



Dawning Dependence

Processes underlying smoking cessation in adolescence



Marloes Kleinjan



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Processes underlying smoking cessation in adolescence

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1 General Introduction

Introduction

During adolescence young people are known to try out a range of risk behaviours, including smoking. Even though the detrimental health consequences of smoking are well known, the prevalence of smoking among Dutch adolescents remains high. Until today, efforts to control adolescent smoking are mainly focused on the prevention of smoking, whereas fewer efforts are made towards facilitating smoking cessation. Since the chance of a successful attempt to cease smoking diminishes the longer that people smoke, it is important that cessation interventions also focus on adolescents. However, compared to the many reports on predictors of smoking initiation, the literature addressing adolescent smoking cessation is rather limited, and the field is still considered to be underdeveloped.

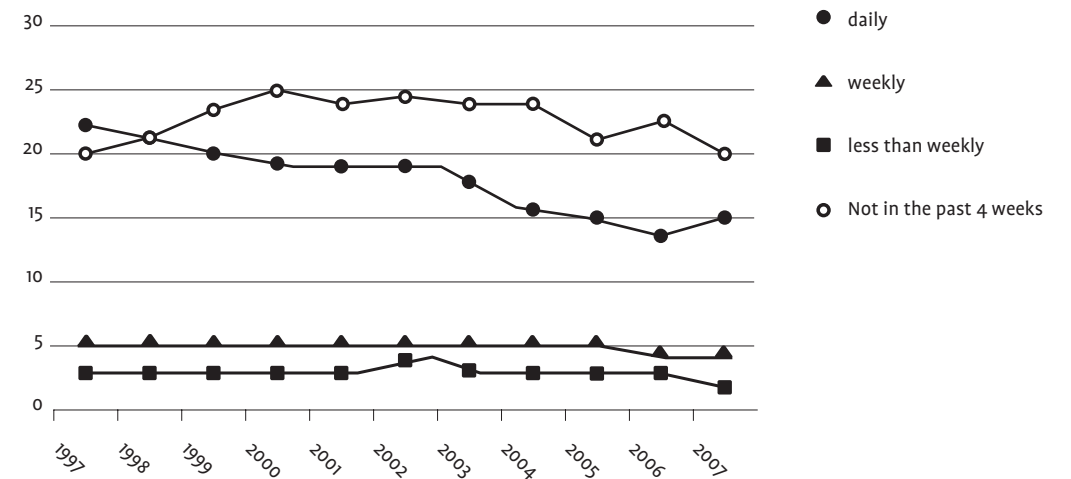
To facilitate the planning and development of programs to promote cessation among adolescents who smoke, the current thesis presents a number of studies that focus on identifying and studying potential determinants of smoking cessation, as well as determinants of important parameters of successful cessation such as readiness to quit smoking and undertaking quit attempts. Multiple levels of influence on the process of adolescent smoking cessation are considered and tested, including addiction, psychological and environmental factors. In addition, predictions and assumptions of several theories that are frequently used in explaining health behaviour, such as the Transtheoretical Model and Social Cognitive Theory, were tested in their applications to adolescent smoking cessation.

In the following sections we elaborate on the above items. First, the prevalence of smoking and smoking-related health consequences is addressed. Second, we discuss the importance of focusing on smoking cessation among adolescents in addition to focusing on the prevention of smoking initiation. Then information is provided on the construct of smoking cessation and its related parameters. This is followed by a summary of the main theories and categories of determinants of smoking cessation. Finally, before presenting the aims and outline of this thesis, we address some of the methodological issues involved in the various studies presented in this thesis.

Prevalence and consequences of smoking

Globally, about one in every five adolescents aged 13 to 15 years is a smoker and between 80,000 and 100,000 children start smoking every day (WHO, 2002b; WHO, 2005). If current trends continue, over 200 million persons who are currently children and teenagers will die from tobacco-related illnesses (Peto et al., 1994). Although in the Netherlands a decrease in adolescent smoking occurred around 2003, the prevalence has been relatively stable since that time. Demographic data still provide a troubling picture (Figure 1), given that 45% of adolescents aged 10-19 years indicate that they have tried smoking at least once, 24% indicate to have smoked during the last four weeks, and 16% indicate to smoke on a daily basis (Stivoro, 2007). The health consequences of smoking are considered to be two-fold. First, once started smoking, dependence on nicotine can develop rapidly (e.g. DiFranza et al., 2000). By inhaling cigarette smoke, smokers deliver the addictive drug nicotine to the brain about as efficiently as an intravenous injection with a syringe (Benowitz, 1996).

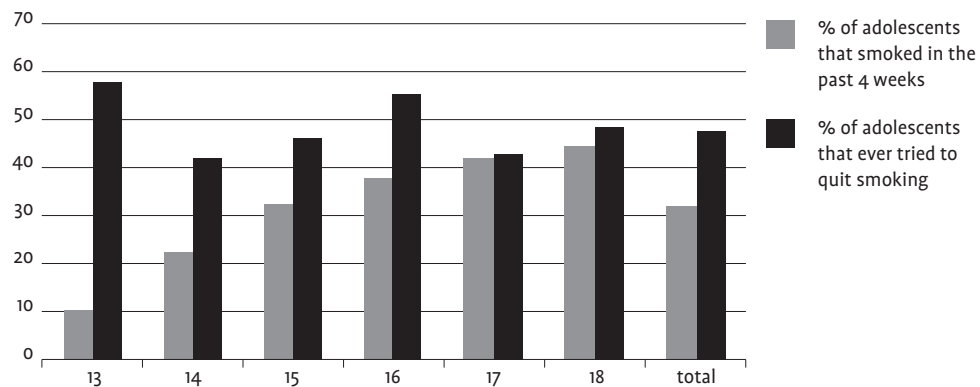
Figure 1 Prevalence of smoking among 10-19 year old Dutch adolescents from 1997 until 2007 (%) (Source: Stivoro)



Over the years, several behavioural and neurobiological theories for the development of nicotine dependence have been proposed, amongst others the Nicotine Fixed-Effect Theory, Pomerleau and Pomerleau's Theory, and the Sensitization-Homeostasis Model. The Nicotine Fixed-Effect Theory (Hall et al., 1973) maintains that smoking is reinforcing because nicotine stimulates reward centres in the nervous system. In addition to that, nicotine speeds up the heart and causes relaxation of the skeletal muscles. As indicated by the Nicotine Fixed-Effect Theory, nicotine has the paradoxical capacity to produce feelings of mental alertness and relaxation simultaneously. According to Pomerleau and Pomerleau's Theory, nicotine may be a way of regulating performance and affect (Pomerleau & Pomerleau, 1984; 1989). Nicotine alters the availability of active neuroregulators, such as acetylcholine, norepinephrine, dopamine, endogenous opioids, and vasopressin. Smokers are considered to continue the use of nicotine because it produces temporary improvements in performance or affect by influencing the different neuroregulators. Finally, the Sensitization-Homeostasis Model proposes that the danger of becoming dependent on nicotine originates from its ability to stimulate the neural pathways that are responsible for the suppression of craving (DiFranza & Wellman, 2005). As a result of sensitization (a phenomenon occurring when repeated administrations of nicotine generate increasingly greater behavioural reactions) the craving suppression produced by nicotine is magnified to super-physiological levels. The over-inhibition of neurons responsible for craving initiates compensatory homeostatic measures that stimulate the craving pathways and result in craving when nicotine is absent. However, even though knowledge on the development on nicotine dependence has advanced greatly, none of the theories available are considered to offer a complete explanation. The exact mechanisms underlying nicotine dependence are still largely unknown (Grunberg & Acri, 1991; Watkins et al., 2000; DiFranza et al. 2002a).

The notion that nicotine is highly addictive is often underestimated by novice smokers. It has been estimated that adolescents who initiate smoking can expect to continue smoking for at least 16 years if female and 20 years if male (Pierce & Gilpin, 1996). When started smoking, a considerable number of both adults and adolescents indicate they would like to quit (Balch, 1998; Balch et al., 2004; Sussman et al., 1998; WHO, 1999). However, maintenance of cessation attempts is generally poor (e.g. Mermelstein, 2003).

Figure 1 Prevalence of quit attempts among 13-18 year old Dutch adolescents in 2008 (Source: Stivoro)



Besides its addictive properties, cigarette smoking is known to cause a range of serious disabling and fatal diseases. Diseases associated with smoking include cancers of the lungs and other organs, cardiac diseases, vascular diseases, as well as pulmonary and respiratory diseases such as emphysema (WHO, 2005). Smoking also affects the health of non-smokers, as a result of the effects of second-hand smoke (WHO, 1999). Furthermore, babies of smoking mothers have higher risks of respiratory disease and to die of sudden infant death syndrome as compared to babies born to non-smoking mothers (WHO, 1999).

Research on Primary and Secondary Prevention of Smoking in adolescents

The majority of smokers lit their first cigarette before their 18th birthday and more than half of those who initiate smoking have become a regular smokers by that same age (USDHHS, 1994). Even smoking just one cigarette in early adolescence increases the chances of smoking in later years (Fidler et al., 2006). Because of the addictive nature and the harmful health effects of cigarette smoking, preventing adolescents from trying cigarettes and starting smoking is a very relevant issue.

Numerous studies have examined predictors of smoking onset among adolescents (e.g. Conrad et al., 1992; Tyas & Pederson, 1998). The identification of predictors of smoking onset can help to shape smoking prevention programs. One of the major foci of adolescent smoking control efforts has therefore been on identifying and influencing

factors that contribute to experimentation and initiation. However, prevention programs at school and mass-media campaigns do not seem to result in a significant decline of adolescent smoking prevalence rates. Given the large number of adolescent smokers, it is therefore important that efforts are also directed towards facilitating cessation.

Compared to the ample data on predictors of smoking initiation, few studies have focused on the predictors of smoking cessation among adolescents. Moreover, a sound theoretical basis for developing interventions aiming at adolescent smoking cessation is still missing (e.g. Buttross and Kastner, 2003). The available evidence implies that a considerable number of adolescent smokers indicate wanting to quit smoking and that many have already tried to do so (Balch, 1998; Balch et al., 2004; Burt & Peterson, 1998; Dozois et al., 1995; Stanton et al. 1996a, 1996b; Sussman et al., 1998; Zhu et al., 1999). Nevertheless, relapse rates are high and few adolescents who try to quit on their own are successful. Research also suggests that few adolescents find formal smoking cessation programs acceptable, and even fewer would be willing to participate in school-based programs (Balch, 1998; Gillespie et al. 1995). Other factors that contribute to a lack of success for many cessation intervention programs include low participation rates, high attrition, low quit rates, inappropriate interventions for adolescents, and inadequate evaluation (Garrison et al., 2003; Moolchan et al., 2000; Stanton and Smith, 2002). This indicates that motivating and facilitating adolescent smoking cessation is not a simple matter. Consequently, additional research is required to provide policymakers and practitioners with the knowledge needed to plan and develop programs to promote cessation among adolescents who smoke (Lamkin et al., 1998; Redmond, 2002). Therefore, the main focus of this thesis is to identify factors that predict quitting among adolescent smokers.

Smoking Cessation among adolescents

Health behaviour change does not usually take place overnight, but is considered to unfold through a series of changes. Quitting smoking can be viewed as a process with the maintenance of actual smoking cessation as a final stage. Becoming motivated to quit smoking and undertaking attempts to quit can be seen as earlier stages in the process of quitting smoking (e.g. Burt & Peterson, 1998; Prochaska et al., 1992a). A significant number of adolescents are in the process of quitting, as quitting is regarded as both desirable and achievable by many of them (Balch et al., 2004).

The following sections describe in more detail the various smoking cessation outcomes.

Readiness or motivation to quit

The traditional view of behaviour has changed from being a more or less passive response to the environment (e.g. Pavlov, 1927; Skinner, 1938), to behaviour being a rational decision to act as a result of processing information from the environment (e.g. Lewin, 1951). Readiness or motivation to change behaviour is considered to be a proximal predictor of behaviour change in several cognitive-behavioural theories, such as the Theory of Planned Behaviour (Ajzen, 1988), the Theory of Triadic Influence (Flay & Petraitis, 1994) and the

Transtheoretical Model (Prochaska et al., 1992a). These models imply that an individual's motivation to (try and) change is an immediate precursor of behaviour change, and it has been postulated that interventions and treatments aiming at smoking cessation will only work if smokers are ready and motivated to quit (West, 2004). Of the three models mentioned, the Transtheoretical model (TTM) is particularly widely used within the addiction research field (Prochaska et al., 1992a). The core concept of the TTM is the stages of change construct. The stages of change construct is used as an indication of the motivation to change behaviour and describes a temporal dimension containing five levels of readiness to change: precontemplation (not planning to quit within six months), contemplation (planning to quit within six months, but not within the next month), preparation (planning to quit within one month and having made a prior quit attempt in the past year), action (having quit within the past six months), and maintenance (having quit for more than six months).¹ The first three stages are pre-action stages and concern the readiness to undertake deliberate actions to change behaviour. According to the TTM, behaviour change is not a linear process. People are expected to cycle through the different stages and both progression as well as regression from one stage to another is possible. The movements between the stages of change are referred to as stage transitions.

However, despite its popularity, a number of concerns about the validity of the stages of change construct have been articulated. Researchers have questioned, amongst others, the ordering of the stages, the stability of the stages, the classification system to define stages, and the qualitative difference of the stages (Bandura, 1997; Davidson, 1998; De Nooijer et al., 2005; Littell & Girvin, 2002; Sutton, 2000; West, 2005). In the present thesis, the stages of change construct will be used to test the relevance of the TTM in explaining adolescent smoking cessation. Additionally, the usefulness of the stages of change construct to assess adolescents' readiness to change smoking behaviour will be discussed and tested.

Quit attempts

Among adolescent smokers, about two thirds regret initiating smoking, half are contemplating cessation, and half to three quarters have made a quit attempt (Henningfield et al., 2000; Stanton et al., 1996a; Stanton et al., 1996b; Pallonen et al., 1998). A quit attempt is mostly defined as a deliberate period of minimally 24 hours of abstinence because they want or desire to quit. Among those who try to quit, about a half succeed for a period of 2 weeks (Stanton et al., 1996b). However, relapse rates are high and often multiple quit attempts are undertaken before achieving long-term cessation (Mermelstein, 2003). Because past quitting history has been found to be a strong predictor of successful smoking cessation in adolescents (Burt & Peterson, 1998; Zhu et al., 1999), the present thesis will utilize the number of previously undertaken quit attempts as a parameter of adolescents' process of smoking cessation.

Smoking Cessation

When determining the number of people that quit smoking in a population or sample, one has to consider which definition and operationalization of smoking cessation is

most suitable for the purpose of the study or intervention (Stivoro, 2006). Since many adolescents aged 12-16 years are still considered to be in the process of smoking acquisition, criteria for smoking cessation among adults may be less appropriate for adolescents. Within the present thesis longitudinal survey studies were conducted among smokers and non-smokers. Consequently, unlike intervention studies, participants did not have to smoke, quit smoking, or remain abstinent in order to participate. Therefore, we adopted a definition of smoking cessation from the 1994 Surgeon General's Report (USDHHS, 1994), which was previously utilized by Zhu and colleagues (1999) in their study on predictors of adolescent smoking cessation. In this definition, participants were considered to have quit smoking if they were current smokers (having smoked in the past month) at the baseline measurement but had not smoked for at least 30 days at the time of the follow-up measurement.

Predictors of smoking cessation

Only a few longitudinal studies have investigated predictors of smoking cessation among youngsters (e.g. Engels et al. 1998; Rose et al. 1996; Zhu et al, 1999; Sussman et al, 1998). Nevertheless, some interesting results have emerged. Some studies showed that individual factors, such as the nicotine dependence level and smoking-specific cognitions, were associated with quitting (e.g. Engels et al., 1998; Zhu et al., 1999). In addition, social influence or social-environmental factors, such as peer and parental smoking, have been found to correlate with adolescents' quitting (e.g. Burt & Peterson, 1998; Ershler et al., 1989; Hansen et al., 1985a; Zhu et al., 1999; Rose et al., 1996). However, little is known about whether these or other potentially relevant (yet untested) factors contribute independently to the prediction of smoking cessation when studied in a multivariate framework. The following sections describe factors that refer to the individual; these include features of dependence, cognitions, the use of cognitive and behavioural strategies, and personality. Subsequently, we discuss relevant environmental factors, such as peers and parents.

Individual factors

Nicotine Dependence.

Tobacco is produced from the dried leaf of the tobacco plant 'Nicotiana', and contains nicotine. Nicotine is considered to be one of the most addictive of all drugs. Compared to users of drugs of abuse (such as alcohol, marijuana, heroin and cocaine), a far greater proportion of those experimenting with smoking seem to progress to dependence (Kassel, 2000). What is interesting is that compared to other drugs the subjective effects of smoking are subtle, i.e. without any effects approaching euphoria or high. Effects of nicotine include (amongst others), increased blood pressure and heart rate, relaxation of skeletal muscles, enhanced brain activity, and improved concentration and cognitive processing (e.g. Hall, 1973; Pomerleau & Pomerleau, 1984; 1989; DiFranza & Wellman, 2005). According to Shiffman (1995), the absence of striking subjective effects makes the addictive potential and compulsive use of nicotine all the more impressive.

