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The relative role of nicotine dependence and smoking-related cognitions in adolescents’ process of smoking cessation

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The present study evaluates the role of distinct components of nicotine dependence (craving, withdrawal, behavioural dependence) in comparison to smoking-related cognitions (attitudes, perceived social approval, self-efficacy) in adolescent smoking cessation. In the process towards smoking cessation, we distinguish between distinct behavioural transitions, respectively, short-term abstinence, reduction in smoking behaviour and prolonged cessation, to evaluate differences in cessation-related antecedents as a function of varying behavioural outcomes. A total of 850 adolescent smokers (age 14–16) participated in the present study. Smoking behaviour was assessed 1 year after baseline. Results showed that all dependence components had a distinct role in the prediction of behavioural change towards cessation. Furthermore, each behavioural transition was predicted by a distinct set of variables, indicating that contributions of cessation-related factors vary across the course towards cessation. Overall, our findings suggest that smoking-related cognitions are particularly relevant in the initiation of behavioural change, such as short-term abstinence, whereas nicotine dependence, craving in particular, becomes increasingly important in the prediction of maintained behavioural change, such as prolonged cessation. Implications encompass enhanced attention to the multidimensional nature of nicotine dependence and the value of comparing different behavioural outcomes in a comprehensive understanding of cessation-related factors.

Keywords: adolescents; smoking cessation; nicotine dependence; cognitions; longitudinal research

Introduction

Initiation of cigarette smoking typically occurs during adolescence. Once regular patterns of smoking behaviour are established, 75% of adolescents will continue to smoke in adulthood (Sussman, Dent, Severson, Burton, & Flay, 1998). Similar to adults, the majority of adolescent smokers wish to quit, and approximately 60% report that they have tried to quit during the past year (Abrantes et al., 2009; Burt & Peterson, 1998). Unfortunately, most quit attempts fail with relapse rates up to 92% (Bancej, O’Loughlin, Platt, Paradis, & Gervais, 2007). In order to develop effective
approaches to reduce youth smoking, there is a need to increase the understanding of
the mechanisms underlying smoking cessation.

Smoking cessation is commonly regarded as a process rather than a dichotomous
event. In the course towards eventual cessation, smokers may often shift between a
variety of smoking-related motivational and behavioural patterns. In past research,
intrapersonal change has often been examined in terms of motivational transitions,
for example, as conceptualised by the transtheoretical model of change (Prochaska &
DiClemente, 1983). In terms of behavioural transitions, antecedents of smoking
cessation are often evaluated emphatically for prolonged abstinence, as this is usually
considered the main criterion in smoking cessation research. In consequence,
important precursors of cessation, such as short-term abstinence or reduction in
smoking behaviour (Carpenter, Hughes, Solomon, & Callas, 2004; Hymowitz et al.,
1997), are easily overlooked. The role of factors that facilitate or compromise one’s
ability to refrain from smoking may vary greatly as a function of the individual’s
position in the cessation process (Tucker, Ellickson, Orland, & Klein, 2005).

To facilitate a more comprehensive understanding of cessation-related factors, the
present study distinguished between short-term abstinence, reduction in frequency of
smoking behaviour and prolonged smoking cessation for at least 1 month. These
outcomes are frequently distinguished in cessation trials. Additionally, comparison
between short-term abstinence and prolonged cessation enables the distinction
between the initiation and the maintenance of behavioural change, as both have been
proposed to be regulated by different factors (Baldwin et al., 2006).

Up to this point, only a limited number of studies have prospectively examined
the predictors of smoking cessation among adolescents (Chang et al., 2006; Engels,
Knibbe, De Vries, & Drop, 1998; Kleinjan et al., 2008, 2009a; Rose, Chassin,
Presson, & Sherman, 1996; Tucker, Ellickson, & Klein, 2002; Zhu, Sun, Billings,
Choi, & Malarcher, 1999). Repeatedly, nicotine dependence and smoking-related
cognitions have emerged as predictors of adolescent smoking cessation. However,
little is known about how these factors relate to prospective cessation when studied
in a multivariate framework and, moreover, how these factors relate to varying
behavioural outcomes in the process of smoking cessation.

