Trajectories in cigarette dependence as a function of anxiety: a multilevel analysis

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Abstract

BACKGROUND: We assessed the association of anxiety with cigarette dependence over time, depending on smoking status (daily, occasional or ex-smoker); and the association of anxiety with (a) smoking cessation, (b) reduction, and (c) relapse. METHODS: A prospective Internet survey of 1967 ever smokers was assessed three times at 2 weeks interval, in 2007-2010. Cigarette dependence was assessed using the cigarette dependence scale. Predictors included time, smoking status (daily, occasional or ex-smoker) and anxiety. All measures were assessed at each time point. RESULTS: Dependence decreased over time (slope=-0.21, p
Trajectories in cigarette dependence as a function of anxiety: A multilevel analysis

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Methods: A prospective Internet survey of 1967 ever smokers was assessed three times at 2 weeks interval, in 2007–2010. Cigarette dependence was assessed using the cigarette dependence scale. Predictors included time, smoking status (daily, occasional or ex-smoker) and anxiety. All measures were assessed at each time point.

Results: Dependence decreased over time (slope = −0.21, p < 0.001), as did feeling prisoner of cigarettes (slope = −0.25, p < 0.001). Both decreased faster between week 0 and week 2 then between week 2 and week 4 (slopes = 0.25, and 0.13; p < 0.01). Differences in anxiety across individuals were associated with dependence (slope = −0.28, p = 0.001), feeling prisoner of cigarettes (slope = −0.38, p < 0.001), cessation (OR = 0.42, p = 0.001), relapse (OR = 1.81, p < 0.01), but not with smoking reduction (OR = 0.85, p = 0.35). Change over time in anxiety (within individuals) was associated with dependence (slope = −0.11, p = 0.04), nor feeling prisoner of cigarettes (slope = −0.21, p = 0.02), predicted smoking cessation (OR = 0.51, p < 0.001), smoking reduction (OR = 0.67, p = 0.047), and relapse (OR = 1.52, p = 0.03).

Conclusions: Cross-sectionally, cigarette dependence, feeling prisoner of cigarettes, and smoking cessation were associated with anxiety; whereas prospectively, smoking cessation, reduction, and relapse were predicted by state anxiety. Thus, anxiety is an important factor that is associated with smoking behavior. Implications for treatment are discussed.

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1. Introduction

Understanding factors that influence the variability of smoking behavior can be useful for clinicians who treat dependent smokers. Studies of day-to-day variation in smoking behavior, in particular studies using ecological momentary assessment (EMA) have shown that the number of cigarettes smoked is quite stable (Hughes et al., 1991; Shiffman et al., 2008; Stone and Shiffman, 1994). However, the predictors of the variability of smoking behavior and tobacco dependence over time are incompletely documented. Determinants of a specific smoking event include negative affect regulation (Colvin and Mermelstein, 2010; Hedeker et al., 2009; Shiffman, 2009; Shiffman and Waters, 2004), mood variability (i.e., different ratings of mood across time), mood regulation (i.e., using strategies to modulate a personal mood state), and depression (Weinstein and Mermelstein, 2013). Mood variability is closely connected to variability in anxiety, in that difficulties to use certain strategies to regulate ones mood, may be related to difficulties to regulate ones anxiety. This, in turn, may predict variability in smoking behavior.

Dependent smokers seek to maintain a satisfactory blood level of nicotine. However, chronic administration of nicotine leads to an increase in the number of nicotinic receptors, which in turn reinforce nicotine withdrawal symptoms (Dani and De Biasi, 2001)
that include anxiety and anxiolytic responses (Costall et al., 1985). Smokers could also be smoking predominantly for pleasure and relaxation effects that approach the effects produced by anxiolytics (Juniper et al., 2005). Thus, smoking behavior may be stable over time, due to the entrenched habits, the short half-life of nicotine and the possibility of reduced withdrawal symptoms, but it may also be variable, due to its association with anxiety and stress, which vary over time (Huang, 2011; Iversen, 2009). People may for example smoke occasionally to reduce anxiety in given moments, but since nicotine has been shown to be anxiety provoking, they may momentarily reduce anxiety, only to then find themselves with greater anxiety levels (Moylan et al., 2012).