Since the onset of nicotine dependence takes place when most tobacco users are teenagers, it has been suggested that treatment should be available for all those afflicted and not just adults (Kessler, 1995; Kessler et al., 1997). However, most of the research on nicotine dependence has focused on adult smokers. The lack of studies on nicotine dependence among adolescents has been explained by the prime orientation of adolescent research on the prevention of smoking onset, together with a certain level of scepticism regarding the ability to develop diagnosable levels of nicotine dependence during the short period of adolescence (Prokhorov et al., 1996). However, several studies have indicated that symptoms of nicotine dependence already occur after very little exposure and may develop in a rapid manner after the initial onset of smoking (DiFranza et al., 2000; DiFranza et al., 2002a, Van Andel et al., 2003). One possible explanation for the rapid development of nicotine dependence symptoms has been offered in the form of the previously mentioned Sensitization-Homeostasis Theory. This theory implies that even from smoking the first cigarette, neurophysiological processes underlying nicotine dependence are set in motion (DiFranza & Wellman, 2005). According to the Sensitization-Homeostasis Theory, relieving physiologically driven craving and withdrawal becomes the main motivator for individuals who only smoke a few cigarettes per month. It is postulated that, at first, craving and withdrawal symptoms can be controlled by smoking approximately one cigarette every week. However, as tolerance increases, the duration of relief offered by each cigarette shortens progressively. Eventually, if the smoker does not restrain consumption, withdrawal symptoms may be experienced whenever 20 to 30 minutes have passed without smoking.

The effect and occurrence of nicotine dependence is considered different for adolescents than for adults. For example, the adolescent brain is still developing and is thought to be more vulnerable to nicotine (DiFranza et al., 2002a), also, nicotine dependence rates among adolescents, although substantial, are generally lower than adult rates (Colby et al., 2000a). Therefore, measures of nicotine dependence designed for adults are not considered suitable for the measurement of nicotine dependence among adolescents (Colby et al., 2000a; Wheeler et al., 2004). Currently, no 'gold standard' to measure adolescent nicotine dependence is available (Colby et al., 2000b). Therefore, in this thesis, we first developed and tested a nicotine dependence measure to be used among adolescent smokers. Second, because little is known about the manifestation and development of nicotine dependence among novice smokers, we aimed to provide a better understanding of the epidemiology and aetiology of nicotine dependence among adolescent smokers. Finally, although nicotine dependence was found to be negatively associated with the motivation and ability to quit, few studies have investigated the impact of nicotine dependence on the process of adolescent smoking cessation using a longitudinal design. Therefore, this thesis also focuses on the direct and indirect effects of nicotine dependence in the process of adolescent smoking cessation using both cross-sectional and longitudinal designs.

Readiness or motivation to quit

There is general consensus that psychological readiness or motivation to quit plays an essential role in any theory of behaviour change (e.g. Fisher, 1996; Hughes, 1996; Pierce et al., 1996; Prochaska and Velicer, 1996; Shiffman, 1996; Stockwell, 1996; Sutton, 1996, West,

2004). In the present thesis we employed a 9-point ordinal scale to assess readiness to quit ranging from 1: "I am planning to quit within the next 10 days" to 9: "I am planning to never quit and not planning to cut down" (Dijkstra et al., 1997). This ordinal scale allows for categorization into the three different motivational stages of the stages of change construct, consistent with the approach described by Prochaska et al. (1992a), namely the stage of precontemplation (not wishing to stop within 6 months), contemplation (thinking about stopping but not in the next month), and preparation (planning to stop within the next month). Whereas several studies have tested the predictive validity of readiness to change in relation to smoking cessation among adolescents, few studies have focused on the independent contribution or interactive effect of readiness to change in relation to smoking cessation in a multivariate framework, or on identifying the antecedents of readiness to change. The present thesis aims to increase insight into these topics.

Use of cognitive evaluations and behavioural strategies

As previously described, smoking cessation can be regarded as a process that is considered to unfold through a series of changes. According to the TTM, movement through the different stages of change is expected to be facilitated by certain strategies known as the processes of change (Prochaska et al, 1988; Prochaska et al., 1992a; Prochaska et al., 1992b). Earlier studies have identified ten processes of change that an individual can engage in, in order to attempt to change risk behaviours (see Table 1).

The ten processes can be grouped into two higher order categories, namely experiential processes and behavioural processes. Experiential processes are best explained as cognitive and evaluative processes, whereas behavioural processes can be viewed as active strategies to change behaviour. The experiential processes are thought to be most important in explaining changes in motivation, for instance transition from the precontemplation to the contemplation or preparation phase, whereas the behavioural processes are believed to be more important in explaining changes towards action, such as undertaking a quit attempt.

Table 1 Description of the Processes of Change.

Experiential Processes	Description
Consciousness Raising	Increasing knowledge and information about one's smoking
Social Liberation	Awareness, availability, and acceptance of alternative, problem-free lifestyles in society
Dramatic Relief	Experiencing and expressing feelings about one's smoking
Self-Reevaluation	Considering feelings and thoughts about the self in relation to one's smoking
Environmental Reevaluation	Considering how smoking affects one's environment

Behavioural Processes	Description
Helping Relationship	Trust others and being open about one's smoking
Self-Liberation	Choosing and commitment to act or belief in ability to change
Counter-Conditioning	Replacing smoking with alternatives
Stimulus Control	Avoidance or dealing with stimuli that bring out smoking
Reinforcement Management	Rewarding oneself or being rewarded by others for changing smoking behaviour

In the literature there is a growing controversy about the usefulness of the processes of change in explaining smoking cessation. Some studies have claimed supporting evidence of the significance of engaging in the processes of change and forward stage movements (Prochaska et al., 1992a; Prochaska et al., 2001), whilst others have failed to show support for this basic assumption of the TTM (Herzog et al., 1999; Segan et al., 2002; Segan et al., 2004). Among adult smokers, even though results on the effectiveness of the processes of change have been contradictory, efforts have been made to validate its use in adolescent samples (Hoepfner et al., 2006). However, knowledge on the value of the processes of change in explaining smoking cessation among adolescents is lacking. This thesis tests the applicability of the processes of change in aiding the process of smoking cessation among adolescents, in studies with both a cross-sectional and a longitudinal design.

Disengagement beliefs

Given that most people value their health, it is expected that engaging in unhealthy behaviours and at the same time knowing that these behaviours have negative health effects creates a certain extent of uneasiness. This phenomenon is referred to as cognitive dissonance (Festinger, 1957), and can be described as uncomfortable feelings or stress that results from holding two contradictory beliefs simultaneously. According to the theory of cognitive dissonance, people have a fundamental cognitive drive to reduce dissonance by altering an existing belief, or rejecting one of the contradictory ideas. Avoiding cognitive dissonance may also contribute to the denial of discomfiting information. Adult smokers who have persisted to smoke despite their knowledge of the disease risks are expected to have developed stable dissonance reduction mechanisms in the form of counterarguments favouring smoking and denying or distorting threatening information, also referred to as disengagement beliefs. Research among adults found that having disengagement beliefs was negatively related to the process of smoking cessation. Until now, however, it has not been investigated to what extent adolescents may adhere to disengagement beliefs. Also, we do not know whether having disengagement beliefs is

important in explaining adolescents' readiness to quit and actual smoking cessation. Youth were found to have health concerns that are, in many aspects, similar to that of adults (Cohn et al., 1995); therefore, adolescent smokers are also likely to experience some forms of cognitive dissonance reduction. If adolescents indeed experience a fairly constant threat by knowing that smoking makes them susceptible to possible health damage and other negative consequences, this threat may be perceived as less worrisome when disengagement beliefs are used to deny or distort this knowledge. Therefore we expect that, similar to adults, disengagement beliefs may also play a significant role in the continuation of smoking behaviour among adolescents. Both issues are examined within this thesis.

Personality

Personality traits are enduring dispositions and important determinants of behaviour (McCrae & Costa, 2003; Paunonen, 2003). Personality traits were shown to be heritable and generalisable across cultures (e.g. Jang et al., 1998; McCrae & Costa, 1997; Terracciano, 2003). Linking individual differences in personality traits to the engagement in risky behaviour may help explain why some people are more vulnerable to develop certain behaviours than others. Although research has yet to identify which personality traits or characteristic best predict tobacco use, it has been shown that both neuroticism and extraversion exert some influence on tobacco use (Canals et al., 1997; Eysenck et al., 1960; Gilbert & Gilbert, 1995; Pritchard & Kay, 1993; Spielberg & Jacobs, 1982). While several studies examined the relationships between personality traits and smoking onset (e.g. Otten et al., 2008; Harakeh et al., 2006b), a personality approach has not yet been applied in explaining the development of nicotine dependence among adolescent smokers. Among adults, neuroticism was found to be an important predictor of craving following the pharmacological manipulation of the dopamine system (Reuter & Netter, 2001). Moreover, frequency of smokeless tobacco use was found to be positively associated with higher scores in extraversion (Spielberger et al., 1995; Spielberg, et al., 2000). In this thesis we used a longitudinal design to focus on the effect of extraversion and neuroticism in relation to the development of nicotine dependence symptoms.

Environmental factors

Parental and peer smoking

From the perspective of the Social Cognitive Theory, smoking behaviour is likely to be the result of a dynamic interplay of personal, behavioural, and environmental influences (Bandura, 1986). With regard to environmental influences, parents and peers are believed to be the two most important social agents among adolescents. According to the Social Cognitive Theory, adolescents' ideas regarding substance use are formed through exposure to beliefs and behaviour of parents and close friends. In previous studies, smoking behaviour of parents and friends was shown to be related to adolescents' smoking behaviour. Adolescents whose parents smoke are more likely to smoke themselves as compared to adolescents who do not have smoking parents (e.g.

Den Exter Blokland et al., 2004; Engels et al., 1999; Vink et al., 2003a). Also, there appears to be some preliminary evidence that smoking of parents and peers has a negative effect on adolescent smoking cessation practices. Adolescents seem less ready to quit smoking and undertake fewer quit attempts when their parents and/or peers are smokers (Burt & Peterson, 1998; Ershler et al., 1989; Farkas et al., 1999; Hansen et al., 1985a; Van Zundert et al., 2007; Zhu et al., 1999).

Having smoking parents and peers may contribute to smoking continuation through various mechanisms. For instance, smoking parents and peers may establish pro-smoking norms, may increase the availability of cigarettes, may act as cues that continue to trigger the craving for cigarettes, and may be unable to provide appropriate encouragement and support to quit smoking (Carter & Tiffany, 2001; Hansen et al., 1985a; Simons-Morton et al., 2001). Most studies have investigated the direct influence of peer and parental smoking on adolescent readiness to quit and actual smoking cessation efforts, whereas the possible mechanisms by which parental and peers' smoking affect adolescent smoking continuation has received less attention. One particular finding with regard to exposure to smoking by significant others is that having smoking parents and peers was associated with higher levels of nicotine dependence in adolescents (Audrain-McGovern et al., 2006; Hu et al., 2006; Lieb et al., 2003). Since nicotine dependence appears to be associated with adolescent smoking cessation, parental and peer smoking may also influence adolescent smoking indirectly through nicotine dependence. The present thesis will focus on both the direct and indirect associations of peer and parental smoking with adolescent smoking cessation. In addition, because of the presumed association between parental and peer smoking and nicotine dependence, the role of parental and peer smoking in the development of nicotine dependence will be more closely examined within a multivariate framework.

Methodological Issues

Before elaborating on the different studies included in this thesis, some important methodological and theoretical issues related to our approaches have to be addressed.

Measuring dependence symptoms

To establish whether nicotine dependence among adolescents consists of multiple features which are not directly observed, we examined the conceptual relatedness of items derived from two well-known and frequently used measures of dependence by using factor analysis. The Hooked on Nicotine Checklist (HONC: DiFranza et al., 2000) is a measure assumed to assess feelings of addiction, withdrawal symptoms, loss of control, craving, and psychological addiction (Johnson et al., 2005; O'Loughlin et al., 2002a), and is considered especially valuable to measure dependence symptoms in early onset smokers (Wellman et al., 2005). The modified Fagerström Tolerance Questionnaire (mFTQ: Prokhorov et al., 1996), on the other hand, is a measure that provides an indication of behavioural aspects of physical tolerance, and was not principally designed to measure

the earlier stages of nicotine dependence (Kandel et al., 2005; O'Loughlin et al., 2002b). To establish whether the two measures together represent multiple components of dependence, we examined the conceptual relatedness of the items of the HONC and the mFTQ using exploratory factor analysis. Factor analysis can be used to explain variability between the observed variables in terms of fewer unobserved variables, called factors. These factors can subsequently be used to predict smoking-specific outcomes.

In factor analysis the focus is on relationships between variables; however, in substance use research, data often include heterogeneous groups with individuals that are highly susceptible to dependence symptoms and those who are less (or not at all) susceptible (Muthén & Muthén, 2000). To investigate whether there are subpopulations that can be classified by distinct symptom profiles, a person-centred focus is useful. Latent Class Analysis (LCA) is a method which assumes that the associations between items can be explained by the existence of several subgroups that cannot be observed directly. LCA is therefore a typological rather than a dimensional approach. Within a specific latent class, participants are assumed to have identical response patterns, whereas between classes there are differences with respect to the response probabilities. Similar to exploratory factor analysis (EFA), LCA can be seen as a method to reduce data. Whereas EFA is used to explain observed inter-item correlations by a reduced number of common factors, the aim of LCA is to explain inter-individual differences in item response patterns by a reduced number of groups (latent classes). Both approaches are applied in this thesis.

Structural Equation Modeling

Smoking cessation is thought to be subject to a large number of influential factors. Therefore, the use of complex multivariate models is essential to capture the process underlying smoking cessation. Structural Equation Modeling (SEM) is especially suited for testing theories about causal relationships that include a combination of factors. More specifically, SEM is a technique that allows to take into account mediation and moderation, to include covariations between predictors, and to reduce measurement error. Additionally, one of its strengths is the ability to model constructs as latent variables (i.e., variables that are not directly measured, but rather estimated in the model from measured variables assumed to 'tap into' the latent variables). This method allows the structural relations between latent variables to be accurately estimated and subsequently to explicitly capture the unreliability of measurement in the model (e.g. Kaplan, 2000; Muthén & Muthén, 1998-2007c).

Moderation and Mediation

To formulate a model approaching reality, it is not enough to only focus on direct effects. Potential underlying factors that may influence or confound the link between two variables should also be investigated. Mediation and moderation are two main mechanisms through which relationships between certain determinants and smoking cessation may be explained. Moderation examines whether relationships between independent and dependent variables interact on different levels. In other words, a moderator is a variable that changes the impact of one variable on another (Baron &

Kenny, 1986). Moderation effects can be tested within multiple regression models by including interaction terms (Aiken & West, 1991; Jaccard et al., 1990). Alternatively, multi-group analyses can be used to test moderation within structural equation models.

In a mediation model, rather than hypothesizing a direct causal relationship between the independent variable and the dependent variable, it is hypothesized that the independent variable causes the mediator variable, which in turn causes the dependent variable (Baron & Kenny, 1986). In the present thesis, mediation effects were tested within multiple regression models and structural equation models.

Smoking phases.

Another issue to address is the classification of adolescent smokers. As mentioned, many adolescents aged 12-16 years are still considered to be in the process of smoking acquisition. Irregular smokers, having a more fluctuating smoking pattern, may respond differently to smoking interventions as compared to regular smokers. When testing the usefulness of cognitive and behavioural constructs in guiding intervention development, it could be hypothesized that only regular smokers should be included. On the other hand, in the aim to understand the role of tobacco dependence in the persistence of smoking and to evaluate tobacco dependence aetiology, some argue that the entire spectrum of cigarette smokers must be represented, rather than limiting the sample to regular or daily tobacco smokers (e.g., Kandel et al., 1997; Breslau et al., 2001; Kandel & Chen, 2000). Most of the studies in the present thesis set out to assess the processes of smoking cessation among the adolescent population, which includes both regular and irregular smokers. However, since it is important to understand how different types of smokers may differ so that smoking cessation programs can be targeted appropriately, the present thesis also includes two studies focusing on specific subgroups of adolescent smokers, namely, weekly smokers (Chapter 4), and daily smokers (Chapter 10).

Objectives of this thesis

The main objective of this thesis is to provide a better understanding of the process of smoking cessation during adolescence. As mentioned previously, one of the risks of adolescent smoking is that youngsters develop dependency and continue to smoke into adulthood. Research on nicotine dependence among adolescents has been scarce. Furthermore, besides the influence of addiction, also cognitive and environmental influences are considered to be important in explaining smoking behaviour (Centre for Disease Control and Prevention, 1994; Fiore et al., 1996; Moolchan et al., 2000). This thesis aims to provide a better understanding of the measurement, manifestation and development of nicotine dependence among adolescents, as well as exploring the relative influences of different factors in explaining smoking cessation practices, by investigating cross-sectional and longitudinal associations.

More specific research questions are:

1. How can nicotine dependence be adequately conceptualized and measured among adolescent smokers? (Chapter 2)
2. Is there individual variation in the development and intensity of nicotine dependence symptoms among adolescent smokers? (Chapter 3)
3. What are the most important factors and mechanisms underlying smoking cessation practices among adolescents? (Chapters 4, 5, 7, 8, 9 and 10)

To answer these questions, data were collected from Dutch adolescents. In Chapter 6 we discuss the results of a study conducted among adult smokers. This latter study focused on disengagement beliefs among adult smokers and is included here mainly as a comparison for a similar study focusing on disengagement beliefs among adolescent smokers. Table 2 provides an overview of the specific features of the different data sets described and used in this thesis.²

Table 2 Characteristics of the data sets used in the present thesis.

Data Characteristics	Data set 1	Data set 2	Data set 3
Chapters	2, 3, 4, 5, 7, 8, 9	10	6
Design	Cross-sectional and longitudinal	Short-term longitudinal	Longitudinal
Measurements	4	3	2
Participants	Adolescents	Adolescents	Adults
Sample size	≤ 2,041	98	367
Data collection	Written questionnaires completed at school	Questionnaires completed online or by phone at home, and written questionnaires at school	Written questionnaires completed at home

Overview of the present thesis

Part 1 of this thesis focuses on providing a better understanding of the measurement and development of nicotine dependence in adolescents. In *Chapter 2* we describe the development and validation of a new multidimensional measure to assess nicotine dependence among adolescents. Because a gold standard to measure adolescent nicotine dependence is still lacking, we concentrated on forming a scale that would adequately capture the construct of nicotine dependence among adolescent smokers. The new multidimensional scale was tested in a second sample and, in addition, convergent validity was assessed. In *Chapter 3* the multidimensional measure of nicotine dependence was used to examine whether distinct nicotine dependence symptom profiles could be identified among an adolescent smoking population. Because nicotine dependence may still be developing among adolescent smokers, youngsters may move in and out of the different profiles over time. To better understand the aetiology of nicotine dependence, we also assessed changes in subtype membership during a one-year period.