Nicotine dependence is one of the strongest known predictors of smoking
cessation. In adolescent smokers, the occurrence of dependence symptoms was found
to be a precursor of daily smoking (DiFranza et al., 2002a), a barrier to smoking
cessation (Colby, Tiffany, Shiffman, & Ni.wha, 2000; Prokhorov et al., 2001) and is
associated with relapse to smoking (Bagot, Heishman, & Moolchan, 2007; Colby
et al., 2000; Horn, Fernandes, Dino, Massey, & Kalsek, 2003). Nicotine
dependence is perceived to be a complex disorder and research suggests variations
in the occurrence and intensity of different nicotine-dependence symptoms among
adolescents (DiFranza et al., 2000). Craving, defined as an urge to smoke or an
intense wanting of cigarettes, is commonly the first symptom of dependence and has
been found to occur within days after smoking initiation (DiFranza et al., 2000).
With increasing tolerance, the duration of relief provided by each cigarette shortens
progressively (DiFranza & Wellman, 2005). If the adolescent does not restrain
consumption, the latency to craving shortens increasingly and may be experienced as
soon as 20 min after having smoked the last cigarette. Withdrawal symptoms as well
as physical tolerance are assumed to be related to physiological adaptations due to
the repeated nicotine administration. Withdrawal-related adaptations are proposed
to occur quickly after nicotine administration while tolerance, usually measured in
terms of smoking behaviour (e.g. smoking frequency and time to first cigarette), is considered to develop more slowly – on an average it takes youth 2 years to develop moderate daily use (DiFranza & Wellman, 2005).

We hypothesised that the different components of nicotine dependence relate differently to the varying behavioural outcomes in smoking cessation, which is supported by recent research (Kleinjan et al., 2010). Repeatedly, craving has been found to be strongly associated with relapse following a quit attempt (Bagot et al., 2007; Killen & Fortmann, 1997; Van Zundert, Boogerd, Vermulst, & Engels, 2009). Craving can continue to persist even after other withdrawal symptoms have subsided, and the activation of craving by environmental cues can occur long after deprivation (DiFranza & Wellman, 2005; Killen & Fortman, 1997). Even though craving often occurs within hours after deprivation, it usually shows a strong increase during the first week of abstinence (Van Zundert et al., 2009). With increasing duration of craving and increasing demands on coping with craving, chances on relapse may increase correspondingly. We therefore hypothesised that craving would interfere particularly with the maintenance of abstinence (i.e. prolonged cessation), and that craving would be less interferential with short-term abstinence (24 h abstinence). Furthermore, withdrawal levels in adolescent cessation trials, other than craving, are often found to be quite low (Bailey et al, 2009; Hanson, Allen, Jensen, & Hatsuakami, 2003; Smith, Cavallo, McFetridge, Liss, & Krishnan-Sarin, 2008). Usually withdrawal symptoms are seen as less impedimental to cessation than craving, as these symptoms are time limited and characterised by gradual reduction (Hughes, Higgins, & Bickel, 1994; Killen & Fortmann, 1997). Therefore, it is expected that symptoms of withdrawal constitute a relatively minor interference in the cessation process, regardless of the behavioural outcome. Finally, an indication of tolerance (e.g. longer time to first cigarette in the morning) was significantly related to smoking cessation (Hymowitz et al., 1997; Norregaard, Tonnesen, & Peterson, 1993). Also, behavioural dependence, which is indicative of tolerance, has been previously found to predict time to heavy relapse in a recent ecological momentary assessment of adolescents undertaking a quit attempt (Van Zundert, Ferguson, Shiffman, & Engels, in press). In theory, physical tolerance provides an explanation of the quick resumption of previous smoking intensity following a quit attempt. Upon development, tolerance is enduring (DiFranza & Wellman, 2005). After a period of abstinence, a single dose of nicotine may reactivate physiological adaptations as well as behavioural patterns that were at play before quitting; thus, rekindling psycho-physiological barriers to cessation (Shiffman et al., 2000). As tolerance is likely to facilitate relapse to previous smoking patterns, we expected behavioural dependence, which is indicative of tolerance, to be particularly relevant in case of lapsing or incomplete abstinence and, therefore, to be most likely interferential with reduction in smoking behaviour.