Risk factors for being a smoker include depression, anxiety (McClave et al., 2009), and stress (Childs and De Wit, 2010; Parrott, 1999; Parrott and Murphy, 2012). The immediate positive reinforcement of smoking includes the reduction of anxiety, increased alertness and concentration, whereas smoking withdrawal evokes anxiety, restlessness, impatience, and depressed mood (Hughes et al., 1991). Furthermore, the prevalence of smoking is high among people with psychiatric disorders, (Leonard, 2002; Lichlyter, 2010; McKenzie et al., 2010), including those with anxiety disorders (Kenfield et al., 2010; McKenzie et al., 2010). However, this association between anxiety and smoking could be due to anxious individuals being more prone to smoking (this effect could be called an inter-individual effect of anxiety). But increased anxiety and/or stress within individuals over time could also lead to increased smoking (intra-individual effect). The current study therefore investigated both inter-individual differences and within-individual fluctuations in anxiety, and how these were related to smoking behavior.

2. Methods

Between 2007 and 2010, all visitors of a smoking cessation website were invited to answer the survey. Previous research showed that visitors of this website were more motivated to quit than smokers in the general population (Wang and Etter, 2004).

The Internet self-report questionnaire, in French, is available here: http://www.stoptabac.ch/fr/TabletHum/q-del-phine-200-08-06.htm. Participants who provided an e-mail address were invited to complete two follow-up surveys, 2 and 4 weeks after their initial participation. Participants were not paid but received feedback on their level of dependence after the completion of the last survey at 4 weeks. Analyses were restricted to participants who answered at least two surveys, because we needed at least two data points in order to calculate cessation, reduction, and relapse. The study was approved by the ethics committee of the Faculty of Psychology of the University of Geneva. The participants informed of the purpose of the study and had an option to decline to have their data stored on file.

2.1. Measurements at each time point

2.1.1. The cigarette dependence scale (CDS). The CDS is a 12-item self-report measure of dependence intended for current smokers, which measures craving, cigarettes smoked per day, loss of control, time allocation, neglect of other activities, and persistence of use despite harm, as defined by the DSM-IV (American Psychiatric Association, 1994) and the ICD-10 (World Health Organization, 1992). Most items are answered on a 5-point Likert scale from totally disagree (coded 1) to fully agree (coded 5). The CDS has high test retest reliability ($r_{xx} = 0.83$), and high internal consistency ($\alpha = 0.90$; Courvoisier and Etter, 2010; Etter et al., 2003; Etter, 2005), even though the internal consistency of CDS-12 is lower among light smokers (Okuyemi et al., 2007).

2.1.2. Feeling prisoner to cigarettes (“prisoner”). This CDS item assesses whether participants feel prisoners to cigarettes (psychological dependence) on a 5-point Likert scale from not at all (coded 1) to completely (coded 5), and is the only CDS item that can be answered by both current and former smokers.

2.1.3. The State-Trait Anxiety Inventory – State (STAI-S). The STAI-S (Spielberger et al., 1983) is a 20-item inventory that assesses the temporary or emotional state anxiety in adults. The essential qualities evaluated by the STAI-S Anxiety scale are feelings of nervousness, tension, apprehension, and worry. Items are answered on a 4-point Likert scale from not at all (1) to completely (4) with higher scores reflecting greater levels of anxiety. The STAI-S has a high degree of internal consistency ($\alpha = 0.86$; Spielberger, 2005).

2.1.4. Smoking status. Smoking status was assessed by a question asking participants if they were (1) daily, (2) occasional or (3) ex-smokers.

2.1.5. Smoking cessation. Based on the question above, we compared baseline daily smokers who were still smoking at follow-up (n = 717) with baseline smokers who had quit smoking at the 2- or 4-week follow-up (n = 249).

2.1.6. Smoking relapse. We compared baseline ex-smokers who were still abstinent at the 2- or 4-week follow-up (n = 474) with baseline ex-smokers who relapsed to smoking at the 2- or 4-week follow-up (n = 73).

2.1.7. Smoking reduction. We compared baseline daily smokers who maintained their cigarette consumption at the 2- or 4-week follow-up (n = 286) versus baseline daily smokers who reduced cigarettes/day by at least 50% (n = 136).