While researchers have previously investigated adolescent smoking cessation from different perspectives (including cognitive-behavioural viewpoints, environmental influences, and aspects of nicotine dependence) these approaches have rarely been integrated. Therefore, Part 2 of this thesis focuses on exploring determinants and mechanisms of adolescent smoking cessation practices using a broader theoretical model. In *Chapter 4*, results are presented of a cross-sectional study exploring the associations between the use of cognitive and behavioural strategies to change behaviour, i.e. processes of change, and adolescents' readiness to quit smoking as measured by the stages of change construct. Furthermore, the association between nicotine dependence and readiness to quit was assessed both directly, as well as indirectly, through the processes of change. In *Chapter 5*, we elaborated on the latter study by taking a longitudinal perspective and investigating the role of both the processes of change and nicotine dependence in predicting motivational stage transitions, as well as a transition to smoking cessation.

Chapter 6 describes a longitudinal study on the role of excuses to continue smoking, i.e. disengagement beliefs, within the process of smoking cessation among adults. *Chapter 7* elaborates on this study by testing two assumptions that are partly derived from the study among adult smokers. First, we compared the extent to which adolescent smokers adhere to disengagement beliefs with that of adult smokers. Second, it was tested whether adolescents' adherence to disengagement beliefs also inhibits the engagement in smoking cessation practices. Furthermore, the association and interplay between disengagement beliefs and level of nicotine dependence, and their relative value in relation to cessation, was assessed.

In *Chapter 8*, a longitudinal approach was used to test two theoretical models (specifying multiple levels of influence) on adolescent smoking cessation. The models specify the direct and indirect relations between adolescents' readiness to quit smoking, levels of nicotine dependence, smoking behaviour of their parents and friends, and the outcome variables of undertaking quit attempts and actual smoking cessation.

After having explored the role of nicotine dependence as a predictor of adolescent smoking cessation, *Chapter 9* further elaborated on the occurrence of nicotine dependence

symptoms. More specifically, early predictors of nicotine dependence symptom profiles were examined. The study concentrated on the role of personality and parental and peer smoking in predicting later membership in the symptom profiles described in *Chapter 3*. To increase our knowledge on the psychological and physiological effects of nicotine dependence on cessation, in *Chapter 10* we studied the impact of 24-hour abstinence on indicators of nicotine dependence in adolescent daily smokers. Within 98 daily smoking adolescents, the effects of experienced craving and withdrawal symptoms on smoking cessation were examined during a period of abstinence as well as during a period of ad libitum smoking. Specifically, it was assessed whether craving and withdrawal measured in vivo are better indicators of bio-psychological dependence and, therefore, stronger predictors of smoking cessation.

Chapter 11 provides a summary and discussion of the findings of the different chapters. In addition, we address the limitations of these studies, discuss theoretical and practical implications, and present opportunities for future research.

Footnotes

¹ In the literature both the term readiness to quit and motivation to quit are used to refer to the stages of change concept of the TTM (Prochaska et al., 1992a). Therefore, in this thesis both these terms are employed when referring to the stages of change measure.

² The sample sizes across studies based on Dataset 1 may differ due to differences in selection criteria, for example the selection of different measurement waves, the inclusion of specific subgroups of respondents, the inclusion of certain variables or the use of specific analytic strategies.

Part 1

On the measurement and development
of nicotine dependence in adolescence

2 Factorial and convergent validity of nicotine dependence measures in adolescents: Towards a multidimensional approach

Based on
Kleinjan, M. Van den Eijnden, R. J. J. M. Van Leeuwe, J. Brug, J. Otten, R. & Engels R. C. M. E. (2007)
Factorial and convergent validity of nicotine dependence measures in adolescents:
Towards a multidimensional approach. *Nicotine & Tobacco Research*, 9, (11), 1109-1118.

Abstract

The present study investigated the possibility of forming a multidimensional scale for the measurement of nicotine dependence among adolescents, based on the modified Fagerström Tolerance Questionnaire (mFTQ) and the Hooked On Nicotine Checklist (HONC). A survey was conducted among 33 Dutch secondary schools, resulting in 2,041 smokers who completed the questionnaire. Readiness to quit and number of quit attempts were assessed and used as convergent construct variables for the construct of nicotine dependence. The findings show that combining the items of the mFTQ and the HONC results in three distinct dimensions: behavioural aspects of physical tolerance, craving, and withdrawal during abstinence. We examined this new multidimensional model in a second sample using confirmatory factor analysis. The new multidimensional measure fitted the data satisfactorily and showed good psychometric properties. Results of this study support the notion that nicotine dependence among adolescents is multidimensional.

Introduction

In contrast to theories stating that nicotine dependence symptoms in adolescents only develop after regular exposure to cigarettes, it seems that even irregular and sporadic smoking can cause adolescents to become addicted to nicotine after smoking only a short period of time (DiFranza, Rigotti, McNeill, et al., 2000; DiFranza, Savageau, Fletcher, et al., 2002b; DiFranza, Savageau, Rigotti, et al., 2002a; O'Loughlin, DiFranza, Tarasuk, et al., 2002a). Therefore, besides adult smokers, adolescent smokers are also considered to be at risk of developing nicotine dependence (Colby, Tiffany, Shiffman, & Niaura, 2000a). This knowledge has led to considerable debate about the construct of nicotine dependence, as well as its measurement among the adolescent smoking population. Regarding the lack of consensus over what actually comprises nicotine dependence, DiFranza and colleagues (2002b) reported that it is difficult to establish how nicotine determines dependence, and to distinguish physiological components from psychological components. Furthermore, adolescents seem to have a different experience of nicotine dependence than adults, probably because the adolescent brain is still developing and is thought to be more vulnerable to nicotine (DiFranza et al., 2002a). As a result, smoking initiation in adolescence is more likely to lead to daily smoking and continuation of smoking into adulthood. Moreover, those who began smoking as adolescents are more likely to become dependent than those who began smoking during another period in life (Breslau, Fenn & Peterson, 1993; Chassin, Presson, Sherman, et al., 1990). Another difference between adults and adolescents is that nicotine dependence rates among adolescents, although substantial, are generally lower than adult rates (Colby et al., 2000a). Measures of nicotine dependence designed for adults are no longer considered suitable for the measurement of nicotine dependence in adolescents (Colby et al., 2000a; Wheeler, Fletcher, Wellman, & DiFranza, 2004). Until now no gold standard measure of adolescent nicotine dependence exists (Colby, Tiffany, Shiffman, & Niaura, 2000b). To improve the current measures and to develop new ones, direct comparisons between alternative measures of dependence should be made to determine their relative strengths, limitations, and potential biases (Colby et al., 2000b).

Kandel and colleagues (2005) reported on the availability of five instruments to measure nicotine dependence in adolescents; of these, however, only one was specifically developed for adolescents, i.e., the Hooked on Nicotine Checklist (HONC; DiFranza et al., 2000; O'Loughlin, DiFranza, Tyndale, et al., 2003). The remaining four measures mentioned are 1) the Nicotine Dependence Syndrome Scale (NDSS; Shiffman, Waters, & Hickcox, 2004a), 2) the Wisconsin Inventory of Smoking Dependence Motives (WISDM-68; Piper, Piasecki, Federman, et al., 2004), 3) instruments based on definitions in the Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R or DSM IV; American Psychiatric Association [APA], 1987, 1994), and 4) alternate versions of the Fagerström Tolerance Questionnaire (FTQ; Fagerström & Schneider, 1989). In addition to these five instruments, a new 54-item measure for tobacco dependence in adolescents has been proposed, i.e., the Dimensions of Tobacco-Dependence Scale (DTDS; Johnson, Ratner, Tucker, et al., 2005).

Of the instruments available, the HONC and the modified Fagerström Tolerance Questionnaire are frequently used, are short and easily applicable in survey research, and can be considered the most practical measures for identifying nicotine dependence

in adolescents. The modified Fagerström Tolerance Questionnaire (mFTQ; Prokhorov, Pallonen, Fava, Ding, & Niaura, 1996) was adapted from the adult version to make it more suitable for adolescent smokers. The eight original items of the FTQ are derived from theoretical notions of reliance on nicotine (Fagerström, 1991; Prokhorov et al., 1996), and capture behavioural aspects of physical tolerance (Kandel et al., 2005). Prokhorov and colleagues (2000) reported that the mFTQ was applicable to adolescent smokers and had satisfactory internal consistency and acceptable test-retest reliability; moreover, they found a significant positive correlation between the mFTQ and saliva cotinine values. The HONC was based on a theoretical definition of nicotine dependence, namely that an individual is 'hooked' when he or she experiences a loss of autonomy over nicotine use. DiFranza et al. (2002b) suggested that autonomy over tobacco use is lost when at least one symptom presents a barrier to quitting. The HONC was developed to screen adolescent smokers' diminished autonomy. The HONC has high internal consistency, excellent test-retest reliability and has been found valid for use among low-dose occasional smokers (Wheeler et al., 2004; O'Loughlin et al., 2002a).

For the mFTQ and the HONC, previous studies reported a one-factor construct (DiFranza et al., 2000; DiFranza et al., 2002b; Prokhorov et al., 1996; Prokhorov, Koehly, Pallonen, & Hudmon, 1998). Recently, however, nicotine dependence in adolescents is considered to be a multidimensional phenomenon, consisting of behavioural, physiological, and psychological features (Colby et al., 2000b; Johnson et al., 2005; Shadel, Shiffman, Niaura, Nichter & Abrams, 2000; Stanton, 1995). Measurements consisting of a single factor cannot be expected to reflect the multidimensional nature of the nicotine dependence construct (Cohen, Myers, & Kelly, 2002); therefore, assessing nicotine dependence in adolescents may be better represented by a multi-factorial structure (Hudmon et al., 2003; Johnson et al., 2005).

To gain more insight into the concept of nicotine dependence and psychometric properties of measurement instruments often used for adolescent smokers, the first goal of the present study was to test whether the HONC and the mFTQ indeed measure a one-dimensional construct. The second goal was to determine whether the mFTQ and the HONC could complement each other, and form a new and more multidimensional measure of nicotine dependence. Our final goal was to test this new measure for convergent construct validity using constructs related to nicotine dependence. Nicotine dependence in adults has been found to be related both to a high number of previous quit attempts and to a low readiness to quit (John, Meyer, Rumpf, & Hapke, 2004). Among adolescents, nicotine dependence was also found to be associated with a lower readiness and ability to quit smoking (Prokhorov, Hudmon, De Moor, et al., 2001; Horn, Fernandez, Dino, Massey, & Kalsekar, 2003). Readiness to quit and the previous number of quit attempts are therefore used as convergent construct variables. It is hypothesized that the new measure will show a negative relation with readiness to quit and a positive relation with the number of previous unsuccessful quit attempts.

Methods

Recruitment

A total of 33 secondary schools in the Netherlands participated in the present study, resulting in 2,181 respondents indicating they had smoked at least once in the past month [for more details of the study see Otten, Engels, & Van den Eijnden (2005) and Van de Ven, Van den Eijnden, & Engels (2006a)]. Respondents with more than 3 missing values on the items of either the HONC or the mFTQ were excluded, leaving a sample of 2,041 smokers with a mean age of 15.2 years ($SD = 0.98$). This total sample of 2,041 smokers was randomly divided into two subsamples, with Sample 1 including 1,021 respondents and Sample 2 1,020 respondents. Independent sample t-tests showed that the two samples did not differ significantly with regard to respondents' sex, age, educational level, and amount of cigarettes smoked per day.

Measures

mFTQ. The modified Fagerström Tolerance Questionnaire (mFTQ) is a seven-item version of the Fagerström Tolerance Questionnaire (FTQ), designed to assess nicotine dependence in adolescents (Fagerström, 1991; Prokhorov et al., 1996).

HONC. The Hooked on Nicotine Checklist is a 10-item instrument that was designed to measure loss of autonomy over tobacco use (DiFranza et al., 2000). For the HONC, we used multiple response choices instead of the dichotomous Yes/No category described by DiFranza et al. (2000). The multiple response choices are based on the study of O'Loughlin et al. (2002a), in which multiple response choices were provided for each item to provide better insight into the different degrees of lost autonomy; any affirmative response category indicates a loss of autonomy.

Readiness to quit. The readiness to quit was assessed by asking respondents to indicate if and when they planned to stop smoking on a nine-point ordinal scale ranging from 1 ("I am planning to quit within the next 10 days") through several levels to 9 ("planning to never quit and not planning to cut down") (Dijkstra, Bakker, & De Vries, 1997; Dijkstra, Roijackers, & De Vries, 1998; Dijkstra, Tromp, & Conijn, 2003).

Number of quit attempts. To assess the number of previously undertaken quit attempts respondents were asked, "How many times did you try to quit smoking in the past twelve months".

Statistical analyses

For both the mFTQ and the HONC descriptive statistics on item-level were examined (mean, standard deviation, skewness, and kurtosis), along with the inter-item and item-total correlations. Reliability was established using Cronbach's alpha. Furthermore, for both scales exploratory factor analysis (EFA) using principal axis factoring with oblique rotation (promax) was conducted.

To establish whether the two measures together represent multiple components of dependence, we examined the conceptual relatedness of the items of the HONC and

the mFTQ within Sample 1 using EFA with principal axis factoring and oblique rotations (promax). A minimal loading of 0.45 was considered satisfactory for item preservation (Van Dyke, Prybutok & Kappelman, 1999); however, the selection of items was also based on conceptual interpretation, scores on descriptive statistics, and the inter-item and item-total correlations. The dimensions identified using EFA were subsequently confirmed in Sample 2 by means of confirmatory factor analysis (CFA) using Amos 4.0 (Arbuckle & Wothke, 1999). The CFA analysis was performed on the covariance matrix.¹ Because of the large sample (n = 1,020), there was a chance that relatively small deviations from the model would lead to significant chi-square estimates, and consequently to a premature rejection of the model. Therefore, besides the chi-square goodness-of-fit test, a sequence of other standard goodness-of-fit indices were reported, i.e., the root mean square error of approximation (RMSEA), the goodness of fit index (GFI), and the standardized root mean square residual (SRMR). The RMSEA is known to be rather insensitive to sample size, and a value smaller than 0.05 is regarded indicative of a good fit (Browne & Cudeck, 1993). The GFI is ideally close to or above 0.90 (Byrne, 1998). A value below 0.08 on the SRMR is considered indicative for a good fit (Hu & Bentler, 1999). Structural equation model analyses, using Mplus version 2.12 were used to examine convergent construct validity for the combined measurement with readiness to quit smoking and number of quit attempts (Muthén & Muthén, 1998-2007a; 1998-2007b). Mplus is particularly recommended because of its ability to accommodate non-normality and ordinal variables without reliance on large samples (Kaplan, 2000).

Results

Scale Characteristics

Table 1 presents the descriptive statistical data of the mFTQ and HONC. The inter-item and item-total correlations for the mFTQ and HONC are given in Tables 2 and 3, respectively. Inter-item correlations of the mFTQ were low to moderate, falling largely below 0.5 (M = 0.31). Item-total correlation for the items of the mFTQ ranged from 0.27 to 0.69. Inter-item correlations of the HONC were moderate, except for item four "Have you ever tried to quit smoking, but couldn't" which correlated low with all other items (-0.02 to 0.16). The mean inter-item correlation including item four was 0.40, and excluding item four 0.48. Item-total correlations for the items of the HONC ranged from 0.48 to 0.77, when the item-total correlation for item four (0.14) was excluded. Internal reliability of the 7-item mFTQ was Cronbach's alpha 0.73. Cronbach's alpha for the 10-item HONC was 0.88.

Exploratory factor analyses

mFTQ. To examine the factor structure of the mFTQ, EFA with principal axis factoring and oblique rotation (promax) was conducted in Sample 1. A one-factor solution was found on basis of the Kaiser rule, supporting the unidimensionality of the mFTQ. The one-factor solution accounted for 42% of the variance. Two items within the one-factor solution of the mFTQ have a loading below 0.40, indicating that these items are less meaningful related to the first factor compared to the other 5 items. The factor loading pattern is given in Table 4.