Besides nicotine dependence, smoking-related cognitions, such as attitudes towards smoking, social norms and self-efficacy, were repeatedly found to predict smoking cessation over time (Chang et al., 2006; Engels et al., 1998; Tucker et al., 2002). To extend previous findings, the present study aimed to evaluate whether these cognitions relate differently to different behavioural outcomes in smoking cessation. According to Dijkstra, De Vries, and Bakker (1996), personal attitudes and social influences differentiate between smokers based on their motivation to quit while self-efficacy differentiates between smokers on the basis of actual behavioural change and its maintenance. Moreover, recent studies demonstrate the importance of
self-efficacy in the prediction of successfully maintained cessation following a quit attempt (Shiffman et al., 2000; Van Zundert et al., 2010). Based on these findings, we expected personal attitudes towards smoking and social influences to be motivational factors in the initiation of behavioural change, and we hypothesised that both are specifically associated with short-term abstinence. On the other hand, we expected self-efficacy to be particularly relevant for the ability to maintain abstinence, and therefore to be specifically associated with prolonged cessation. Finally, we examined interaction effects between nicotine dependence and the cognitive concepts. Possibly, the proposed relations between the smoking-related cognitions and behavioural change may be attenuated or exaggerated as a function of nicotine-dependence levels. For example, physical tolerance may facilitate relapse to previous smoking intensity after experiencing a lapse to smoking, as outlined previously. Therefore, the occurrence of a lapse may be particularly detrimental in adolescents who display high levels of behavioural dependence, which is indicative of tolerance, while the prevention of a lapse in this group may be particularly beneficial.

As self-efficacy beliefs constitute a major preventive factor of a lapse to smoking (Shiffman et al., 2000), high self-efficacy may be particularly beneficial in adolescents who display high levels of behavioural dependence. Similarly, craving and withdrawal may function as a moderator between smoking-related cognitions and behavioural change. Conceivably, the experience of strong urges to smoke or physically adverse effects of nicotine deprivation may undermine the positive effects of cessation-related cognitions. Alternatively, cognitions (i.e. ‘focus on long-term consequences’) have been shown to attenuate craving reports (Kober, Kross, Mischel, Harts, Ochsner, 2010), suggesting that cognitive concepts may be particularly relevant in the prevention of relapse when craving levels are high. Up to this point, nicotine dependence as a moderator in adolescent smoking cessation remains under-investigated.

In summary, the present study aimed to evaluate the role of distinct components of nicotine dependence in comparison to smoking-related cognitions across different behavioural transitions in the adolescents’ process of smoking cessation. The main hypotheses are: (1) distinct dependence components can be distinguished and contribute to the understanding of smoking cessation in adolescents, (2) the dependence components and the cognitive concepts relate differently to the three behavioural transitions in the process towards smoking cessation, as described above and (3) smoking-related cognitions interact with levels of nicotine dependence in the prediction of adolescent smoking cessation.

**Methods**

**Procedure and sample**

We used data from two waves of a larger longitudinal study (started in January 2003) on psychological and environmental processes in tobacco use among Dutch adolescents (for details see Otten, Engels, & Van Den Eijnden, 2007; Van De Ven, Engels, Otten, & Van Den Eijnden, 2007). At the first wave (T1), data were collected among 6750 respondents from 25 randomly selected secondary schools. One year later, at the second wave (T2), 4940 respondents (73.2%) participated again. At T1 and T2, respondents completed questionnaires during school hours. They were informed that data would be processed anonymously. Use of respondent-specific
codes and unmarked envelopes assured confidentiality. Participation was voluntarily. The study was approved by the medical ethical committee (CMO Arnhem-Nijmegen).