2.2. Analysis

We used mixed linear models with an identity link to examine the effect of anxiety on (1) cigarette dependence, and (2) feeling prisoner to cigarettes. Mixed linear models allow the assessment of individual characteristics that vary among individuals over time (e.g., level of dependence). For example, individual differences in baseline dependence may be affected by these varying characteristics across different individuals (random intercept model). They also allow estimating differences in change over time in dependence ratings across different individuals (random slope model). The usefulness of including a random intercept and random slope was assessed using likelihood ratio tests. Multilevel modeling is also more appropriate for clinical longitudinal data, because it does not require listwise deletion and allows using all available data (i.e., different number of measures for each individual). Residual plots were examined to check for conditional normality and homogeneity of variance.

To examine the effect of both inter-individual differences and intra-individual differences in anxiety, we separated anxiety into a mean level over the three time points (mean anxiety score) and a deviation from that mean level for each individual at each time point (deviation anxiety score) and included these two repeated measure variables as fixed effects predictors (Neuhaus and Kalbfleisch, 1998). Mean level in anxiety would allow us to test the hypothesis that more anxious individuals could be inclined to smoke more (effect of inter-individual differences). Deviation in anxiety would test the hypothesis that an individual who is more anxious at a specific moment could be inclined to smoke more at that moment (effect of intra-individual differences).

The independent repeated measure variables were (1) time and time squared, to estimate a (potentially non linear) trend over time, (2) mean anxiety and deviation anxiety, and (3) smoking status. Time and time squared were centered around their mean to avoid multicollinearity problems. To examine whether the impact of intra-individual anxiety on subjects’ trajectories of dependence differ for daily versus occasional smokers, we included the following two-way interactions: time and smoking status (to investigate whether the effect of smoking status on dependence is dependent on time), time and intra- as well as inter-individual anxiety (to investigate whether the effect of smoking status on dependence is dependent on time), smoking status and intra- and inter-individual anxiety (to investigate whether the effect of smoking status on dependence is dependent on intra-individual anxiety). To control for age and sex, those variables were added to the model as covariates.

Since the cigarette dependence scale consists of questions that cannot be answered by ex-smokers (e.g., how many cigarettes they smoke a day), we excluded ex-smokers from this analysis. Because feeling prisoner to cigarettes is a CDS item that can be answered by both current and former smokers, the mixed linear model with prisoner as the outcome included also ex-smokers in the analysis.

We used generalized linear mixed models with a logit link for the effect of anxiety on (1) smoking cessation, (2) smoking reduction, and (3) smoking relapse. For each outcome, the fixed effects were the same: time difference (0-2 weeks and 0-4 weeks), mean anxiety, and deviation in anxiety. Again age, and sex were added as covariates to be controlled for. We did not include any interactions in these models. Analyses were performed using SPSS v21.0 (IBM Corp., Armonk, NY, USA).