Table 1 Item descriptions and characteristics

Item	Response categories	Mean (SD)	Skewness (SD)	Kurtosis (SD)
MFTQ				
1. How many cigarettes a day do you smoke	1. Less than 1 a day 2. About 1-5 a day 3. About 6-10 a day 4. About 11-20 a day 5. About 21-30 a day 6. Over 30 a day	2.55 (1.26)	0.32 (0.77)	-0.78 (1.53)
2. Do you inhale	1. Never 2. Seldom 3. Quite often 4. Always	3.61 (0.80)	-2.03 (0.77)	3.13 (1.53)
3. How soon after you wake up do you smoke your first cigarette	1. Within 5 minutes 2. Within 6-30 minutes 3. Within 31-60 minutes 4. After 60 minutes	1.81 (1.03)	0.83 (0.77)	-0.73 (1.53)
4. Do you smoke more during the first hours after waking than during the rest of the day	1. No 2. Yes	1.14 (0.35)	2.08 (0.77)	2.35 (1.53)
5. Which cigarette would you hate to give up	1. First cigarette in the morning 2. Any other cigarette	1.35 (0.47)	0.60 (0.77)	-1.62 (1.53)
6. Do you find it difficult to refrain from smoking in places where it is forbidden	1. No, not at all difficult 2. No, not unusually difficult 3. Yes, somewhat difficult 4. Yes, very difficult	1.60 (0.88)	1.37 (0.77)	0.725 (1.53)
7. Do you smoke if you are so ill that you are in bed most of the day	1. No 2. Yes	1.19 (0.39)	1.60 (0.77)	0.550 (1.53)

Item	Response categories	Mean (SD)	Skewness (SD)	Kurtosis (SD)
HONC				
1. Have you ever felt like you were addicted to tobacco	1. Never 2. Seldom 3. Sometimes 4. Often	2.50 (1.10)	-.120 (0.77)	-1.320 (1.53)
2. Do you ever have strong cravings to smoke	1. Never 2. Seldom 3. Sometimes 4. Often	3.01 (0.86)	-.657 (0.77)	-.112 (1.53)
3. Have you ever felt like you really needed a cigarette	1. Never 2. Seldom 3. Sometimes 4. Often	2.70 (0.99)	-.389 (0.77)	-.865 (1.53)
4. Have you ever tried to quit smoking, but couldn't	1. No 2. Yes	1.33 (0.45)	.746 (0.77)	-1.322 (1.53)
5. Do you smoke because it is really hard to quit	1. No, not at all 2. A little 3. Quite 4. Very difficult	1.75 (0.92)	.909 (0.77)	-.321 (1.53)
6. Do you find it difficult to refrain from smoking in places where it is forbidden	1. No, not at all difficult 2. No, not unusually difficult 3. Yes, somewhat difficult 4. Yes, very difficult	1.60 (0.88)	1.327 (0.77)	.725 (1.53)

Item	Response categories	Mean (SD)	Skewness (SD)	Kurtosis (SD)
<i>At times that you tried to stop or weren't able to smoke, how often did you experience the following:</i>				
7. Trouble concentrating	1. Never 2. Seldom 3. sometimes 4. Often	1.61 (0.90)	1.246 (0.77)	.377 (1.53)
8. Feeling irritable or angry	1. Never 2. Seldom 3. sometimes 4. Often	1.81 (1.03)	.863 (0.77)	-.675 (1.53)
9. Feeling a strong need or urge to smoke.	1. Never 2. Seldom 3. sometimes 4. Often	2.14 (1.14)	1.246 (0.77)	-1.334 (1.53)
10. Feeling nervous, restless or anxious	1. Never 2. Seldom 3. sometimes 4. Often	1.48 (0.85)	1.659 (0.77)	1.604 (1.53)

Table 2 Inter-item and item-total correlations for the mFTQ

items	1	2	3	4	5	6	7
1.	–						
2.	0.38**	–					
3.	0.67**	0.25**	–				
4.	0.27**	0.05*	0.30**	–			
5.	0.37**	0.14**	0.42**	0.24**	–		
6.	0.47**	0.21**	0.41**	0.21**	0.24**	–	
7.	0.45**	0.19**	0.49**	0.20**	0.24**	0.36**	–
item total	0.69**	0.34**	0.62**	0.27**	0.29**	0.59**	0.51**

Note: Total scores are adjusted for the item being correlated.

* p < 0.05 ** p < 0.01

Table 3 Inter-item and item-total correlations for the HONC

items	1	2	3	4	5	6	7	8	9	10
1.	–									
2.	0.64**	–								
3.	0.66**	0.70**	–							
4.	0.11**	0.06**	0.08**	–						
5.	0.56**	0.45**	0.44**	0.14**	–					
6.	0.44**	0.45**	0.47**	-0.02	0.43**	–				
7.	0.38**	0.37**	0.41**	0.16**	0.37**	0.44**	–			
8.	0.42**	0.38**	0.44**	0.13**	0.38**	0.41**	0.66**	–		
9.	0.60**	0.57**	0.60**	0.15**	0.50**	0.49**	0.57**	0.61**	–	
10.	0.32**	0.32**	0.35**	0.12**	0.31**	0.35**	0.55**	0.57**	0.50**	–
item total	0.69**	0.66**	0.70**	0.14**	0.58**	0.48**	0.64**	0.66**	0.77**	0.55**

Note: Total scores are adjusted for the item being correlated.

** p < 0.01

Table 4 Factor loadings for the mFTQ

Scale items	Loadings
1. How many cigarettes a day do you smoke	0.821
2. Do you inhale	0.350
3. How soon after you wake up do you smoke your first cigarette	0.795
4. Do you smoke more during the first hours after waking than during the rest of the day	0.372
5. Which cigarette would you hate to give up	0.466
6. Do you find it difficult to refrain from smoking in places where it is forbidden	0.527
7. Do you smoke if you are so ill that you are in bed most of the day	0.572

HONC. For the HONC, EFA with principal axis factoring and oblique rotation (promax) in Sample 1 initially showed three components with eigenvalues above 1 (based on the Kaiser Rule), accounting for 56% of the variance. The third component however, was formed solely by the item “Do you smoke because it is really hard to quit”. Because components generally represent several items forming a communal theoretical construct, a component consisting of one item does not form an interpretable solution. A two-component solution is therefore more fitting. EFA with principal axis factoring and oblique rotation resulting in a two-component solution, accounted for 52% of the variance. The component loading patterns are given in Table 5.

MFTQ and HONC combined

Exploratory factor analysis. EFA with principal axis factoring and oblique rotation on the items of the mFTQ and the HONC combined (17 items), suggested a three-factor solution (based on the Kaiser Rule), explaining 47% of the variance. The three distinct factors could be interpreted as behavioural aspects indicative of physical tolerance, craving, and withdrawal symptoms experienced during abstinence, respectively.

Table 5 Rotated pattern loadings for the HONC

scale items	loadings	
	component	
	1	2
1. Have you ever felt like you were addicted to tobacco	0.843	-0.046
2. Do you ever have strong cravings to smoke	0.873	-0.115
3. Have you ever felt like you really needed a cigarette	0.794	0.001
4. Have you ever tried to quit smoking, but couldn't	0.026	0.139
5. Do you smoke because it is really hard to quit	0.499	0.193
6. Do you find it difficult to refrain from smoking in places where it is forbidden	0.348	0.307
<i>At times that you tried to stop or weren't able to smoke, how often did you experience the following:</i>		
7. Trouble concentrating	-0.028	0.828
8. Feeling irritable or angry	-0.008	0.811
9. Feeling a strong need or urge to smoke.	0.459	0.449
10. Feeling nervous, restless or anxious	-0.071	0.755

We modified the candidate three-factor model through a process of removing single items with unsatisfactory factor loadings (< 0.45), skewness and kurtosis scores exceeding the value of two, and items loading simultaneously on multiple components. Eleven items loaded exclusively on one of the three factors and showed satisfactory factor loadings and skewness and kurtosis scores. The internal reliability of this combination scale was satisfactory, with a Cronbach's alpha of 0.84 for the overall scale of 11 items, and $\alpha = 0.70$ for the behavioural construct, $\alpha = 0.84$ for the craving construct, $\alpha = 0.82$ for the withdrawal construct.

Confirmatory factor analysis. In order to confirm the three-factor structure of the 11 items found using exploratory analyses in Sample 1, we conducted a CFA in Sample 2 (Table 6).

Table 6 Confirmatory factor analysis: Scale items and standardized factor loadings of the three-factor model

Dimensions of dependence and scale items	Loadings		
	1	2	3
Behavioural			
B1: How soon after you wake up do you smoke your first cigarette	0.780		
B2: Which cigarette would you hate to give up	0.462		
B3: How many cigarettes a day do you smoke	0.871		
B4: Do you smoke if you are so ill that you are in bed most of the day	0.560		
Craving			
C1: Have you ever felt like you were addicted to tobacco		0.828	
C2: Do you ever have strong cravings to smoke		0.814	
C3: Have you ever felt like you really needed a cigarette		0.842	
C4: Do you smoke because it is really hard to quit		0.586	
Withdrawal			
W1: At times that you tried to stop or weren't able to smoke, how often were you troubled by finding it hard to concentrate			0.790
W2: At times that you tried to stop or weren't able to smoke, how often were you troubled by feeling more irritable or angry			0.832
W3: At times that you tried to stop or weren't able to smoke, how often were you troubled by feeling nervous, restless or anxious			0.678

Note: The items B1, B2, B3, and B4 correspond to items 3, 5, 1 and 7 of the mFTQ as shown in Table 1. The items C1, C2, C3 and C4 correspond to items 1, 2, 3, and 5 of the HONC as shown in Table 1. The items W1, W2, and W3 correspond to items 7, 8, and 10 of the HONC in Table 1.

The results showed a well fitting model [$\chi^2=166.77$, $df = 41$, $RMSEA = 0.06$, $GFI = 0.97$, $SRMR = 0.03$], with inter-factor correlations ranging from 0.54 to 0.77. The three-component distinction suggested by the exploratory analyses in Sample 1 was thus confirmed in Sample 2. For comparison with the three-factor structure, we also conducted a CFA to test the fit of a one-factor solution of the 11 items. The results showed that this model did not fit at all to the data [$\chi^2=1065.91$, $df = 44$, $RMSEA = 0.15$, $GFI = 0.82$, $SRMR = 0.08$]. Moreover, this one-factor model fitted significantly less well compared to the three-factor solution [Chi-square difference test: $\chi^2=1065.91$, $df = 44$, $p < 0.001$].

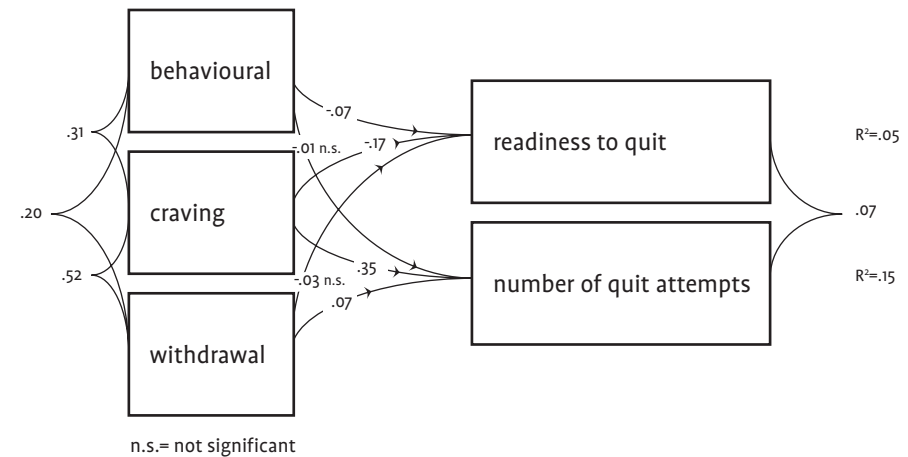
Within Sample 2, the reliability of the combination scale (consisting of items from the mFTQ and the HONC) had a satisfactory reliability, with $\alpha = 0.72$ for the behavioural construct, $\alpha = 0.85$ for the craving construct, $\alpha = 0.81$ for the withdrawal construct, and $\alpha = 0.88$ for the 11 items overall. Two items in the behavioural scale had loadings that were considerably lower than the other two items, i.e., “Which cigarette would you hate to give up” and “Do you smoke if you are so ill that you are in bed most of the day”. This might indicate that these items are less meaningfully related to the behavioural factor than the other two items. The same can be observed in the craving scale for the item “Do you smoke because it is really hard to quit”. The loading of this item is considerably lower than the loadings of the other three items making up the craving factor.

Convergent construct validity. Evidence of convergent construct validity is provided if the examined construct correlates with indicators related to the construct under investigation (Streiner & Norman, 1996). We examined the convergent construct validity of the multidimensional measure with readiness to quit and with the number of quit attempts, using path modeling in structural equation analyses (SEM).

For the total sample ($n = 2,041$), using Mplus, SEM-analyses showed that all paths were significant with two exceptions, i.e., the behavioural aspects of physical tolerance were not associated with the number of quit attempts, and withdrawal was not associated with readiness to quit (Figure 1). Paths were labelled as significant when the results for the model showed a value above 1.98 when the estimate was divided by the standard error.

To investigate whether the three-factor model has a higher validity when compared to the single 11-item measure, additional models were calculated. In these additional models we examined both the convergent construct validity of the three separate factors and the convergent construct validity of the unidimensional 11-item construct with readiness to quit and the number of quit attempts as criteria. It was found that the total 11-item construct yielded lower R^2 values compared with the model shown in Figure 1, i.e., R^2 is 0.04 versus 0.05 for readiness to quit, and R^2 is 0.12 versus 0.15 for the number of quit attempts, respectively. R^2 values for the behavioural factor were 0.01 for readiness to quit and 0.01 for number of quit attempts; for the craving factor 0.04 and 0.15 and for the withdrawal factor 0.02 and 0.06, respectively. Furthermore, adding the R^2 values for the separate factors results in a total of 0.07 for readiness to quit and 0.22 for number of quit attempts; these explained variances are higher than the values of the total 11-item scale. These results indicate that the three-factor structure has a higher validity compared with the unidimensional 11-item measure.

Figure 1 Structural Equation Model: Standardized regression weights of the three-factor solution.



Discussion

In a large sample of adolescents, we explored the unidimensionality of the mFTQ and the HONC as measures of nicotine dependence among adolescents. In addition, we examined whether the mFTQ and the HONC could be combined to form a new multidimensional measurement. While the mFTQ indeed consisted of a single component, we failed to find a one-factor solution for the HONC. In contrast to previous research, results for the HONC showed two components; one indicative of craving, and a second component indicative of aspects of withdrawal during abstinence.

The HONC is assumed to measure feelings of addiction, withdrawal symptoms, loss of control, craving, and psychological addiction (Johnson et al., 2005; O’Loughlin et al., 2002a), and can be valuable in identifying tobacco users in whom dependence is developing before they reach a diagnosable level (Wellman, DiFranza, Savageau, Godiwala, Friedman, & Hazelton, 2005). The mFTQ, on the other hand, is assumed to measure behavioural aspects and strength of physical dependence, and was not designed to measure the earlier stages of nicotine dependence (Kandel et al., 2005; O’Loughlin et al., 2002c). When combining the mFTQ and the HONC, both EFA and CFA showed three distinct factors. Using a combination of these two measures could offer important advantages over the use of a single measure, since multiple components can capture the overall construct of nicotine dependence. Moreover, the combination of the mFTQ and the HONC contains items thought to be indicative of early symptoms, as well as items presumably indicative of symptoms that occur when dependence is more manifest; taken together, these items may enable the measurement of a wider range of nicotine dependence.

The three components of the combined scale were uniquely related to the convergent validity variables of readiness to quit and number of quit attempts. In their study on

nicotine dependence among adults, Hudmon and colleagues (2003) concluded that distinct factors with differing strengths of association with convergent validity variables, support the idea that dependence is multidimensional. Our findings thus also indicate that nicotine dependence in adolescents is indeed a multidimensional construct.

Several attempts have been made to develop or adapt multidimensional scales to measure nicotine dependence in adolescents (Clark et al., 2005; Johnson et al., 2005). In our opinion, the multidimensional measure developed in the present study has several strengths. First, the conceptual framework of the new multidimensional measure was based on two scales that have been well explored in previous studies. The Dimensions of Tobacco-Dependence Scale (DTDS), for example, was developed based on qualitative research asking adolescents about their need to smoke and thus includes a variety of reasons why adolescents smoke. The DTDS includes four dimensions, i.e., social reinforcement, emotional reinforcement, sensory reinforcement, and physical reinforcement (Johnson et al., 2005). The dimensions of social reinforcement and sensory reinforcement encompass the notion that dependence can begin to emerge while physical needs for nicotine are still absent. The mFTQ and HONC mostly include items anticipating the presence of a physical need (behavioural, cognitive, or emotional) for nicotine. Although social reinforcement and sensory reinforcement did correlate with the mFTQ and the HONC (Johnson et al., 2005), future research is needed to identify whether it is appropriate to include social and sensory reinforcement as being part of the wider construct of nicotine dependence. Secondly, the new multidimensional measure consists of 11 items, which makes the scale practical to use and easy to apply in measuring nicotine dependence among adolescents. Furthermore, the measure was developed within a large sample of adolescent smokers ($n=2,041$), whereas in most previous studies relatively small samples were used to test new nicotine dependence measures (Clark, et al., 2005; DiFranza, et al., 2002b; Johnson et al., 2005; Prokhorov et al., 1996). Finally, the combined measure proved to be reliable and fitted the data well.

In addition to developing a new multidimensional measure of nicotine dependence, the present study shows that a greater amount of explained variance was found in the more behavioural convergent construct (number of quit attempts) than in the more psychological measure (readiness to quit). Social cognitive models (such as the Theory of Planned Behaviour) are generally satisfactory in predicting people's readiness to quit (Ajzen & Madden, 1986; Cote, Godin, & Gagne, 2004; Moan & Rise, 2005). The present finding, however, suggests that nicotine dependence has a stronger association with actual behaviour than with motivation.

Some limitations of the present study should also be addressed. One limitation of the mFTQ is the item "number of cigarettes smoked per day"; this item can be seen as a direct indication of the degree of nicotine dependence and is, therefore, sometimes used as a criterion for establishing concurrent validity (Hudmon et al., 2003; Van den Eijnden, Spijkerman, & Fekkes, 2003). Secondly, one might assume that respondents attending the same school are likely to produce common sources of variance, which could violate

the accuracy of the effects. In our sample, the intraclass correlation coefficient (ICC) for readiness to quit was 0.019, indicating that 1.9% of the variance could be explained by a school effect. The ICC for number of quit attempts was 0.012, indicating that 1.2% of the variance could be explained by a school effect. According to the simulation study by Muthen and Satorra (1995), the impact of the violation of independent observation assumption is not serious when the size of the effect is less than 2%. Based on these findings, we assume that the use of multilevel analyses would not be a substantial improvement in statistical analyses. The approach we employed also facilitates comparison with other studies using the same instruments; therefore we decided to stay with the current strategy of analyses. Thirdly, to avoid repeating questions within the questionnaire, some of the items of the mFTQ and HONC needed adjustment with regard to the scoring. We emphasize, however, that all original items of both measurements were used, and that all questions were stated in their original form. Fourthly, it can be argued that the items comprising the "Withdrawal" factor are similar in style and wording and may therefore be affected by method variance. The items used in the present study are, however, stated in exactly the same manner as in the original versions. All previous studies on the psychometric properties of the HONC yielded a one-factor solution. The questions constituting "Withdrawal" have so far not shown up as a separate factor due to the similarity of style and wording. Fifthly, it should be mentioned that the use of one-item criterion measures (i.e., readiness to quit and number of quit attempts) may have formed a constrain on the strength of the associations between these criterion measures and the three separate factors of nicotine dependence. A final limitation may be that, although our analyses resulted in a reliable and conceptually diverse model for measuring dependence, our approach was limited to two measurements of nicotine dependence. Therefore, other dimensions of nicotine dependence in adolescents may have fallen outside the scope of this study.