At T1, a total of 850 of the 4940 respondents (17.2%), who completed assessments at T1 and T2, reported to be smokers. Of the 850 respondents, 54.8% were female. A total of 38.4% attended preparatory vocational training, 16.7% attended junior general secondary training, 30.9% attended senior general secondary training, 13.4% attended university preparatory training and 0.6% reported some other form of education. At T1, the mean age was 14.99 years (SD = 0.8), the mean number of cigarettes smoked per week was 30.9 (SD = 38.5), and the mean age of initial smoking was 11.8 (SD = 2.2).

Measures

Nicotine dependence

The nicotine-dependence measure consisted of a 10-item multidimensional scale based on both the modified Fagerström Tolerance Questionnaire (Prokhorov, Pallonen, Fava, Ding, & Niaura, 1996) and the Hooked on Nicotine Checklist (DiFranza et al., 2002b). The scale was validated by Kleinjan et al. (2007) who identified and confirmed a three-factor structure.

Craving was measured using four items assessing the frequency of urges to smoke and the perception of being addicted. Withdrawal was measured using three items assessing the occurrence of several withdrawal symptoms such as restlessness, irritability and trouble concentrating. These items could be scored on a 4-point scale ranging from 1 (never) to 4 (often). An indication of tolerance was measured using three items assessing the behavioural aspects of dependence, for example, time to first cigarette in the morning or smoking when one is ill. Answer categories for these items varied and were standardised to contribute an equal weight to the scale. In contrast to the study of Kleinjan et al. (2007), the present study did not include a fourth item (‘number of cigarettes smoked per day’) in this subscale as this item can be seen as a direct indicator of the degree of nicotine dependence and is therefore mostly used as a criterion for establishing concurrent validity (Hudmon et al., 2003; Van Den Eijnden, Spijkerman, & Fekkes, 2003). For all components, higher scores indicate a higher level of nicotine dependence. Cronbach’s alphas for the three subscales were 0.85 for craving, 0.82 for withdrawal and 0.66 for behavioural dependence. Descriptions of the ten nicotine-dependence items are given in Table 1.

Attitudes towards smoking

Attitudes towards smoking were divided into pros of smoking and pros of quitting. Both measures were validated in previous studies (Dijkstra, Bakker, & De Vries, 1997). Response categories for both scales ranged from 1 (totally disagree) to 4 (totally agree). Example items of the 10 pros of smoking and the 14 pros of quitting are, ‘Smoking helps me cope with stress’ and ‘Quitting smoking improves my health’, respectively. Higher scores indicate greater perceived advantages of smoking and greater perceived advantages of cessation. Cronbach’s alpha was 0.85 for the pros of smoking and 0.91 for the pros of quitting.
Table 1. Nicotine dependence items.

<table>
<thead>
<tr>
<th>Item</th>
<th>Response categories</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Craving</strong></td>
<td></td>
</tr>
<tr>
<td>C1: Have you ever felt like you were addicted to tobacco?</td>
<td>1. Never 3. Sometimes</td>
</tr>
<tr>
<td>C2: Do you ever have strong cravings to smoke?</td>
<td>2. Seldom 4. Often</td>
</tr>
<tr>
<td>C3: Have you ever felt like you really needed a cigarette?</td>
<td>1. Never 3. Sometimes</td>
</tr>
<tr>
<td>C4: Do you smoke because it is really hard to quit?</td>
<td>2. Seldom 4. Often</td>
</tr>
<tr>
<td><strong>Withdrawal</strong></td>
<td></td>
</tr>
<tr>
<td>At times that you tried to stop or weren’t able to smoke, how often did you experience the following:</td>
<td></td>
</tr>
<tr>
<td>W1: Trouble concentrating</td>
<td>1. Never 3. Sometimes</td>
</tr>
<tr>
<td>W2: Feeling irritable or angry</td>
<td>2. Seldom 4. Often</td>
</tr>
<tr>
<td>W3: Feeling nervous, restless or anxious</td>
<td>1. Never 3. Sometimes</td>
</tr>
<tr>
<td><strong>Behavioural dependence</strong></td>
<td></td>
</tr>
<tr>
<td>B1: How soon after you wake up do you smoke your first cigarette?</td>
<td>2. Within 6–30 min</td>
</tr>
<tr>
<td>B2: Which cigarette would you hate to give up?</td>
<td>1. First cigarette in the morning</td>
</tr>
<tr>
<td>B3: Do you smoke if you are so ill that you are in bed most of the day?</td>
<td>2. Any other cigarette</td>
</tr>
</tbody>
</table>