3. Results

3.1. Characteristics of participants

A total of 1967 individuals completed the initial survey, 889 completed the second survey (45%) and 637 the third survey (32% Table 1). Response rates to the 2-week and 4-week surveys were similar in daily, occasional and ex-smokers (data not shown). Two thirds of the participants were female and the mean age at baseline was 39 years (SD: 11.4). Most participants at baseline (69%) were daily smokers and 25% were ex-smokers (mean duration of abstinence: 174 days, SD = 887 days). Participants showed a large range of dependence and anxiety scores (Table 1). Many participants quit
### Table 1
Sample characteristics.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Initial survey (N = 1967)</th>
<th>p-Value</th>
<th>2-Week follow-up (N = 886, 1117 missing)</th>
<th>p-Value</th>
<th>4-Week follow-up (N = 633, 1370 missing)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daily (N%)</td>
<td>Occasional (N%)</td>
<td>Ex (N%)</td>
<td>Daily (N%)</td>
<td>Occasional (N%)</td>
<td>Ex (N%)</td>
</tr>
<tr>
<td>Smoking status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N (%)</td>
<td>1382 (69%)</td>
<td>73 (3.6%)</td>
<td>502 (25.1%)</td>
<td>&lt;0.001</td>
<td>409 (20.4%)</td>
<td>65 (3.2%)</td>
</tr>
<tr>
<td>Age, mean (SD)</td>
<td>34.05 (11.73)</td>
<td>29.55 (12.91)</td>
<td>37.81 (10.64)</td>
<td>&lt;0.001</td>
<td>38.17 (11.68)</td>
<td>34.09 (11.57)</td>
</tr>
<tr>
<td>Sex, N (%)</td>
<td>Male</td>
<td>102 (31.5%)</td>
<td>6 (50.0%)</td>
<td>66 (29.5%)</td>
<td>&lt;0.01</td>
<td>140 (34.6%)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>222 (68.5%)</td>
<td>6 (50.0%)</td>
<td>158 (70.7%)</td>
<td>265 (65.4%)</td>
<td>41 (63.1%)</td>
</tr>
<tr>
<td>Dependence, mean (SD)</td>
<td>3.90 (0.71)</td>
<td>2.30 (0.71)</td>
<td>3.00 (1.35)</td>
<td>&lt;0.001</td>
<td>3.70 (0.73)</td>
<td>2.35 (0.83)</td>
</tr>
<tr>
<td>Student Anxiety, mean (SD)</td>
<td>0.05 (0.21)</td>
<td>0.06 (0.25)</td>
<td>0.07 (0.30)</td>
<td>0.156</td>
<td>0.04 (0.29)</td>
<td>-0.01 (0.30)</td>
</tr>
</tbody>
</table>

Note: Multiple comparisons Bonferroni corrected.

3.2. Cigarette dependence

Data are shown in Table 2. In current smokers, CDS scores decreased over time (significant effect of time; p < 0.01), quickly between week 0 and week 2, then more slowly between week 2 and week 4 (significant effect of time squared; p < 0.01). Neither the linear nor the quadratic decrease varied between daily and occasional smokers (no significant interactions). In current smokers, anxiety ratings were associated with CDS ratings, both when looking at inter-individual differences, and when looking at intra-individual differences. At the inter-individual level, one unit increase in anxiety (range: 1–4) across different persons was associated with 0.28 points higher CDS scores (range: 1–5) (p < 0.0001), independently of smoking status (no significant interaction). At the intra-individual level, trajectories of dependence over time were associated with a one unit decrease in anxiety (range: 1–4) across different persons, independently of smoking status (no significant interaction). As expected, occasional and ex-smokers felt significantly less prisoner to cigarettes than daily smokers (p < 0.001; Table 3). Feeling prisoner to cigarettes' scores decreased over time (significant effect of time; p < 0.01), quickly between week 0 and week 2, then more slowly between week 2 and week 4 (significant effect of time squared; p < 0.01). However, this decrease varied across smoking status (p interaction time by smoking status: <0.0001; Fig. 1) in that stable ex-smokers showed a significantly greater decrease than stable daily smokers over time (difference in slope = 0.44, p < 0.0001). Anxiety ratings were associated with feeling prisoner to cigarettes, both when looking at inter-individual differences (p < 0.001), and when looking at intra-individual differences (p = 0.02). A one unit increase in anxiety was associated with 0.36 points greater scores of feeling prisoner to cigarettes (p < 0.001), independently of smoking status (no significant interaction). 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Table 2
Main effects of multilevel analysis for CDS.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>CDS scores&lt;sup&gt;*&lt;/sup&gt;</th>
<th>B</th>
<th>p</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking status</td>
<td>Daily</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Occasional</td>
<td>−1.28</td>
<td>&lt;0.0001</td>
<td>−1.67</td>
<td>−0.90</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>−0.21</td>
<td>&lt;0.0001</td>
<td>−0.32</td>
<td>−0.10</td>
</tr>
<tr>
<td>Time&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td>0.07</td>
<td>&lt;0.001</td>
<td>0.03</td>
<td>0.12</td>
</tr>
<tr>
<td>Mean anxiety</td>
<td></td>
<td>0.28</td>
<td>&lt;0.0001</td>
<td>0.21</td>
<td>0.34</td>
</tr>
<tr>
<td>Deviation anxiety</td>
<td></td>
<td>−0.11</td>
<td>0.04</td>
<td>−0.21</td>
<td>−0.01</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>0.01</td>
<td>&lt;0.0001</td>
<td>0.008</td>
<td>0.014</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td>0.04</td>
<td>0.24</td>
<td>−0.03</td>
<td>0.11</td>
</tr>
</tbody>
</table>

<sup>*</sup> Note: Total N at baseline = 1465, total N after 2 weeks = 474, and total N after 4 weeks = 305. Daily smokers = reference group.