To conclude, although both the mFTQ and the HONC aim to measure nicotine dependence in adolescents, they do not seem to measure the same underlying construct. Based on our findings, we endorse the idea that nicotine dependence in adolescents is not likely to be a one-dimensional construct, but rather a multidimensional phenomenon. In order to fully understand the emergence and occurrence of nicotine dependence in adolescence, and to develop effective cessation interventions, it is necessary to capture all the relevant features of nicotine dependence. It is therefore important to study the exact nature of nicotine dependence. This study has demonstrated the multidimensional features of the mFTQ and the HONC. Further psychometric research is needed to establish the feasibility, usefulness and comprehensiveness of the combined measurement to evaluate nicotine dependence among adolescent smokers.

Footnotes

¹ We conducted extra calculations for which all items were rescaled to range between 0 and 1. This method ensures that each item contributes an equal amount of weight to the scale. We found no difference using this approach as compared to the approach presented. Amos controls for the impact of the different item response scales by providing standardised solutions accounting for the number of response options.

3 Nicotine dependence subtypes among adolescent smokers: Examining the occurrence, development and validity of distinct symptom profiles

Based on

Kleinjan, M. Wanner, B. Vitaro, F. Van den Eijnden, R.J.J.M. Brug, J. & Engels, R.C.M.E. (Resubmitted). Nicotine dependence subtypes among adolescent smokers: Examining the occurrence, development and validity of distinct symptom profiles. *Psychology of Addictive Behaviors*.

Abstract

To increase understanding of the aetiology and epidemiology of nicotine dependence among adolescent smokers, the present study examined the occurrence and development of distinct nicotine dependence symptom profiles in a sample of adolescent smokers. A total of 25 secondary schools throughout the Netherlands participated in a one-year longitudinal study. Multiple dimensions of nicotine dependence were assessed, at two time points, among 641 adolescents who were classified as smokers. Results showed four distinct, yet stable, nicotine dependence subtypes that could be characterized along a severity spectrum, as well as by qualitative differences. The symptom profiles were similar for males and females but differentially associated with previously identified correlates of nicotine dependence, namely parental and peer smoking, depressive mood, and self-efficacy to refrain from smoking. Finally, differential links of the four subtypes were found with regard to smoking uptake and cessation. The findings of this study provide important implications for identifying different subgroups of adolescent smokers with specific needs in terms of intervention efforts regarding nicotine dependence and smoking cessation.

Introduction

Adolescent smokers are known to experience symptoms of nicotine dependence, even if their exposure to cigarette smoking has been relatively short and intermittent (e.g. Kandel et al., 2007; DiFranza, et al., 2000, 2002a). Tobacco is a highly addictive substance and the occurrence of nicotine dependence symptoms has been found to interfere with adolescents' readiness and their ability to quit smoking (Prokhorov et al., 2001; Kleinjan et al., 2008a; 2008b). Because of the detrimental health effects of smoking and the alleged significance of nicotine dependence in the persistence of adolescent smoking, a better understanding of nicotine dependence in adolescents is important.

Nicotine dependence is perceived to be a complex disorder and, as such, is considered to encompass an array of properties. In adolescents, nicotine dependence is believed to consist of behavioural, physiological, as well as psychological features (Colby et al., 2000b; Johnson et al., 2005; Shadel et al., 2000; Stanton, 1995). Hence, instruments with a multi-factorial structure are required to reflect the multidimensional nature of the nicotine dependence syndrome (Hudmon et al., 2003; Johnson et al., 2005). In this regard, a recent study among a large nationwide sample of Dutch adolescent smokers found that combining two frequently used and well-tested measures for identifying nicotine dependence in adolescents, namely the modified Fagerström Tolerance Questionnaire (mFTQ; Prokhorov et al., 1996) and the Hooked on Nicotine Checklist (HONC; DiFranza et al., 2002b; O'Loughlin et al., 2002a), resulted in three distinct dimensions of dependence: behavioural aspects of nicotine dependence that are indicative of physical tolerance (i.e., items assessing when, where, and how much one smokes), craving (i.e., items assessing the urge to smoke), and withdrawal symptoms experienced during periods of abstinence (i.e., items assessing trouble concentrating, irritability, nervousness, restlessness, or anxiousness) (Kleinjan et al., 2007).

Studies among adult smokers found substantial between-subject variability in the intensity of nicotine dependence symptoms (Storr et al., 2005; Xian et al., 2007). Xian and colleagues (2007) postulated that identifying individual variation in the experience of different features of nicotine dependence can help explain why some smokers are more likely to overcome dependence than others. Also, among adolescents, there is evidence indicative of individual variation in the occurrence and intensity of nicotine dependence symptoms, with some adolescent smokers appearing to be more susceptible to the development of specific symptoms than others (DiFranza et al., 2000). Thus, the identification of distinct, yet reliable, qualitative differences in the occurrence of important features of nicotine dependence in adolescents may make an important contribution to a more complete understanding of the epidemiology of nicotine dependence among the adolescent smoking population.

To our knowledge, studies on nicotine dependence symptom profiles have focused almost solely on (young) adults (Storr et al., 2004a; 2005; Xian et al., 2005; Xian et al., 2007). The exception is a study by Storr and colleagues (2004b), which examined DSM nicotine dependence symptoms 1-2 years after initiation of smoking among respondents aged 10-29 years; however, even though that study included adolescents, its focus was

not on identification of possible subtypes of nicotine dependence within a population of adolescent smokers. We are not aware of any study examining the occurrence or the stability of subtypes of nicotine dependence in such a population sample.

With respect to the above-mentioned dependence features found among adolescents (including behavioural aspects indicative of physical tolerance, craving and withdrawal symptoms), it was also found that the development of physical tolerance may begin with the very first doses of nicotine and that, thereafter, other symptoms of dependence may follow (Benowitz, 1988; DiFranza et al., 2000). Moreover, DiFranza and colleagues (2000) found that almost two-thirds of all adolescent daily smokers and half of all adolescent occasional smokers experienced craving and withdrawal symptoms. Thus, daily smoking does not appear to be a prerequisite for the occurrence of tolerance, craving and withdrawal symptoms in adolescent smokers (see also Panday et al., 2007). Instead, vulnerability to develop specific symptoms appears to be explained by different factors, such as genetic and biological vulnerability, in addition to actual smoking habits. Based on this, we might expect to find distinctive groups of adolescent smokers that differ with regard to the occurrence of behavioural aspects indicative of physical tolerance, craving and withdrawal symptoms partly independent of their smoking habits. For instance, we may find a group reporting low levels of all three types of dependence symptoms, as well as a group reporting high levels of all three types of dependence symptoms. In addition, some subgroups may be high with respect to one or two types of symptoms and low on the remaining one or two types of symptoms. More specifically, on the basis of the finding that not all daily adolescent smokers experience craving or develop withdrawal symptoms, we might encounter a group that reports high levels of physical tolerance, including high cigarette consumption, but does not report significant craving and withdrawal symptoms.

Therefore, the first aim of the present study was to examine whether distinctive subtypes of nicotine dependence exist among a population sample of adolescent smokers by using a multidimensional measure encompassing items indicative of behavioural aspects of physical tolerance, craving, and withdrawal symptoms experienced during abstinence. If different dependence profiles do exist among adolescent smokers, intervention efforts may be targeted to these profiles.

To further explore the meaningfulness of different subtypes of dependence, the second aim of the study was to examine whether the potential subtypes differ with respect to previously identified correlates of nicotine dependence. Validating the different subclasses by relating them to key covariates of nicotine dependence allows to test whether the subtypes of nicotine dependence are defined by a severity dimension or whether they reflect qualitative differences as well.

Factors previously identified as being associated with the development of nicotine dependence in adolescence include gender, the exposure to smokers in the proximate social environment, and psycho-social or psychological characteristics. Nicotine dependence is generally higher among girls than among boys (e.g. DiFranza

et al., 2002a; O'Loughlin et al., 2002a; Panday et al., 2007). Additionally, adolescents whose parents are smokers are more likely to report higher levels of nicotine dependence (Kleinjan et al., in press), and have a higher risk to become nicotine dependent when growing into early adulthood, particularly when their mothers smoked (Hu et al., 2006; Lieb et al., 2003). It is also reported that having smoking peers is associated with higher levels of nicotine dependence in adolescents (Audrain-McGovern et al., 2007; Hu et al., 2006; Kleinjan et al., in press). Furthermore, self-efficacy (i.e. strength of one's perceived capability to resist smoking in specific high-risk situations) was also found to be negatively related to the degree of nicotine dependence (Van Zundert et al., 2008). Finally, a well-documented finding regarding nicotine dependence is its comorbidity with depressive mood (e.g. Lerman et al., 1996; O'Loughlin et al., 2002a; Panday et al., 2007).

Besides the identification and validation of possible symptom profiles (i.e., subtypes), it is also essential to note that, because of the relatively short period between onset of smoking and regular smoking in adolescence, nicotine dependence may still be developing and subtypes identified at an earlier time point may not be found at a subsequent time point. In other words, an adolescent smoker could move in and out of the different subtypes over time, and members of specific subtypes may be more likely to change to a specific other subtype. It will be particularly interesting to see whether some subtypes of dependence are more prone than others to overcome dependence and tobacco use altogether. The last goal of the present study was therefore to integrate a symptom profile and a developmental approach based on assessments of nicotine dependence symptoms from two time points.

To conclude, the aims of the present study were to examine (1) if empirically derived profiles of nicotine dependence symptoms exist within a population sample of early adolescent smokers, (2) if these profiles differ with respect to well-established environmental and individual correlates of nicotine dependence, (3) if the different dependence profiles are stable over a one-year interval, and (4) if certain subtypes are more likely to overcome tobacco use than others.

Method

Sample

The data of the present study pertain to the third and fourth waves of a larger longitudinal study that started in January 2003, focusing on psychological and environmental processes in relation to tobacco use among Dutch adolescents. Following random selection from the telephone book, schools in four regions of the Netherlands were randomly selected and approached to take part. The main reason given for refusal to join this study was participation in other studies. A total of 25 schools participated in all four measurement waves. In the fall of 2004, at the time of the third wave, data were collected for 6,750 respondents aged 13-18 ($M=14.8$, $SD=0.88$). In the fall of 2005, at the time of the fourth wave, 4,940 respondents participated again (response rate 73.2%). Because the different nicotine dependence features were only assessed at the third and fourth waves,

in the present study the third wave will represent the first time point (T1) and the fourth wave will represent the second time point (T2). Sickness, truancy, leaving school, and repeating class were noted by teachers as the primary causes for non-response [for more details about the study see Van De Ven and colleagues (2006b) and Otten and colleagues (2008)]. The local medical ethical committee (CMO Arnhem-Nijmegen) approved this study.

Adolescents were considered smokers if they indicated to have smoked at least once during the past month. A total of 850 of the 4,940 respondents (17.2%) indicated at T1 that they had smoked at least once in the past month, whereas 1,026 respondents (20.8%) indicated that they had smoked at least once in the past month at T2. Of the original 850 adolescent smokers at T1, 209 were no longer classified as smokers at T2. Conversely, 385 adolescents were classified as smokers at T2, whereas they were labeled non-smokers at T1. A total of 641 respondents thus indicated that they had smoked at least once in the past month at both time points. Of these 641 smokers that were included in the main analyses, 55.1% were female. A total of 42.6% received preparatory vocational training, 16.1% junior general secondary training, 27.7% senior general secondary education, 13.1% received university preparatory training, and 0.5% reported to receive some other form of education.

Procedure

Respondents completed questionnaires during school hours. Students were informed that the data would be processed anonymously, i.e., respondent-specific codes were used to link the data from one point in time to the next. To assure confidentiality, each participant received an unmarked envelope in which to return the completed questionnaires. In addition, respondents were informed that participation was voluntary, not obligatory.

Attrition Analyses

Attrition analyses on gender, age, education, and smoking status, revealed differences between the respondents that participated in both waves and those that dropped out. Respondents that dropped out were more likely to be boys, to be older, to have general secondary training, and to be smokers. Although significant, the explained variance by these variables was very limited, i.e., 2%.

Measures

Nicotine Dependence. The different aspects of nicotine dependence were assessed for respondents who indicated to have smoked at least once during the past month. Non-smokers were instructed to skip this section. The nicotine dependence measure consisted of a newly developed multidimensional scale based on both the modified Fagerström Tolerance Questionnaire (mFTQ; Prokhorov et al., 1996) and the Hooked on Nicotine Checklist (HONC; DiFranza et al., 2002b). The 11-item scale was validated in a study by Kleinjan and colleagues (2007), showing that combining items from the mFTQ and the HONC results in three distinct dimensions: (1) behavioural aspects of nicotine dependence that are indicative of physical tolerance, (2) craving, and (3) distress or withdrawal symptoms experienced during abstinence. The multidimensional model was subsequently

replicated in a second sample using confirmatory factor analyses. We found evidence for convergent validity. Cronbach's alphas for the three subscales were 0.77 at T1 and 0.77 at T2 for behavioural aspects of nicotine dependence, 0.84 at T1 and 0.81 at T2 for craving, and 0.81 at T1 and 0.85 at T2 for withdrawal symptoms experienced during abstinence. Descriptions of the 11 items and the respective response scales are presented in Table 1. All items with answer categories not scaled to range from 1 to 4 were rescaled to range between 1 and 4. This method ensures that each item contributes an equal amount of weight to the scale.

Parental smoking. Two items were used to assess parental smoking behaviour: 1) "Does your mother smoke?" and 2) "Does your father smoke?". These items could be scored on a seven-point scale ranging from 1 "No, not at all", 2 "Yes, but less than one cigarette a day" to 7 "Yes, more than 31 cigarettes a day". Adolescents' proxy reports on parental

Table 1 Item descriptions of the nicotine dependence scale

Item	Response categories
<i>Behavioural aspects indicative of physical tolerance</i>	
B1: How soon after you wake up do you smoke your first cigarette	1. Within 5 minutes 2. Within 6-30 minutes 3. Within 31-60 minutes 4. After 60 minutes
B2: How many cigarettes a day do you smoke	1. Less than 1 a day 2. About 1-5 a day 3. About 6-10 a day 4. About 11-20 a day 5. About 21-30 a day 6. Over 30 a day
B3: Which cigarette would you hate to give up	1. First cigarette in the morning 2. Any other cigarette
B4: Do you smoke if you are so ill that you are in bed most of the day	1. No 2. Yes
<i>Craving</i>	
C1: Have you ever felt like you were addicted to tobacco	1. Never 2. Seldom 3. Sometimes 4. Often

Item	Response categories
C2: Do you ever have strong cravings to smoke	1. Never 2. Seldom 3. Sometimes 4. Often
C3: Have you ever felt like you really needed a cigarette	1. Never 2. Seldom 3. Sometimes 4. Often
C/W4: Do you smoke because it is really hard to quit	1. No, not at all 2. A little 3. Quite 4. Yes, very
<i>Withdrawal</i>	
At times that you tried to stop or weren't able to smoke, how often did you experience the following:	
W1: Trouble concentrating	1. Never 3. Sometimes 2. Seldom 4. Often
W2: Feeling irritable or angry	1. Never 3. Sometimes 2. Seldom 4. Often
W3: Feeling nervous, restless or anxious	1. Never 3. Sometimes 2. Seldom 4. Often

Note: C/W4 = Do you smoke now because it is really hard to quit? The answer to this item can be regarded as being a result of both craving and withdrawal symptoms

smoking have been found to be valid indicators of parents' lifetime and current smoking status (e.g. Harakeh et al., 2006a).

Peer smoking. Two items were used to assess peer smoking status: 1) "Does your best friend smoke?" and 2) "How many of your friends smoke?". The first item could be scored on a seven-point scale ranging from 1 "No, not at all", 2 "Yes, but less than one cigarette a day", to 7 "Yes, more than 31 cigarettes a day." The second item could be scored on a five-point scale ranging from 1 "None of them", to 5 "All of them."

Depressive Mood. Depressive mood was measured using the six-item Depressive Mood List 'DML' (Kandel & Davies, 1982, 1986; for a Dutch version used in adolescents: see Engels and colleagues, 2001). Cronbach's alpha was 0.81 at T1 and 0.82 at T2. Answers were given to the following question "How often do you experience the following feelings?" Exemplary answers are: "too tired to do things" and "felt hopeless about the future." The six items could be scored on a five-point scale ranging from 1 "Never", to 5 "Often".

Self-efficacy. Self-efficacy represented the perceived difficulty to resist smoking in tempting situations on a scale from 1 "Very easy" to 5 "Very difficult". Respondents were asked to consider the following: "Imagine that you have quit smoking. How easy or difficult would you find it to refrain from smoking in the following situations?" Exemplary situations of the 8 situations given are: "When things are not going your way and when you are frustrated", and "When friends offer you a cigarette". Cronbach's alpha was 0.88 at T1 and 0.90 at T2.

Strategy of Analyses.

Latent class analysis. We applied latent class analysis (LCA) to examine whether empirically derived profiles of nicotine dependence exist within a population sample of adolescent smokers, using the software package MPLUS 4.1 (Muthén & Muthén, 1998-2007a). Items measuring the three types of dependency symptoms (see Table 1) were used to generate the latent profiles. The aim of LCA is to explain inter-individual differences in item response patterns by a reduced number of groups (latent profiles). The number of classes needs to appropriately represent the data.

