms and less favourable smoking cessation outcomes was mediated by higher situational negative affect. As negative affect is a main characteristic of depression [43], we expected a strong effect on situational negative affect during the smoking cessation attempt. More surprising was the lack of a direct effect of depressive symptoms on abstinence-related self-efficacy, which was only indirectly influenced via negative affect. However, the association between depression and self-efficacy [61] must be qualified in the context of an unassisted smoking cessation attempt. One prerequisite of an unassisted quit attempt is a certain degree of abstinence-related self-efficacy, which might be more robust than in individuals who do not try to quit smoking at all or undergo a smoking cessation intervention. However, situational negative affect in self-quitters might compromise otherwise robust abstinence-related self-efficacy. Also in contrast to other studies [8,9,12], our findings did not

support an association between baseline depressive symptoms and elevated physical withdrawal symptoms or higher urge levels when controlling for nicotine dependence.

In summary, our results suggested that the path linking baseline depressive symptoms and smoking cessation outcomes was mediated by increased negative affect experienced by a person during the quit attempt, which in turn decreased situational abstinence-related self-efficacy and increased the urge to smoke. Thus, baseline depressive symptoms, controlled for nicotine dependence, seemed to have more impact on affective than on cognitive or behavioural antecedents of lapses during the smoking cessation attempt.

Some limitations of this study must be kept in mind. EMA assesses real experiences in a given context at a particular time better than self-report questionnaires, which measure rather subjective mental representations of experiences. Therefore, EMA data are less prone to memory or cognitive judgment biases [51,62]. This is important as there is evidence for biased memory processes for emotional material, overly general autobiographical memory, and increased elaboration of negative information in depressed individuals [44]. A drawback of our EMA approach is that filling out the ecological momentary assessments three times a day may have increased self-monitoring and affected the associations of the antecedents of lapses and lapse risk in high-risk situations. Furthermore, in order not to be too disruptive we limited the number of EMA items. Thus, the intensity of physical withdrawal symptoms and abstinence-related self-efficacy were assessed with a one-item question instead of a more comprehensive measure.

Moreover, we assessed negative affect, self-efficacy, withdrawal symptoms, and the urge to smoke for the same timeframe. Therefore, we could not establish the temporal associations between these variables. Lapses as outcomes were used from the subsequent EMA assessment, which was not necessarily from the same day. Although there is a longitudinal sequence in the assessment of baseline characteristics, EMA items, subsequent

lapses, and the smoking frequency at follow-up, the results can only be interpreted in terms of predictive but not causal relationships.

Some sample characteristics may limit generalisability of the results. This study included a self-selected sample in which participants were prepared to undergo intensive data collection. The extensive EMA over 30 days may be a reason for the relatively low response rate of 55%. Men were overrepresented in our sample, average age of the participants was relatively low and the level of nicotine dependence was low to moderate. One explanation for the lacking direct effects of baseline depressive symptoms may be that our sample consisted of self-quitters with an average level of low to moderate nicotine dependence and non-clinical depressive symptoms. Therefore, our results have to be replicated in other samples with participants with higher nicotine dependence. Furthermore, we measured depressive symptoms retrospectively at baseline within a one-week window and did not ascertain how long they had persisted before the start of the study. Thus, we cannot differentiate between depressive symptoms that were associated with the anticipation of the quit attempt and a depressive disorder or personality trait. Furthermore, we could not verify self-report data on smoking biochemically.

Conclusions: Negative affect was associated with decreased self-efficacy and increased urge to smoke, which in turn increased lapse risk at the situation level. Depressive symptoms at the baseline, controlling for the effects of nicotine dependence, were strongly associated with higher average negative affect experienced by a person during the smoking cessation attempt. This was the only pathway through which depressive symptoms influenced lapse risk and a higher smoking frequency three months after the smoking cessation attempt.

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Table 1

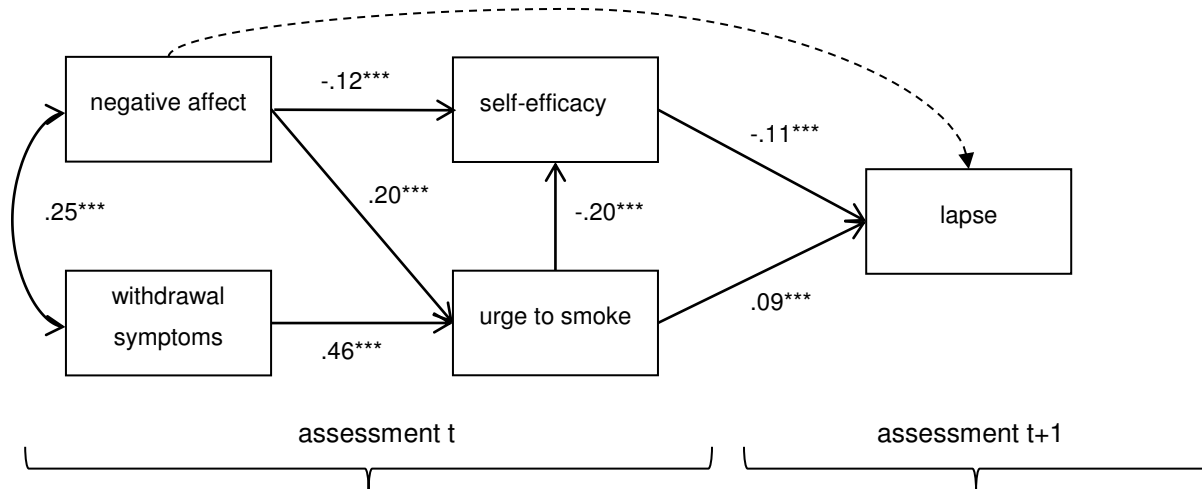
Descriptive Statistics for the Baseline Characteristics, the EMA Outcomes and the Frequency of Smoking at the Three-Month Follow-up

	Mean or %	SD
Baseline characteristics (N = 242)		
Male sex	66.94%	
Not married	83.00%	--
Age	28.16	5.50
Swiss Nationality	91.49%	--
Age of smoking onset	16.89	2.87
Cigarettes per day		
- between 11 and 20	83.00%	--
- over 20	17.00%	--
Depressive symptoms (CES-D total score)	14.44	9.14
Nicotine dependence (FTND total score)	3.86	1.88
Experience sampling observations (N=7,112)		
Negative affect (3-12)	5.47	1.70
Withdrawal symptoms (0-10)	3.46	0.15
Urge to smoke (0-10)	4.64	1.14
Self-efficacy (0-10)	6.56	1.14
Lapses ^a	24.83%	--
Frequency of smoking in the previous month at follow-up (N = 173)		
Never	23.70%	--
1-3 times a month	15.61%	--
1-6 times a week	19.65%	--

Daily	41.04%	--
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Note: ^a percentage of participants reporting lapses; * $p < .05$, ** $p < .01$, *** $p < .001$

Figure 1: Two-level model of momentary and distal effects of depressive symptoms and nicotine dependence on lapse risk, with standardised estimates of path coefficients (* $p < .05$, *** $p < .001$, broken line = non-significant path, ave. = average).



Situational level (level 1)