Table 3
Main effects of multilevel analysis for prisoner.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>Prisoner scores&lt;sup&gt;*&lt;/sup&gt;</th>
<th>B</th>
<th>p</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking status</td>
<td>Daily</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Occasional</td>
<td>−1.31</td>
<td>&lt;0.0001</td>
<td>−1.97</td>
<td>−0.67</td>
</tr>
<tr>
<td></td>
<td>Ex</td>
<td>−2.08</td>
<td>&lt;0.0001</td>
<td>−2.50</td>
<td>−1.65</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>−0.25</td>
<td>&lt;0.01</td>
<td>−0.44</td>
<td>−0.07</td>
</tr>
<tr>
<td>Time&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td>0.13</td>
<td>&lt;0.01</td>
<td>0.05</td>
<td>0.20</td>
</tr>
<tr>
<td>Mean anxiety</td>
<td></td>
<td>0.38</td>
<td>&lt;0.0001</td>
<td>0.27</td>
<td>0.49</td>
</tr>
<tr>
<td>Deviation anxiety</td>
<td></td>
<td>−0.21</td>
<td>0.02</td>
<td>−0.40</td>
<td>−0.03</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>0.02</td>
<td>&lt;0.0001</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td>0.24</td>
<td>&lt;0.0001</td>
<td>0.14</td>
<td>0.34</td>
</tr>
</tbody>
</table>

<sup>*</sup> Note: Total N at Baseline = 1967, total N after 2 weeks = 886, and total N after 4 weeks = 633. Daily smokers = Reference group.

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3.6. Smoking relapse

Smoking relapse rates were different across the 2-week and 4-week follow-up. In baseline ex-smokers, significant association involved anxiety ratings with smoking relapse, when looking at inter-individual differences: a one unit difference in anxiety across individuals was associated with 1.81 greater odds of smoking relapse (p = 0.014). At the intra-individual level, trajectories of smoking relapse over time depended on individual deviation in anxiety. In other words, an increase of one unit in intra-individual anxiety led to 1.52 greater odds of smoking relapse (p = 0.041).
4. Discussion

In this prospective study of smokers interested in quitting or having just quit, we examined associations between anxiety and cigarette dependence, and we assessed whether change over time in anxiety within individuals was associated with cigarette dependence.

With respect to trajectories of smoking, smokers decreased their dependence levels over time, but indicators of dependence (e.g., feeling prisoners of cigarettes) decreased much faster in ex-smokers than in occasional or daily smokers, probably because these ex-smokers had quit smoking very recently. These findings contrast with previous studies showing a stability of dependence over time (e.g., French and Sutton, 2010; Hughes et al., 1991), but are in line with other studies of cigarette consumption (e.g., Yong et al., 2012). This is probably due to the fact that visitors of this study’s website were interested in quitting and were actively trying to quit or to reduce their cigarette consumption (Wang and Etter, 2004). Alternatively, the decrease over time in dependence ratings could be due to a reactivity effect; i.e., repeated self-monitoring may alter the measurement of symptoms or behaviors (French and Sutton, 2010). This effect could also be explained by self-selection, as, like in most Internet studies, we observed a substantial loss to follow-up (Table 1; Cook et al., 2000; French and Sutton, 2010).

Anxiety was associated with dependence levels, both when looking at inter- as well as intra-individual differences in anxiety. Interestingly, our results showed that an increase in mean anxiety predicted an increase in dependence, whereas an increase in anxiety compared to one’s own usual level was associated with a decrease in dependence. Change over time in anxiety within, and between individuals was not related to trajectories in dependence for neither smoking status. Although empirical studies indicate that anxiety is associated with smoking behavior (Brown et al., 2001; Gregor et al., 2008; Zvolensky et al., 2006, 2008), our results of intra- and inter-individual differences were in line with those findings. In this sample only daily, and occasional smokers were included, thus there may not have been enough variability to find differences. However, this result is in line with the assumption that more generally anxious people are more prone to smoking (e.g., Parrot, 1999).