**Perceived social approval**

To examine the degree to which adolescents experience approval or disapproval of their smoking, respondents were asked to indicate to which extent they perceived that (a) their father, (b) their mother and (c) their best friend thought the respondent should quit smoking or would think the respondent should quit smoking in case he/she knew that the respondent smoked (cf Van Zundert & Engels, 2009). Response categories ranged from 1 (very much) to 4 (not at all). Higher scores indicate more social approval. Cronbach’s alpha was 0.70.

**Self-efficacy**

Eight items measuring the perceived difficulty not to smoke in smoking-specific and tempting situations assessed self-efficacy (Velicer, DiClemente, Rossi, & Prochaska, 1990). Response categories varied from 1 (very easy) to 5 (very difficult). An example item is, ‘Not smoking while I feel angry is...’ Higher score indicates greater perceived difficulty to refrain from smoking. Cronbach’s alpha was 0.89.

**Short-term abstinence**

Twenty-four-hours abstinence as a result of a quit attempt was assessed at T2 using two items asking the respondent, ‘Did you attempt to quit smoking during the past 12 months? ‘ and ‘Please indicate for how long you have quit’. Respondents were divided into two categories (‘0’ = no 24 hours quit and ‘1’ = quit for at least 24 hours). Short-term abstinence was assessed only among respondents who reported to be current smokers.

**Reduction in smoking behaviour**

Smoking frequency was assessed using one item asking the respondents which statement applied to them the best (Kremers, Mudde, & De Vries, 2001). Response options ranged from 1 (I have never smoked, not even a puff) to 9 (I smoke at least one a day). The original nine categories were recoded into three categories, ‘1’ occasional smokers who smoked less than weekly, ‘2’ weekly smokers and ‘3’ daily smokers. Smoking reduction was established when a respondent indicated that frequency of smoking had decreased, for instance from daily smoking at T1 to weekly smoking at T2. Reduction was computed as a dichotomous variable (‘0’ = same level and ‘1’ = reduction). The respondents who reported to smoke ‘occasionally’ at baseline were excluded from the reference group, since reduction within this group could not be accomplished. Thus, the reference group contained only respondents who had been weekly or daily smokers at T1 and who had maintained this level of smoking behaviour at T2.

**Prolonged cessation**

Respondents who reported smoking at T1 and T2 indicated that they were no longer smoking and had not done so during the past month were considered to have achieved prolonged cessation (see also Kleinjan et al., 2009a; Zhu et al., 1999).
Attrition analyses

Of the 6750 respondents at T1, 4940 participated again at T2. Respondents lost to follow-up were compared with the remaining respondents on gender, age, education and smoking status using independent sample t-tests and chi-square tests. Respondents lost to follow-up were more likely to be boys [$\chi^2(1, n=6734) = 16.83; p < 0.001$], to be older $[t(6691) = 3.89; p < 0.001]$, to attend general secondary training $[\chi^2(3, n=6581) = 143.38; p < 0.001]$ and to be smokers $[\chi^2(1, n=6750) = 33.70; p < 0.001]$. Multivariate logistic regression analysis including all of the above-mentioned constructs as independent variables showed significant associations between these variables and loss at follow-up. Although significant, the explained variance by these variables was very limited (Nagelkerke $R^2 = 0.02$).

An additional attrition analysis was conducted for smokers. Of 1274 smokers at T1, 850 participated again at T2. Smokers lost to follow-up were significantly more likely to be boys $[\chi^2(1, n=1271) = 7.39; p < 0.01]$, to attend preparatory vocational training or junior general secondary training $[\chi^2(3, n=1234) = 21.32; p < 0.001]$ and to smoke more cigarettes per week $[\chi^2(1, n=1210) = 5.24; p < 0.05]$. Although significant, the explained variance in loss at follow-up by these variables was limited (Nagelkerke $R^2 = 0.04$).