With respect to LCA, to establish how many latent profiles or classes exist in the sample, it is recommended to use both statistical indices and the interpretability of the results (Nylund, 2007). A recent simulation study by Nylund and colleagues (2006) indicated that the bootstrap likelihood ratio test (BLRT: MacLachlan & Peel, 2000) and the Bayesian Information Criterion (BIC: Schwartz, 1978) are the best and most consistent statistical indicators for use in determining the number of classes in LCA models. The adjusted BIC (aBIC) is a commonly used and trusted indicator for model comparison, where lower values of the aBIC indicate a better fitting model. The significance of the BLRT p-value is used to assess if there is a significant improvement in fit between models that differ in the number of classes. Separate LCA were conducted for both time points to determine whether similar profiles emerge at each time point. To ensure the robustness of the identified class structures, the models were estimated for the longitudinal sample of adolescents who were classified as smokers at both time points (N=641), as well as for the larger cross-sectional samples encompassing all smokers present at both time points (N=850 at T1 and N=1,026 at T2). Missing values (between 0.4 and 8.4% per item) were estimated by maximum-likelihood using the EM algorithm according to Little and Rubin (2002) assuming ignorable missingness with missing at random (MAR).

To rule out the possibility that the results may have been confounded by the period of time adolescents had been smokers, we also tested whether different nicotine dependence profiles differ according to the age of smoking initiation using Analyses of Variance (ANOVA).

Test of sex differences in latent profiles. To examine whether the LCA solution for the entire sample showed the same latent class structures and class sizes for boys and girls, we conducted a multiple group analysis approach for LCA (Geiser et al., 2006). This approach includes a test for measurement equivalence across sex after selecting a latent class model for the entire sample. To test for measurement equivalence, we conducted unconstrained, semi-constrained, and fully constrained multi-group latent class analysis (MLCA) with sex as the grouping variable. In all MLCA, the same number of latent classes was chosen for both groups. In the unconstrained multigroup model, both the class sizes and the parameter estimates were allowed to differ across sex, while in the semiconstrained models, the class sizes were still allowed to vary but the parameter estimates in each class were constrained to be equal for boys and girls. Finally, in the fully constrained MLCA, both the class sizes and the parameter estimates were fixed to be the same in both groups. If the semiconstrained model does not fit worse than the unconstrained model, this would indicate that the assumption of measurement equivalence (i.e., equal parameter estimates in both sex groups) is tenable (i.e., the structure of the latent classes does differ for females and males). Furthermore, if the fully constrained model fits better (i.e., has a lower aBIC) than the semiconstrained model, it can be concluded that there are no sex differences in class sizes and therefore also not in the occurrence and manifestation of nicotine dependence symptoms.

Covariates. Covariates were included in the LCA and directly related to the latent class variable to validate subtypes at both time points. Hence, individual differences in a posteriori probabilities of class membership (i.e., uncertainty of being group member) were accounted for when testing differential relationships between covariates and latent classes. To avoid chance capitalization because of the multiple comparisons, Bonferroni correction was applied. The alpha was considered significant when below 0.008.

Latent Transition Analysis. The present study also used Latent Transition Analysis (LTA) to study change in class membership across the two time points (Graham et al., 1991; Nylund, 2007). Similar to LCA, in LTA, profiles are not directly observed but identified with a measurement model. As a result, LTA involves a measurement component that captures the latent profiles, and a structural component that models change among the profiles over time. We used the identified LCA models for both time points as measurement models of the LTA. The main objective of LTA is to study the probability of a transition from a profile at one time point to a profile at a later time point (Muthen & Muthen, 2000). A latent transition probability of 1 for the same class would indicate perfect stability, whereas a latent transition probability of 0 would indicate that it is very unlikely to stay in the same class over time. In contrast, low transition probabilities for different class profiles indicate that it is unlikely for participants to switch from one class to another class between T1 and T2.

Additional Analyses

Using the results of the LCA also within the larger cross-sectional samples that encompassed all smokers present at both time points (N=850 at T1 and N=1,026 at T2), we addressed two additional issues: (1) which nicotine dependence subtype at T1 is most likely to be classified as a non-smoker at T2, and (2) what is the most probable subtype at T2 for adolescents who were classified as non-smokers at T1 but who initiated smoking between T1 and T2. To assess these questions, latent class membership results were imported from MPLUS into SPSS to produce cross tabulations.

Results

Descriptives

Of the 641 smoking participants at T1 and T2, 45% indicated that their fathers were smokers and 40% indicated that their mothers were smokers at T1. At T2, 51.5% indicated that their fathers were smokers and 44.7% indicated that their mothers were smokers. At T1, 70% of the respondents indicated that their best friend smoked; at T2 this was 83%. At T1, 2.9% of the respondents indicated that none of their friends smoked, 27% indicated that less than half of their friends smoked, 19.5% that half of their friends smoked, 43.3% that more than half of their friends smoked, and 7.2% indicated that all of their friends smoked. At T2, 1.2% of the respondents indicated that none of their friends smoked, 12.6% indicated that less than half of their friends smoked, 20.3% that half of their friends smoked, 57.1% that more than half of their friends smoked, and 8.7% indicated that all of their friends smoked.

The mean score on depressive mood at T1 was 2.36 (SD = 0.74) and 2.41 at T2 (SD = 0.74). For self-efficacy the mean score at T1 was 2.36 (SD = 0.94) and 2.91 at T2 (SD = 0.74).

LCA

LCA on Overall Sample

The values for the BIC and BLRT for the 1 to 5 class solutions for the entire sample are shown in Table 2 for both time points. The results showed that a five-class solution had the best fit at both time points. However, to avoid over-extraction, we selected the more parsimonious four-group model for both time points for the following reason: in the five-class model, the largest group that scored lowest on nicotine dependence symptoms was split into two smaller groups with identical class structures except that one group scored slightly higher on the nicotine dependence items than the other. Given the similarity in the profiles of these two groups for both time points, the five-group model did not provide an actual gain in information but resulted mostly in smaller groups compared to the respective four-group models.

The latent class membership statistics for the two nominal items, i.e. 'B3: Which cigarette would you hate to give up?' and 'B4: Do you smoke if you are so ill that you are in bed most of the day?' are given in Table 3 for both time points, whereas the Latent

Class profiles for the continuous items are depicted in Figure 1. The class profiles in Figure 1 show that the first class was composed of adolescents who display hardly or no behavioural symptoms indicative of tolerance and withdrawal symptoms, but who did, to some extent, display symptoms of craving. This first class was estimated for 42.3% (n=271) of the sample at T1 and 29.6% (n=190) at T2 and will be referred to as 'low cravings only'.

Table 2 BIC values and BLRT p-values for different latent class analysis models

	Time point 1		Time point 2	
	aBIC	BLRT Ho Loglikelihood value	aBIC	BLRT Ho Loglikelihood value
1 Class	16915.73	-	16990.00	-
2 Classes	14848.82	-8424.87***	15283.58	-8462.12***
3 Classes	14239.05	-7371.80***	14504.00	-7589.18***
4 Classes	13923.94	-7047.19***	14246.02	-7179.66***
5 Classes	13628.83	-6869.90***	14021.24	-7030.94***

* p < 0.05; ** p < 0.01; ***p < 0.001

Note: N = 641. BLRT = Bootstrap likelihood ratio test; ABIC = Adjusted Bayesian information criterion.

The second class was composed of adolescents who display hardly any behavioural symptoms indicative of physical tolerance, high scores for craving and intermediate scores for withdrawal symptoms. The second class was estimated for 27.6% (n=177) at T1 and 33.3% (n=213) at T2 and will be referred to as 'high craving and withdrawal'. The third class was composed of adolescents who display high scores for the behavioural symptoms and craving, but low scores for withdrawal symptoms. The third class was estimated for 15.6% (n=100) at T1 and 17.2% (n=110) at T2 and will be referred to as 'high craving and physical tolerance'. Finally, the fourth class was composed of adolescents who scored overall high on the items of behavioural symptoms indicative of physical tolerance, craving and withdrawal symptoms. This class was estimated for 14.5% (n=93) at T1 and 19.9% (n=128) at T2 and will be referred to as 'overall high dependent'.

Table 3 Item response probabilities for the two nominal behavioural aspects of physical tolerance items

	Timepoint 1		Timepoint 2	
	Item response probabilities ^a		Item response probabilities ^a	
	Item B3	Item B4	Item B3	Item B4
Class 1	0.08	0.01	0.05	0.03
Class 2	0.30	0.13	0.21	0.04
Class 3	0.57	0.30	0.47	0.26
Class 4	0.61	0.64	0.64	0.56

Note: ^a Probability of responding to the answer category indicative of dependence
Item B3 = Which cigarette would you hate to give up; Item B4 = Do you smoke if you are so ill that you are in bed most of the day; Class 1 = 'low cravings only'; Class 2 = 'high craving and withdrawal'; Class 3 = 'high craving and physical tolerance'; Class 4 = 'overall high dependent'

Studying the class profiles at both time points reveals mostly similarities, with the 'low cravings only' class and the 'overall high dependent' class showing the same structure reflecting mainly quantitative differences regarding severity, whereas the 'high craving and withdrawal' class and the 'high craving and physical tolerance' class show structurally different patterns.

When replicating the results for the different latent class models within the larger cross-sectional samples encompassing all smokers present at one of the time points (N=850 at T1 and N=1,026 at T2), as opposed to the results regarding the 641 adolescents classified as smokers at both time points, we found virtually identical results.

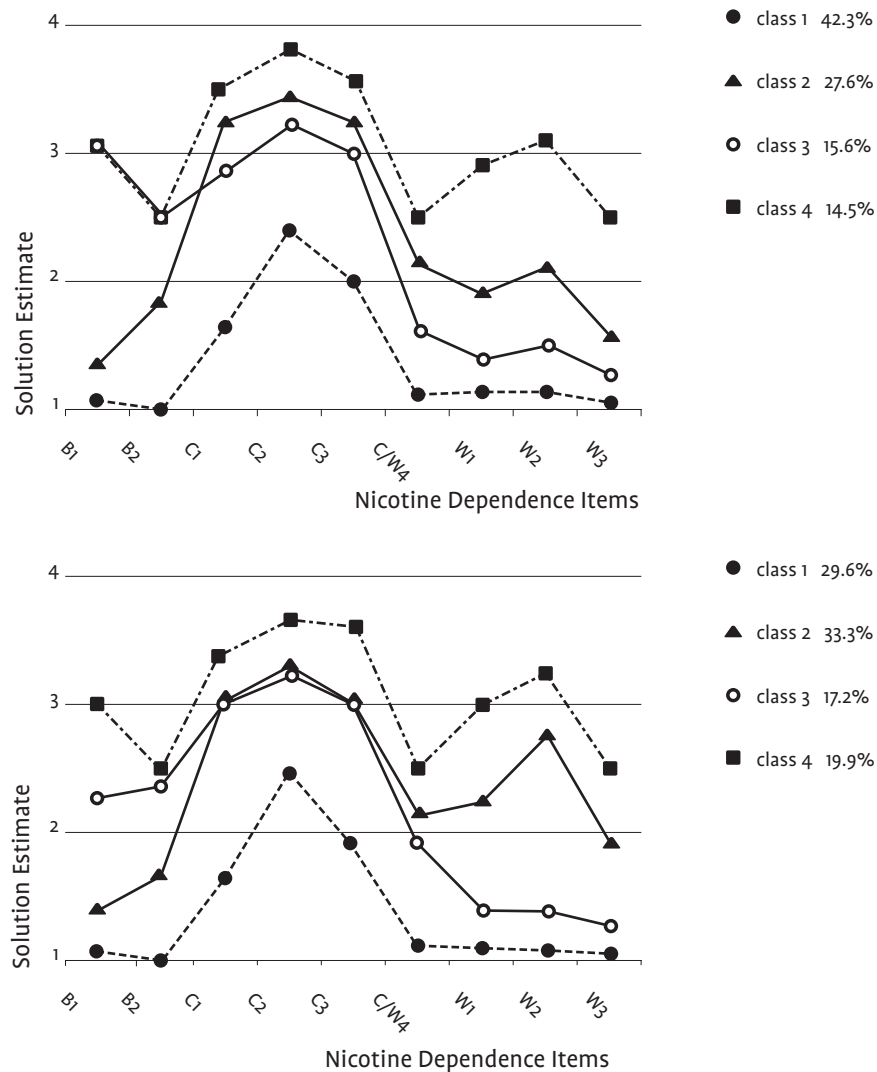
The four nicotine dependence profiles found at T1 did not differ regarding the age of the adolescents or the age of smoking initiation [Age: F (3, 640) = 1.32, p = n.s.; age of initiation: F (3, 640) = 1.71, p = n.s.]. The results were similar at T2 [Age: F (3, 640) = 0.23, p = n.s.; age of initiation: F (3, 640) = 2.02, p = n.s.].

Gender comparisons

In a next step, we tested whether the four-class LCA solution found for the total sample was equally tenable for boys and girls. We thus estimated a series of three-nested multiple-group LCA models that differed regarding the number of parameter constraints, as described above. The sample size adjusted BIC values (aBIC), indicated that the fully constrained model which assumes measurement equivalence (equal parameter estimates) and equal class sizes across gender showed superior fit compared to the less constrained models for both time points (at T1: aBIC unconstrained model = 14869.82; aBIC semi constrained model = 14810.98; aBIC fully constrained model = .24; and at T2: aBIC unconstrained model = 15148.55; aBIC semiconstrained model = 15138.95; aBIC fully

constrained model = .32). Consequently, the four-class solution found for the total sample was equally tenable for both male and female smokers.

Figure 1 Latent class profiles for the four class model at time point 1 and time point 2, respectively



Note: The items B1 and B2 correspond to the Behavioural aspect items as shown in Table 1. The items C1, C2, C3 and C/W4 correspond to the craving items as shown in Table 1. The items W1, W2, and W3 correspond to the withdrawal items in Table 1.
 Class 1 = 'low cravings only'; Class 2 = 'high craving and withdrawal'; Class 3 = 'high craving and physical tolerance'; Class 4 = 'overall high dependent'

Covariates

The associations of the six covariates (i.e., smoking of father, smoking of mother, smoking of best friend, number of smoking friends, depressive mood, and self-efficacy not to smoke) with the nicotine dependence classes are presented in Table 4. For each covariate, comparisons were made regarding the covariate's score in the one class as compared to the other classes.

Table 4 Beta Coefficients and Standard Errors for the Four-class Model with Parental and Peer Smoking, Depressive Mood and Self-efficacy as Covariates.

Covariate	Reference	Time point 1		Time point 2		
		β	S.E.	β	S.E.	
Smoking of Father	Class 1	Class 2	0.24*	0.06	0.18*	0.07
		Class 3	0.46*	0.07	0.31*	0.06
	Class 2	Class 3	0.21*	0.08	0.12	0.07
		Class 4	0.44*	0.07	0.37*	0.07
		Class 4	0.20	0.08	0.19	0.07
Smoking of Mother	Class 1	Class 2	0.13	0.06	-0.03	0.09
		Class 3	0.42*	0.07	0.40*	0.07
		Class 4	0.58*	0.09	0.44*	0.07
	Class 2	Class 3	0.30*	0.07	0.43*	0.09
		Class 4	0.45*	0.09	0.47*	0.09
Smoking Best Friend	Class 1	Class 2	0.48*	0.07	0.37*	0.09
		Class 3	0.68*	0.11	0.72*	0.10
		Class 4	0.71*	0.11	0.88*	0.12
	Class 2	Class 3	0.20	0.11	0.35*	0.10
		Class 4	0.23	0.10	0.51*	0.12
Class 3	Class 4	0.03	0.12	0.16	0.11	

Covariate	Reference	Time point 1		Time point 2			
		β	S.E.	β	S.E.		
Number of smoking friends	Class 1	Class 2	1.01*	0.13	0.80*	0.16	
		Class 3	1.08*	0.16	1.15*	0.15	
		Class 4	1.31*	0.20	1.25*	0.19	
	Class 2	Class 3	0.07	0.18	0.35	0.17	
		Class 4	0.29	0.20	0.45	0.21	
		Class 3	Class 4	0.22	0.22	0.10	0.18
	Depressive Mood	Class 1	Class 2	0.05	0.03	0.10*	0.03
			Class 3	-0.14*	0.04	-0.14*	0.04
			Class 4	0.17*	0.04	0.15*	0.03
Class 2		Class 3	-0.19*	0.04	-0.16*	0.03	
		Class 4	0.12*	0.04	0.04	0.04	
Class 3		Class 4	0.31*	0.05	-0.21*	0.03	
Self-efficacy	Class 1	Class 2	-0.18*	0.02	-0.18*	0.02	
		Class 3	-0.14*	0.03	-0.12*	0.02	
		Class 4	-0.37*	0.04	-0.24*	0.03	
	Class 2	Class 3	0.05	0.03	0.06*	0.02	
		Class 4	-0.19*	0.04	-0.07*	0.02	
	Class 3	Class 4	-0.23*	0.04	-0.12*	0.02	

Note. Class 1 = 'low cravings only'; Class 2 = 'high craving and withdrawal'; Class 3 = 'high craving and physical tolerance'; Class 4 = 'overall high dependent'
* p < 0.008

At both time points, adolescent smokers who are categorized in the 'low cravings only' class report lower scores for smoking of the father, best friend and the number of smoking friends compared to the other three classes. In addition, they report more self-efficacy not to smoke. Smoking of the mother differentiated between the 'low cravings only' class and the 'high craving and physical tolerance' and 'overall high dependent' class. Depressive mood was significantly higher for respondents in the 'high craving and withdrawal' class as opposed to the 'low cravings only' class only at the second time point. Compared to the 'high craving and withdrawal' class, smoking adolescents in the 'high craving and

physical tolerance' and 'overall high dependent' class reported higher scores for smoking of the mother at both time points, and higher scores for smoking of the best friend at the second time point only. However, contrary to the results regarding smoking of the mother and best friend, adolescents in the 'low cravings only' and 'high craving and withdrawal' class report higher depressive mood compared to adolescents in the 'high craving and physical tolerance' class at both time points. At the second time point, adolescents in the 'high craving and withdrawal' class additionally reported less self-efficacy not to smoke as compared to adolescents in the 'high craving and physical tolerance' class. Compared to the 'high craving and withdrawal' and 'high craving and physical tolerance' class, adolescents in the 'overall high dependent' class scored significantly higher on depressive mood and lower on self-efficacy not to smoke.