Differences in anxiety across individuals and intra-individual change in anxiety levels over time showed a significant influence on smoking cessation. Overall, individuals less anxious than other individuals, and less anxious than their own usual anxiety levels had more chance to stop smoking, or to reduce number of cigarettes per day. They also had less chance to relapse. This negative association between smoking cessation and anxiety is in line with results from a study following smokers’ anxiety levels just after their cessation (West and Hajek, 1997), which found that anxiety levels decrease after cessation. Additionally, as time goes on, the probability for cessation increases. This could be due to the short time of follow-up, but it also speaks to the proneness to cessation across time. Smoking cessation is not less probable after 4 weeks than it is after 2 weeks. It remains very relevant to further investigate this trend in a longer-term follow-up, to see whether these lapses turn into relapses. The results on smoking relapse and smoking reduction differed from the ones on smoking cessation in that they showed no differences in time, and smoking reduction only showed a significant influence of intra-individual anxiety. In other words, intra-individual anxiety but not inter-individual anxiety significantly predicted smoking reduction. Smoking relapse however, was predicted by both inter-individual, and intra-individual anxiety. Thus both generally anxious persons, as persons who are more anxious compared to their usual level are more prone to relapse, and less prone to stop smoking, whereas only persons who are less anxious compared to their usual level are more prone to smoking reduction.

4.1. Implications for treatment

These results suggest that smokers may benefit from treatment approaches that specifically target these anxiety-related processes for the purpose of facilitating quitting and preventing relapse (Goodwin et al., 2011a,b; Zvolensky et al., 2006). Even if smoking cessation decreases anxiety (West and Hajek, 1997), a greater decrease seems to reduce the risk of relapse. At least two main types of treatment can be considered. First, anti-anxiolytics drugs will reduce anxiety overall, as well as momentary peaks in anxiety. Second, self-help techniques, such as deep breathing and mindfulness exercises, may be an intervention strategy that can be used to allow smokers to lower their anxiety levels when they need it most.

4.2. Strengths and limitations

Strengths included the large sample of current and former smokers from various countries, prospective study design with repeated measurements, and validated instruments of measure. On the other hand, the present sample is composed of a self-selected group of Internet users, who were more motivated to quit and more dependent than smokers in the general population (French and Sutton, 2010). In addition, as is the case in most Internet surveys (Etter, 2008), the response rates at follow-up were relatively low. The self-selection of participants and the low response rates may lead the level of dependence to be underestimated, if more dependent smokers were more often lost to follow-up (for analysis of attrition see Table 1). Similarly, participants may be more or less anxious than a general population of smokers. However, this may not affect the relationship between anxiety and cigarette dependence, which was the main goal in this study, if anxiety is not related to loss to follow-up. A third limitation concerns potential confounders. In particular, we did not collect information on medication and treatments, including smoking cessation treatment. Additional factors such as self-efficacy, social support, life-satisfaction, comorbid mental illness, or psychiatric history, for example, may also confound the relationship between anxiety and smoking behavior. Thus, this association may not be considered as causal, but does indicate how anxiety and dependence and smoking behavior co-vary in time. Also, since we did not measure
lapses in smoking among quitters, it is not possible to examine the impact of lapses on anxiety. Finally, the study lasted only 4 weeks. Future research may want to address these issues over a longer time period (e.g., to address the cessation-lapse-relapse cycle).

4.3. Conclusions

In conclusion, the present findings underline the difference in trajectories of dependence between daily, occasional and ex-smokers. Furthermore, this study highlights the importance of considering both stable and momentary anxiety to predict cigarette dependence.

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Contributors

Dr. Courvoisier designed the study and protocol. Dr. Etter advised on the background to the study. Dr. Haller conducted the background literature search. Dr. Courvoisier collected the data. Dr. Haller conducted the data analysis. Dr. Courvoisier assisted in data analysis. Dr. Haller wrote the manuscript. All authors contributed to the manuscript revisions.

Conflict of interest

There are no conflicts of interest.

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