Strategy for analyses

To examine the effects of the predictors on the three dichotomous outcome variables, we conducted three logistic regression analyses. All reported effects were controlled for gender, education, age of initial smoking and number of cigarettes per week. For the predictors, we calculated the means if at least 50% of the data per predictor were available. To examine interaction effects between predictors, we applied the approach recommended by Hayes and Matthes (2009).

Results

Descriptives

A total of 850 of the 4940 respondents indicated that they had smoked during the past month. At T2, 155 of these 850 respondents (18.2%) reported not to have smoked for at least 1 month. Of the 695 respondents, who at T2 reported to have smoked during the past month, 181 (26.0%) reported to have attempted to quit smoking and remained abstinent from smoking for at least 24 h during the past year. A total of 39 respondents (5.6%) were classified as having reduced their smoking behaviour from T1 to T2.

Correlations between predictor variables

Descriptive statistics and Pearson’s correlations between predictors are given in Table 2 and 3. The number of cigarettes per week correlated moderately with all cognitive concepts and moderately to highly with all dependence components. The cognitive concepts were slightly and significantly associated with each other, except for an insignificant relation between the perceived pros of smoking and the perceived pros of quitting, and a strong correlation between the pros of smoking and
perceived difficulty to refrain from smoking in tempting situations. The dependence components were moderately associated with each other.

**Logistic regression predicting short-term abstinence**

The longitudinal associations between predictors and outcomes are displayed in Table 4. With regard to the cognitive variables, pros of quitting (OR = 1.55, \( p < 0.01 \)) and perceived social approval (OR = 0.72, \( p < 0.05 \)) were significantly associated with short-term abstinence. Specifically, when participants perceived more advantages of quitting and more disapproval of smoking from their environment, they were significantly more likely to quit for a period of at least 24 h during the following year. Of the nicotine-dependence components, withdrawal predicted periodic quitting (OR = 1.54, \( p < 0.01 \)). Specifically, when participants experienced more symptoms of withdrawal, they were significantly more likely to quit smoking for a period of at least 24 h during the following year.

**Logistic regression predicting reduction in smoking behaviour**

Neither of the cognitive concepts nor any of the nicotine-dependence concepts was associated with reduction in smoking behaviour. However, the interaction between craving and social approval was significantly related to prospective reduction (OR = 0.36, \( p < 0.05 \)). Specifically, perceiving low social disapproval of smoking did significantly decrease the likelihood of smoking reduction in participants who experienced average or high levels of craving, whereas this perception was unrelated to smoking reduction in participants who experienced low levels of craving.

**Logistic regression predicting prolonged cessation**

None of the cognitive concepts was significantly associated with cessation. Of the dependence concepts, only craving was significantly related to prolonged cessation (OR = 0.56, \( p < 0.01 \)). Specifically, respondents who experienced less intense craving at baseline were more likely to report prolonged abstinence at 1-year follow-up. In addition, the interaction between behavioural dependence and self-efficacy

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**Table 2. Means and standard deviations of study variables.**

<table>
<thead>
<tr>
<th>Measures</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cigarettes per week</td>
<td>30.87</td>
<td>38.48</td>
<td>0</td>
<td>200</td>
</tr>
<tr>
<td>Age of initial smoking</td>
<td>11.75</td>
<td>2.23</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Pros of smoking</td>
<td>2.47</td>
<td>0.65</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Pros of quitting</td>
<td>2.95</td>
<td>0.67</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Social approval</td>
<td>2.12</td>
<td>0.83</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Difficulty to resist</td>
<td>2.75</td>
<td>1.00</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Craving</td>
<td>1.57</td>
<td>0.83</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Withdrawal</td>
<td>2.37</td>
<td>0.67</td>
<td>1.5</td>
<td>4</td>
</tr>
<tr>
<td>Behavioural dependence</td>
<td>2.20</td>
<td>0.67</td>
<td>1.5</td>
<td>4</td>
</tr>
</tbody>
</table>
Table 3. Pearson correlations between study variables.