Table 5 Latent Transition Probabilities across Time Points

	Time point 2			
	Class 1	Class 2	Class 3	Class 4
Time point 1				
Class 1	0.62	0.28	0.06	0.03
Class 2	0.09	0.56	0.14	0.22
Class 3	0.04	0.06	0.76	0.14
Class 4	0.00	0.08	0.22	0.70

Note. Latent transition probabilities for the same class (class stability coefficients) are printed in boldface. Class 1 = 'low cravings only'; Class 2 = 'high craving and withdrawal'; Class 3 = 'high craving and physical tolerance'; Class 4 = 'overall high dependent'

Latent Class Transitions

Given the structural similarities of the latent classes across time (see Figure 1), we assumed full measurement invariance for the latent transition analysis (LTA). No restrictions were made on the class sizes over time. Comparing the parameter estimates of the LTA to those obtained for the single LCA models previously discussed, showed the class structures to be very similar. The latent transition probabilities are given in Table 5. The results show that the four nicotine dependence classes were relatively stable over time, which can be derived from the fact that all probabilities in the diagonal of Table 5 were above 0.50 (Geiser et al., 2006). The most stable classes were the 'high craving and physical tolerance' class and the 'overall high dependent' class, with transition probabilities exceeding 0.70. Very few adolescents who were in the 'high craving and physical tolerance' class or the 'overall high dependent' class at T1 were found in the 'low cravings only' class or the 'high craving and withdrawal' class at T2. The least stable class

is the 'high craving and withdrawal' class, where adolescents had relatively high transition probabilities to the 'high craving and physical tolerance' class (0.14) and the 'overall high dependent' class (0.22). As for the 'low cravings only' class it can be seen that, over time, a large proportion transferred to the 'high craving and withdrawal' class (0.28). The latent transition results indicate that the 'high craving and physical tolerance' class seems to be more proximal to the 'overall high dependent' class, whereas the 'high craving and withdrawal' class seems to be more proximal to the 'low cravings only' class. The 'high craving and withdrawal' class seems to mark a more transitional and somewhat less developed stage of dependence as opposed to the 'high craving and physical tolerance' class.

Additional Analyses

Cross tabulations using the class-membership results for the cross-sectional sample encompassing all smokers present at T1 (N=850) and the class-membership results for the same sample at T2 including a category of non-smokers (N=209), showed that adolescent smokers in the 'low cravings only' class had the highest likelihood to be a non-smoker at T2. Of all the 209 non-smokers at T2, 73.7% were in the 'low cravings only' class at T1, while 16.3% were in the 'high craving and withdrawal' class, 6.7% in the 'high craving and physical tolerance' class and 3.3% in the 'overall high dependent' class.

Cross tabulations using the class-membership results for the cross-sectional sample encompassing all smokers present at T2 (N=1,026) and the class-membership results for the same sample at T1 including a category of non-smokers (N=385), showed that adolescents who had started smoking at T2 had the highest likelihood to be in the 'low cravings only' class. Of all the 385 newly classified smokers at T2, 64.7% were in the 'low cravings only' class, while 20.8% were in the 'high craving and withdrawal' class, 7.8% in the 'high craving and physical tolerance' class and 6.8% in the 'overall high dependent' class.

Discussion

The present study found four distinct profiles of nicotine dependence among the adolescent smoking population. Whereas previous studies reported gender differences in the occurrence of nicotine dependence (e.g. DiFranza et al., 2002a; O'Loughlin et al., 2002a; Panday et al., 2007), the present study found no evidence of gender differences in underlying dependence symptom profiles. Thus, even though girls may on average report or experience higher levels of nicotine dependence, the underlying symptom profiles appear to be equal to that of boys. As discussed below, the identification of distinct dependence symptom profiles not only provides new insights into the aetiology and epidemiology of nicotine dependence, but may also provide important implications for the development of effective intervention programs.

Four distinct subtypes were found that can be characterized along a severity spectrum, as well as by qualitative differences. The 'low cravings only' class and the 'overall high

dependent' class show the same structure and mainly reflect a quantitative difference in severity. The 'high craving and withdrawal' class and the 'high craving and physical tolerance' class show qualitatively different patterns. These latter two classes scored equally high on craving, but show that among adolescent smokers the presence of behavioural aspects indicative of physical tolerance does not necessarily coincide with the occurrence of withdrawal symptoms and vice versa, and that craving can occur independent of physical tolerance or withdrawal symptoms.

Of the four distinct profiles, the occurrence of the 'low cravings only' profile coincides with the previous discovery of a group of adolescent smokers that seems resistant to developing dependence (DiFranza et al., 2000). Though, as noted by DiFranza and colleagues (2000), it is difficult to identify such individuals because it is difficult to establish how long one would have to smoke without symptoms of dependence before it can be concluded that the risk of developing dependence is minimal. It can further be argued that the 'low cravings only' group comprises mostly adolescents who may have started smoking fairly recently. Dependence symptoms in this group may therefore not yet be apparent or they may not smoke much. However, the present study found no association between class membership and adolescents' age and age of smoking initiation, indicating that recent smoking initiation cannot fully explain the absence of dependence symptoms. The finding that even smokers in the 'low cravings only' class indicated to experience craving to some extent supports the notion postulated by Zhu and Pulvers (2008) that even in low-frequency smokers urges to smoke are to be expected. If low-frequency smokers did not experience cravings, they might not have been smoking to begin with. The finding that the items assessing craving were substantially endorsed within all four profiles coincides with the finding of previous studies, namely that craving is one of the most prominent and most reported features of nicotine dependence in adolescents (Bagot et al., 2007; Killen et al., 2001; Rojas et al., 1998).

Considering that the behavioural aspects indicative of physical tolerance are measured by items assessing when, where, and how much one smokes, the occurrence of the 'high craving and withdrawal' class seems to coincide with previous observations among adolescents showing that a regular and more established smoking pattern is not a prerequisite for the occurrence of withdrawal symptoms (Barker, 1993; DiFranza et al., 2000; McNeill et al., 1986; Panday et al., 2007). The occurrence of the 'high craving and physical tolerance' class on the other hand, indicates that there is a substantial group of adolescents who, even though they display a considerable physical tolerance and a high level of craving, do not seem to experience withdrawal symptoms. Withdrawal symptoms are thought to be primarily caused by nicotine deprivation. Even though adolescent smokers report to experience withdrawal symptoms while not engaging in formal quit attempts (Stanton, 1995), nicotine deprivation seems to be the primary cause of withdrawal symptoms, while craving can be activated by environmental cues in addition to deprivation (Corrigall et al. 2002; Tiffany & Drobes, 1991). In this regard, high cigarette consumption may ensure that nicotine deprivation, and thereby withdrawal symptoms, are kept to a minimum. On the other hand, the absence of withdrawal symptoms or

physical tolerance may also be associated with specific genetic predispositions. Nicotine dependence symptoms are known to be substantially heritable, also among adolescents (Koopmans et al., 1999; McGue et al., 2000; Vink et al., 2005; Audrain McGovern et al., 2006). Among adults, evidence was found that some nicotine phenotypes are more heritable than others (Lessov et al., 2004). The identification of phenotypic variation in the expression of dependence among adolescent smokers may, therefore, form an important contribution to understanding possible underlying genetic and also psychosocial factors (Storr et al., 2005).

With regard to potential underlying psychosocial factors, the present study found that the four phenotypic variations of dependence are differentially related to exposure to smoking in the social environment, perceived self-efficacy not to smoke and depressive mood. Results showed that exposure to smokers primarily differentiated between the 'low cravings only' class and the other three classes, or between the 'low cravings only' and 'high craving and withdrawal' and the other two classes. Some degree of exposure to smoking in the social environment seems to increase the risk of craving and withdrawal symptoms. The exposure of smoking parents and friends may present adolescents with smoking cues that can trigger craving and to some extent also withdrawal symptoms. More extensive exposure to smoking in the social environment may increase the risk of physical tolerance because of the creation of more physical tolerance-enhancing circumstances, such as ample availability or offering of cigarettes and occasions to smoke.

The 'high craving and withdrawal', 'high craving and physical tolerance' and 'overall high dependent' profiles are mainly differentiated by personal dispositions rather than environmental smoking influences. Elevated withdrawal scores seem to co-occur with a lower self-efficacy not to smoke and higher depressive mood, which is also illustrated by the finding that adolescents classified in the 'overall high dependent' class displayed the highest withdrawal scores together with the highest depressive mood and the lowest self-efficacy. This is in line with previous research among adults which found that quantitative differences in nicotine withdrawal were associated with depression (Madden et al., 1997; Xian et al., 2005).

The distinction between the 'low cravings only' profile and the other three profiles by environmental smoking and that of the intermediate and highest profiles by personal dispositions suggests that environment mainly poses a risk for the onset of nicotine dependence, whereas psychological dispositions seem to be responsible for the progression of dependence symptoms. These findings may be partly explained along the lines of the Social Learning Theory and the Diathesis-Stress Model. As mentioned, according to the Social Learning Theory people learn from one another via observation, imitation, and modeling (Bandura, 1977). According to the Diathesis-Stress Model, behaviour is both a result of environment and biological and genetic factors (Zubin & Spring, 1977). As a way to demonstrate maturity and win affiliation with peers, adolescents may be more inclined to imitate smoking behaviour of parents and friends thereby risking the occurrence of dependence symptoms. However, when they advance into real maturity, adolescents may turn gradually to a more conventional non-smoking lifestyle. This change

may not occur, or be delayed, when adolescents have additional risk factors besides exposure to smoking in the environment, such as personal dispositions that may be partly biologically or genetically determined (i.e., higher depressive mood).

Besides the differential links of the four phenotypes with correlates of nicotine dependence, additional analyses revealed differential links with smoking uptake and cessation. Adolescents classified as 'overall high dependent' at T1 and/or T2 were least likely to be either non-smokers one year after the first measurement or non-smokers one year before the second measurement. For adolescents classified as 'low cravings only' the opposite occurred, notwithstanding that a relatively large proportion transferred from the 'low cravings only' class to a higher class. The latter coincides with findings that nicotine dependence may develop rapidly in a subset of youth (Colby et al., 2000a; DiFranza et al., 2002).

That nicotine dependence is not a singular event but rather a dynamic process (Colby et al., 2002a; Kandel et al., 2007) is emphasized by the results of the LTA. Even though the dependence profiles were confirmed one year later and showed high stability, a significant proportion of adolescents shifted between the subtypes, mostly advancing in dependence. These findings thus further indicate a progression along an underlying dimension of increasing severity. However, we did not find an effect of age, or age of initiation, in explaining the subtypes. The lack of age and age of initiation effects may be explained by the fact that the percentage of upward changers was low to moderate and in part outweighed by some downward changers.

The identification of different dependence symptom profiles may prove particularly helpful to decrease dependence and to aid smoking cessation because it enables the specific targeting of the different subtypes according to their specific symptoms. For example, pharmacotherapy may be required to assist those adolescents who are highly dependent on nicotine. though the limited research in this field is inconclusive about the effectiveness of either nicotine replacement therapy (NRT) or Bupropion in aiding adolescent smoking cessation (Hurt et al., 2000; Killen et al., 2004; Smith, 1996), pharmacotherapy might prove useful for certain subtypes of adolescent smokers, such as subtypes with high withdrawal scores. Future research may shed light on whether specific subtypes of nicotine dependence may respond better to pharmacotherapy than others. On a different account, the co-occurrence of elevated withdrawal scores and a low self-efficacy not to smoke endorses the idea that, for adolescents with a dependence profile including elevated withdrawal scores, cognitive based smoking-cessation programs in combination with NRT might be helpful. Adolescents with a less severe dependence profile, on the other hand, may be better targeted by other means, for example by helping them to identify dependence symptoms and develop effective coping skills to deal with these symptoms. Also, a cognitive-based approach might prove useful for low dependent smokers since reasons for smoking continuation in this particular group are likely to be embedded in smoking-related cognitions.

For the interpretation of the results, we draw attention to several limitations of the study.

One limitation may be that our approach to measure nicotine dependence was limited to three dimensions of nicotine dependence. Even though our approach included items appropriate to adolescents, such as items derived from the Hooked on Nicotine Checklist (DiFranza et al., 2000) and assessed clinical features as expressed in the Fagerström tolerance and dependence scales (Fagerstrom & Schneider, 1989; Heatherton et al., 1991; Prokhorov et al., 1996), other possible and relevant dimensions of nicotine dependence in adolescents, such as seeking emotional or sensory reinforcement (Johnson et al., 2005), may have fallen outside the scope of this study. A second limitation is that smoking behaviour was based on self-reports and not biochemically validated. However, studies have shown agreement between self-reports of smoking and biochemical measures (Prokhorov et al., 2000; Rojas et al., 1998). A third limitation is that the relations between the four subtypes and the correlates of nicotine dependence were assessed concurrently and thus do not allow inferences about predictive relationships. Finally, attrition analysis indicated a possible under representation of lower educated adolescent male smokers in our sample. A lower educational level was previously found to be associated with higher levels of nicotine dependence (e.g. Hu et al., 2006). Some caution in interpreting and generalizing the findings to the adolescent smoking population at large is therefore warranted.

To conclude, the present study provides insight into the existence of potentially clinically important subgroups of nicotine dependence among adolescent smokers, which are differentially associated with inter- and intrapersonal characteristics. This knowledge can help determine the expected level of difficulty in quitting smoking, as well as provide important implications for tailoring interventions to effectively target nicotine dependence and aid smoking cessation practices.

Part 2

Identifying determinants and mechanisms
of adolescent smoking cessation

4 Adolescents' movement towards cessation of smoking: Role and relative value of the processes of change and nicotine dependence

Based on
Kleinjan, M. Van den Eijnden, R.J.J.M. Van Leeuwe, J. Brug, J. Van de Ven, M.O.M. & Engels, R.C.M.E. (2008). Adolescents' movement towards cessation of smoking: Role and relative value of the processes of change and nicotine dependence. *Psychology and Health*, 23, 729-743.

Abstract

The present study addresses the applicability of the Transtheoretical Model's processes of change in explaining adolescents' readiness to quit smoking. Furthermore, the association between nicotine dependence and readiness to quit was assessed both directly, as well as indirectly through the processes of change. A cross-sectional survey was conducted, identifying 1,547 weekly smokers aged 14-18 years. Structural equation modeling showed that the processes of change were only marginally associated with readiness to quit. Adding nicotine dependence to the model showed a direct association between nicotine dependence and readiness to quit. Only one process of change, self-liberation (i.e., choice/commitment to change and belief in the ability to change), was found to mediate this association. Nicotine dependence appeared to be highly important in adolescents' readiness to quit.

Introduction

Worldwide, about one in every five adolescents aged 13 to 15 years is a smoker (WHO, 2002a). Previous studies, however, indicated that a considerable number of adolescent smokers want to quit smoking, and that many of them have tried to do so (Balch, 1998; Sussman, Dent, Severson, Burton, & Flay, 1998). Unfortunately, relapse rates are high and maintenance of smoking cessation is poor. Moreover, Johnston, Bachman, and O'Malley (1992) found that approximately 75% of adolescent daily smokers will continue to smoke as adults. Because of the addictive and harmful nature of smoking, it is important to motivate adolescent smoking cessation. Nevertheless, different from the adult population, there has been little research on smoking cessation among adolescents (Hoepfner, Velicer, Redding, Rossi, Prochaska, Pallonen et al., 2006). Moreover, a sound theoretical basis for developing interventions aiming at smoking cessation among this group is still lacking. Because greater insight into the process of quitting smoking among adolescents is required, the aim of the present study is to contribute to a better understanding of the determinants of smoking cessation among adolescents.

A construct previously found to be related to the process of smoking cessation is addiction to nicotine or nicotine dependence (US Department of Health and Human Services [USDHHS], 1988; Farkas, Pierce, Zhu, Rosbrook, Gilpin, Berry et al., 1996). In adults, nicotine dependence was found to be related both to a high number of previous quit attempts and to a low intention to quit (John, Meyer, Rumpf, & Hapke, 2004; Velicer, Rossi, Prochaska, & DiClemente, 1996). It has been suggested that nicotine dependence is an important factor in the process of smoking cessation, not only in adults who have smoked for many years, but also in teenagers (Engels, Knibbe, De Vries, & Drop, 1998). Research among adolescents indeed indicated that nicotine dependence was associated with readiness and ability to quit smoking (Prokhorov, Suchanek Hudmon, De Moor, Kelder, Conroy, & Ordway, 2001; Horn, Fernandes, Dino, Massey, & Kalsekar, 2003). Few studies, however, addressed the means by which nicotine dependence affects processes of smoking cessation. To design optimal ways of increasing readiness to quit and actual smoking cessation in adolescents, it is useful to determine the specific role and relative value of nicotine dependence, as well as the mechanisms by which nicotine dependence may influence the process of smoking cessation.

A construct widely used as an indication of the process of smoking cessation are the stages of change (Prochaska, DiClemente, & Norcross, 1992a; Prochaska, Norcross, Fowler, Follick, & Abrams, 1992b). The stages of change construct is part of the Transtheoretical model (TTM: Prochaska et al., 1992a), and describes a temporal dimension containing five levels of readiness to change: precontemplation, contemplation, preparation, action, and maintenance. Readiness to quit, as measured by the stages of change, has been found to be associated with smoking cessation (DiClemente, Prochaska, Fairhurst, Velicer, Velasques, & Rossi, 1991). According to the TTM, movement through the different stages of change is expected to be facilitated by certain strategies known as the processes of change (Prochaska, Velicer, DiClemente, & Fava, 1988; Prochaska et al., 1992a; Prochaska et al., 1992b). Ten processes of change have been suggested that can be used in changing

one's smoking behaviour, with five processes reflecting experiential (cognitive/affective) strategies and five processes reflecting behavioural strategies. Moreover, these strategies are thought to contribute differentially to transition through the different stages of behaviour change. The experiential processes, including environmental reevaluation, self-reevaluation, consciousness raising, social liberation and dramatic relief, are expected to be most frequently engaged in during the precontemplation and contemplation stages of change, and also, but to a lesser extent, in the preparation stage. The behavioural processes, including reinforcement management, counter-conditioning, stimulus control, self-liberation and helping relationship are supposed to be most frequently engaged in during the preparation, action and maintenance stages of change (Prochaska et al., 1992a; Rosen, 2000, see Table 1).