<table>
<thead>
<tr>
<th>Measures</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Cigarettes per week</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0.37***</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2 Age of initial smoking</td>
<td>–0.32***</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3 Pros of smoking</td>
<td>0.37***</td>
<td>–0.19***</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4 Pros of quitting</td>
<td>–0.15***</td>
<td>0.10*</td>
<td>0.00</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>5 Social approval</td>
<td>0.27***</td>
<td>–0.06</td>
<td>0.12**</td>
<td>–0.23***</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>6 Difficulty to resist</td>
<td>0.47***</td>
<td>–0.16***</td>
<td>0.56***</td>
<td>–0.12***</td>
<td>0.16***</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>7 Craving</td>
<td>0.58***</td>
<td>–0.25***</td>
<td>0.46***</td>
<td>–0.06</td>
<td>0.15***</td>
<td>0.58***</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>8 Withdrawal</td>
<td>0.45***</td>
<td>–0.15***</td>
<td>0.36***</td>
<td>–0.07*</td>
<td>0.08*</td>
<td>0.45***</td>
<td>0.55***</td>
<td>–</td>
</tr>
<tr>
<td>9 Behavioural dependence</td>
<td>0.61***</td>
<td>–0.27***</td>
<td>0.30***</td>
<td>–0.12*</td>
<td>0.22***</td>
<td>0.37***</td>
<td>0.47***</td>
<td>0.42***</td>
</tr>
</tbody>
</table>

*, **, *** are, respectively, $p < 0.05$; $p < 0.01$; $p < 0.001$. 
predicted prolonged cessation (OR = 0.55, \( p < 0.01 \)). Specifically, perceiving many difficulties to refrain from smoking in tempting situations did significantly decrease the likelihood to achieve prolonged cessation in participants who reported high levels of behavioural dependence, whereas this perception was unrelated to prolonged cessation in participants reporting low levels of behavioural dependence.

Discussion
In the present study, all components of nicotine dependence (craving, withdrawal, behavioural dependence) had a distinct role in the prediction of behavioural change. The dependence components, as well as the cognitions, related differently to the different behavioural transitions.

With regard to short-term abstinence, perceiving many pros of quitting and perceiving social disapproval significantly increased the adolescents’ likelihood to quit for a period of at least 24 h during the following year. These results are in line
with the initial expectations. Personal attitudes and social influences have been previously found to be strong motivational forces (Engels et al., 1998; Tucker et al., 2002), which seem to be particularly relevant in the initiation of behavioural change (Dijkstra et al., 1996). In addition, the experience of withdrawal symptoms also significantly increased the adolescents’ likelihood to quit smoking. Controlling for previous quit attempts and motivation to quit did not change the positive effect of withdrawal in the prediction. Hypothetically, experiencing adverse effects of withdrawal may constitute a motivational factor for the initiation of behavioural change in adolescents. Indeed, this idea is in line with the previous finding that a substantial amount of adolescent smokers reports feeling addicted as the most important reason to quit (Stone & Kristeller, 1992).

With regard to reduction in smoking behaviour, neither the dependence components nor the cognitions had a direct effect. Slightly at variance with our initial hypotheses, behavioural dependence was not impedimental to reduction in smoking behaviour. However, the interaction between craving and perceived social approval proved significant. Whereas social disapproval was unrelated to smoking reduction in participants with low levels of craving, strong social disapproval did significantly increase the likelihood of reduction in participants with average or high levels of craving. Possibly, the experience of craving (e.g. experiencing urges to smoke and feeling addicted) constitutes a motivational prerequisite for smoking reduction. Results suggest that intense craving, at the presence of social disapproval, increases the adolescents’ willingness to cut down cigarette use, nevertheless it impedes complete abstinence. According to the sensitization-homeostasis model (SHM) of nicotine dependence (DiFranza & Wellman, 2005), craving is commonly the first symptom of dependence to appear. The occurrence of craving may be a first sign for adolescents that they are loosing autonomy over their smoking behaviour, which may in turn make them more likely to attempt to modify their behaviour. On the other hand, the SHM also posits that if adolescents do not restrain nicotine consumption, the strength of craving increases while the latency to craving shortens, resulting in the experience of craving as soon as 20 min after having smoked the last cigarette. The progressively increasing strength of craving and the decreasing latency to craving may in turn constitute a substantial barrier to cessation.

With regard to prolonged cessation, intense craving strongly decreased the likelihood of adolescents to report abstinence during the last month at follow-up. This finding is in correspondence with previous research (Bagot et al., 2007; Killen & Fortmann, 1997; Van Zundert et al., 2009). Additionally, the interaction between self-efficacy and behavioural dependence, which is indicative of tolerance, was significantly associated with smoking cessation. While perceived difficulties to refrain from smoking did not relate to cessation in adolescents who displayed low or average levels of behavioural dependence, the perception of many difficulties decreased the likelihood of prolonged cessation in adolescents who displayed high levels of behavioural dependence. Both low self-efficacy and high physical tolerance have been previously found to form a barrier in the maintenance of cessation (Shiffman et al., 2000; Van Zundert et al., 2010). Our results suggest that it is specifically the combination of low self-efficacy and high behavioural dependence that impedes prolonged abstinence. As hypothesised, low self-efficacy may increase the likelihood of initial lapsing during a quit attempt, while physical tolerance may account
for relapse to previous smoking patterns. These results suggest that improving self-efficacy is particularly important in adolescents who already display more established patterns of smoking behaviour.

In general, the effects of the smoking-related cognitions are particularly strong for the prediction of short-term abstinence, representing the initiation but no successful maintenance of cessation. However, as behavioural change shifts towards prolonged abstinence, nicotine dependence (i.e. craving and behavioural dependence) becomes increasingly important. Previous research also suggests a limited role of smoking-related cognitions in comparison to nicotine dependence in adolescent smoking cessation (Kleinjan et al., 2009a; Kleinjan, Van Den Eijnden, & Engels, 2009b). In these studies, smoking-related cognitions to reduce cognitive dissonance were strongly associated with motivation to quit, and readiness to quit was strongly associated with attempting to quit. However, both types of cognitions were unrelated to actual smoking cessation, while nicotine dependence constituted the strongest barrier to cessation in adolescents.

Practical implications of this study encompass enhanced attention to the complex nature of nicotine dependence and its role in adolescent smoking cessation. This knowledge may help to determine the expected level of difficulty in adolescents’ quit attempts and may possibly place the use of tailored nicotine replacement therapies in adolescent smoking cessation practice into a different perspective.

The present study has some limitations. First, outcome measures are based on self-report and therefore vulnerable to reporting biases. However, self-reported smoking behaviour has been previously found to be comparable to other methods such as biochemical validation (Dolcini, Adler, & Ginsberg, 1996). Furthermore, the present study distinguished three components of nicotine dependence. Certain other relevant dimensions, such as seeking emotional or sensory stimulation, may have been overlooked (Johnson et al., 2005). Additionally, past literature has often debated the nature and validity of the construct of craving. Criticisms have focused primarily on divergent conceptualisations and inconsistent measures (Sayette et al., 2000). While some definitions of craving are categorically restricted to a desire or urge to smoke, the present study permits a broader focus on the construct of craving. It should be noted that varying craving reports may have different meanings and predictive power (Shiffman et al., 1997). Nevertheless, in the present study, internal consistency of craving has been shown to be high, indicating the unidimensional nature of this construct. Finally, attrition analysis indicated an under-representation of lower educated, male and heavier smokers. Therefore, a certain caution in generalising the findings to the general adolescent smoking population is warranted.

In conclusion, the present study highlights the utility of distinguishing between different behavioural transitions in a comprehensive understanding of cessation-related factors as well as the utility of differentiating between distinct components of nicotine dependence in the prediction of smoking cessation in adolescents. Overall, the results indicate that personal and perceived attitudes towards smoking (i.e. pros of quitting and social disapproval) are particularly important in the initiation of smoking cessation while nicotine dependence and self-efficacy become increasingly important as behaviour shifts towards the maintenance of smoking cessation.
References