Table 1 Description of the Processes of Change

Experiential Processes	Description
Consciousness Raising	Increasing knowledge and information about one's smoking
Social Liberation	Awareness, availability, and acceptance of alternative, problem-free lifestyles in society
Dramatic Relief	Experiencing and expressing feelings about one's smoking
Self-Reevaluation	Considering feelings and thoughts about the self in relation to one's smoking
Environmental Reevaluation	Considering how smoking affects one's environment
Behavioural Processes	Description
Helping Relationship	Trust others and being open about one's smoking
Self-Liberation	Choosing and commitment to act or belief in ability to change
Counter Conditioning	Replacing smoking with alternatives
Stimulus Control	Avoidance or dealing with stimuli that bring out smoking
Reinforcement Management	Rewarding oneself or being rewarded by others for changing smoking behaviour

In adults, however, results regarding the effectiveness of the TTM in explaining smoking cessation have been contradictory. On the one hand, there have been studies supporting the efficacy of Transtheoretical constructs (such as the processes of change) in the process of smoking cessation (Prochaska et al., 1992a), and in addition, the effectiveness of smoking cessation interventions based on the constructs of the TTM (Dijkstra, Conijn, & De Vries, 2006; Prochaska, Velicer, Fava, Rossi, & Tsoh, 2001). On the other hand, some prospective studies among adult smokers failed to support the relevance of the TTM's processes of change in smoking cessation (Herzog, Abrams, Emmons, Linnan, & Shadel,

1999; Segan, Borland, & Greenwood, 2002; Segan, Borland, & Greenwood, 2004)¹. Partly because of the failure to find consistent evidence for the effectiveness of the TTM in explaining smoking cessation, the model has received some critical reviews (see Bridle, Riemsma, Pattenden et al., 2005; Sutton, 2001; West, 2005).

Despite this growing controversy, the TTM remains widely applied. Moreover, several studies have been conducted to test whether the TTM, or parts of the model, could be applied among adolescent smokers as well. Psychometric properties of the processes of change among adolescents have already been reported, as well as adolescents' level of engagement in the processes of change within the different stages of the stages of change construct (Pallonen, 1998; Hoepfner et al., 2006). However, the impact of the processes of change on adolescents' readiness to quit, as measured by the stages of change construct, has hardly been studied. Therefore, in order to establish whether cognitions and behaviours as measured by the processes of change are useful concepts to address in interventions to promote smoking cessation among adolescents, the first goal of the present study is to examine the associations between the processes of change and stages of change in a large nationwide sample of adolescent smokers in the Netherlands.

Because of their anticipated role as catalysts of behaviour change, it is likely that an increased engagement in the processes of change is associated with a higher readiness to quit. Furthermore, since experiential processes are thought to be more important in the earlier motivational stages of change, i.e., precontemplation, contemplation and to some extent in preparation, and behavioural processes are thought to be more important in the later action-oriented stages of change, i.e., preparation, action and maintenance, it is expected that associations between experiential processes of change and readiness to quit are more apparent as compared to associations between behavioural processes of change and readiness to quit.

The second goal is to increase insight into the impact of nicotine dependence on the process of cessation and the mechanisms by which nicotine dependence may influence this process. Velicer et al. (1996) previously described the pattern of change for dependency across four stages of change, i.e., precontemplation, contemplation, action, and maintenance in adults. They found that precontemplators had high levels of dependency and were more likely to continue smoking despite environmental influences. Environment was hereby conceptualized to include personal (emotions and mood), historic or external environment. Dependency in the contemplation and action stage was found to be open to environmental manipulation and smoking status in these stages was increasingly determined by the environment. Persons in the maintenance stage had low levels of dependency and were likely to be non-smokers despite their environment. First of all, in line with these and other previous findings, it is expected that among adolescents, nicotine dependence will be negatively related to readiness to quit as measured by the stages of change. Second, because of the relations found between dependency and environmental influences, it is expected that higher levels of nicotine dependence will be associated with fewer efforts to engage in strategies to influence or control the

environment, such as the avoidance of stimuli that initiate smoking or increasing one's knowledge about smoking and its' consequences. Therefore, it is expected that nicotine dependence will be negatively related to engagement in the cognitive and behavioural strategies known as the processes of change.

To conclude, it will be examined to what extent nicotine dependence will operate through the processes of change in explaining readiness to quit. Here, based on the above, it is expected that higher levels of nicotine dependence will be associated with less engagement in the different processes of change, which in turn will be associated with less readiness to quit.

Methods

Procedure and Sample

Thirty-three secondary schools in four regions of the Netherlands participated in the present study. Through these schools a total of 10,264 respondents were reached. Respondents were predominantly aged 14-16 years and completed paper-and-pencil questionnaires that were administered during classes in grades nine and ten. The questionnaire consisted of two sections: one for respondents who indicated that they had smoked at least once in the past month, and one for respondents who had not smoked during the past month. The respondents who had smoked during the past month (N=2,182) had to answer questions on smoking demographics, smoking history, smoking behaviour, etc. Because previous findings indicate that irregular smokers respond differently to smoking interventions as compared to regular smokers, and in addition are more likely to have fluctuating smoking patterns (Hollis, Polen, Whitlock, Lichtenstein, et al., 2005), only those respondents who reported to smoke at least weekly were selected (N=1,547).

Sample characteristics

Of the 1,547 smokers included in the study, 51% were female. Of the respondents, 51.4% was receiving lower vocational training, 23.1% intermediate vocational training, 17.8% high school education, and 5.6% pre-university education. The mean age was 15.2 (range 12-18) years.

Measures

Processes of change. The measure of the processes of change is conform the original measure as developed by Prochaska et al. (1988), and consisted of 40 items assessing the respondents' use of the processes of consciousness raising, self-liberation, dramatic relief, counter conditioning, stimulus control, helping relationship, environmental reevaluation, social liberation, self-reevaluation, and reinforcement management (see Table 1 for a description of the processes). All items were translated into Dutch by three

independent translators. After solving minor differences, consensus was reached on the final translation of the items. Each item could be scored on a 5-point scale ranging from (1) never to (5) often, and followed the question: "How often did the following occur in the last four weeks?" The reliabilities of the scales were found to be good to excellent (See Table 2).

Nicotine dependence. Nicotine dependence was measured by a recently developed multidimensional scale based on both the modified Fagerström Tolerance Questionnaire (mFTQ; Prokhorov, Pallonen, Fava, Ding, & Niaura, 1996) and the Hooked on Nicotine Checklist (HONC; DiFranza, Rigotti, McNeill et al., 2000; O'Loughlin, DiFranza, Tarasuk et al. 2002a). This 11-item scale has been validated in a study by Kleinjan, Van den Eijnden, Van Leeuwe, Brug, Otten and Engels (2007). In this study it was shown that combining items of the mFTQ and the HONC resulted in three distinct dimensions: behavioural aspects of physical tolerance, craving, and withdrawal during abstinence. Items selected for preservation were required to have a minimal loading of .45 (Van Dyke, Prybutok & Kappelman, 1999). Selection of items was further based on conceptual interpretation, scores on descriptive statistics, and on inter-item and item-total correlations. The multidimensional model was subsequently tested in a second sample using confirmatory factor analysis. The new measure fitted the data satisfactorily and showed good psychometric properties. In addition, to test convergent validity, it was found that the three components of the combined scale are uniquely related to readiness to quit and number of previous quit attempts.

Table 2 Means, standard deviations, and Cronbach's alphas for the Processes of Change

	Means in stages of change (SD)			
	Precontemplators	Contemplators	Preparers	Alpha
Consciousness Raising	2.09 (0.89)	2.31 (0.82)	2.48 (1.03)	.89
Social Liberation	2.54 (0.42)	2.55 (0.61)	2.64 (0.68)	.79
Dramatic Relief	1.74 (0.76)	1.89 (0.88)	2.09 (0.92)	.85
Self-Reevaluation	1.69 (0.80)	1.79 (0.80)	2.07 (0.84)	.86
Environmental Reevaluation	1.80 (0.89)	1.85 (0.81)	2.13 (1.10)	.88
Helping Relationship	3.33 (1.17)	3.51 (1.12)	3.32 (1.15)	.87
Self-Liberation	2.33 (0.90)	2.55 (0.96)	3.04 (0.88)	.82
Counter Conditioning	2.00 (0.84)	2.22 (0.80)	2.57 (1.02)	.80
Stimulus Control	1.31 (0.61)	1.31 (0.57)	1.53 (0.87)	.90
Reinforcement Management	1.82 (0.85)	2.02 (0.88)	2.15 (1.04)	.84

Readiness to quit. to quit was assessed according to respondents' plans to stop smoking. A nine-point ordinal scale was used that ranged from 1. "I am planning to quit within the next 10 days", through 2. "Planning to quit within one month", 3. "planning to quit within six months", 4. "planning to quit within one year", 5. "planning to quit within five years", 6. "planning to quit within ten years", 7. "planning to quit somewhere in the future but not within the next 10 years", 8. "planning to never quit but planning to cut down" and 9. "planning to never quit and not planning to cut down" (Dijkstra, Tromp, & Conijn, 2003). Respondents were categorized into the different stages of change consistent with the approach as described by Prochaska et al. (1988, 1992a), i.e., those respondents who agreed to plan to quit within the next ten days or the next month were labelled preparers, whereas those who agreed to plan to quit within the next 6 months, but not in the next ten days or next month, were categorized as contemplators. The label precontemplators was used for all respondents who were planning to quit within the next year or the next five years, but not in the next six months, those who agreed to quit somewhere in the future but not within five years, and those who had no plans to quit at all.

Statistical analyses

In order to examine to what extent adolescents adhere to the processes of change, we assessed the usage of these processes within the different stages of change. Analysis of variance (ANOVA) with Scheffé post hoc tests were used to stratify the average scores for the processes of change by the stages of precontemplation, contemplation, and preparation.

To assess the association between the processes of change and the stages of change, we used Structural Equation Modeling in Mplus version 4.0 (Muthén & Muthén, 1998-2007a). Mplus was used because of its ability to accommodate non-normality without reliance on large samples or unrealistically small models (Kaplan, 2000; Muthén, du Toit, & Spisic, 1997). The Processes of Change were measured as latent variables with the 40 items providing 4 manifest variables for each of the processes of change. Within the models we accounted for the correlations between the separate processes of change. To assess the associations between nicotine dependence and both the processes of change and readiness to quit, we added the concept to the initial model. Because the nicotine dependence measure used has been previously validated with regard to its psychometric properties and convergent construct validity (Kleinjan et al., 2007), we chose to enter nicotine dependence into the model as a manifest variable. For all analyses p-values < 0.05 are considered significant.

Results

Smoking characteristics

On average, respondents smoked 50 cigarettes a week (SD = 44.5). Subjects reported having smoked their first cigarette or having taken their first puff at an average age of 11.5 years (SD = 4.2). Of the respondents, 15.0% were in the preparation stage, 6.3% in the

contemplation stage, and 78.7% in the precontemplation stage. Quit attempts in the last 12 months were reported by 30.1% (M = 2.8, SD = 5.4).

Processes of Change

Smokers in the three stages of behavioural change differed in the extent to which they engaged in eight of the ten processes of change (Table 3). Precontemplators showed less engagement in the processes of change compared to contemplators, which in turn showed less engagement in these processes compared to preparers. Helping relationship and social liberation were the only processes that did not differ between precontemplators, contemplators and preparers.

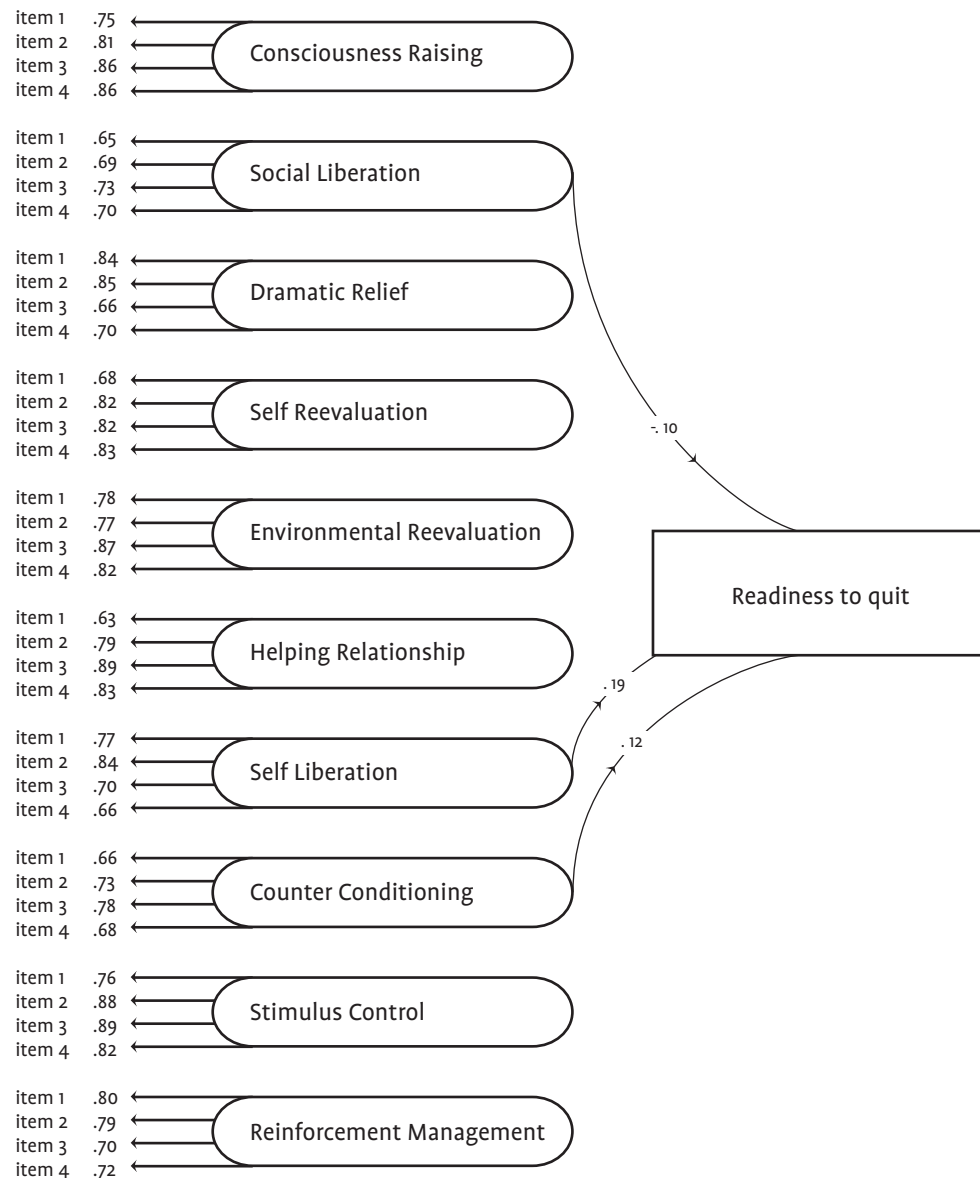
Findings of structural equation modeling showed that three processes of change were significantly associated with readiness to quit as measured by the stages of change construct (see Figure 1). The more smokers engaged in self-liberation and counter conditioning, the higher the reported readiness to quit. More engagement in social liberation was associated with a lower readiness to quit. The total variance explained by the processes of change in readiness to quit was 10%. The model as shown in Figure 1 had a good fit [$\chi^2 = 3713.49$, $df = 725$, $p < .001$, $RMSEA = .05$, $CFI = .92$, $TLI = .91$].

Table 3 ANOVA tests with Scheffé Post Hoc tests for the Processes of Change

Processes of Change	F-value	η^2	Scheffé pattern
Consciousness Raising	$F(2,1547) = 28.13^*$	.04	PC<C=P
Social Liberation	$F(2,1547) = .93$	.00	PC=C=P
Dramatic Relief	$F(2,1547) = 29.83^*$	.04	PC<C=P
Self-Reevaluation	$F(2,1547) = 27.81^*$	.04	PC=C<P
Environmental Reevaluation	$F(2,1547) = 18.20^*$	.02	PC=C<P
Helping Relationship	$F(2,1547) = .58$	.00	PC=C=P
Self-Liberation	$F(2,1547) = 58.27^*$	.07	PC<C<P
Counter Conditioning	$F(2,1547) = 43.21^*$	.05	PC<C<P
Stimulus Control	$F(2,1547) = 17.13^*$	.02	PC=C<P
Reinforcement Management	$F(2,1547) = 25.00^*$	.03	PC<C=P

Note: PC stands for precontemplators, C for contemplators and P for preparers
* $p < .001$

Figure 1 Structural Equation Model analysis: Standardised regression weights of the Processes of Change in relation to readiness to quit as measured with the Stages of Change



Note: Only significant pathways ($p < .05$) are shown within the figure

Nicotine Dependence

Adding nicotine dependence to the model resulted in a good model fit with $\chi^2 = 3827.99$, $df = 755$, $p < .001$, $RMSEA = .05$, $CFI = .92$, $TLI = .91$ (Figure 2). Nicotine dependence was directly negatively associated with readiness to quit. In addition, higher scores on nicotine dependence were associated with more engagement in the processes of stimulus control and social liberation, and with less engagement in self-liberation and counter conditioning.

The model showed one indirect association between nicotine dependence and the readiness to quit, i.e., through the process of self-liberation. The explained variance in readiness to quit increased to 12% when nicotine dependence was added to the model.

Discussion

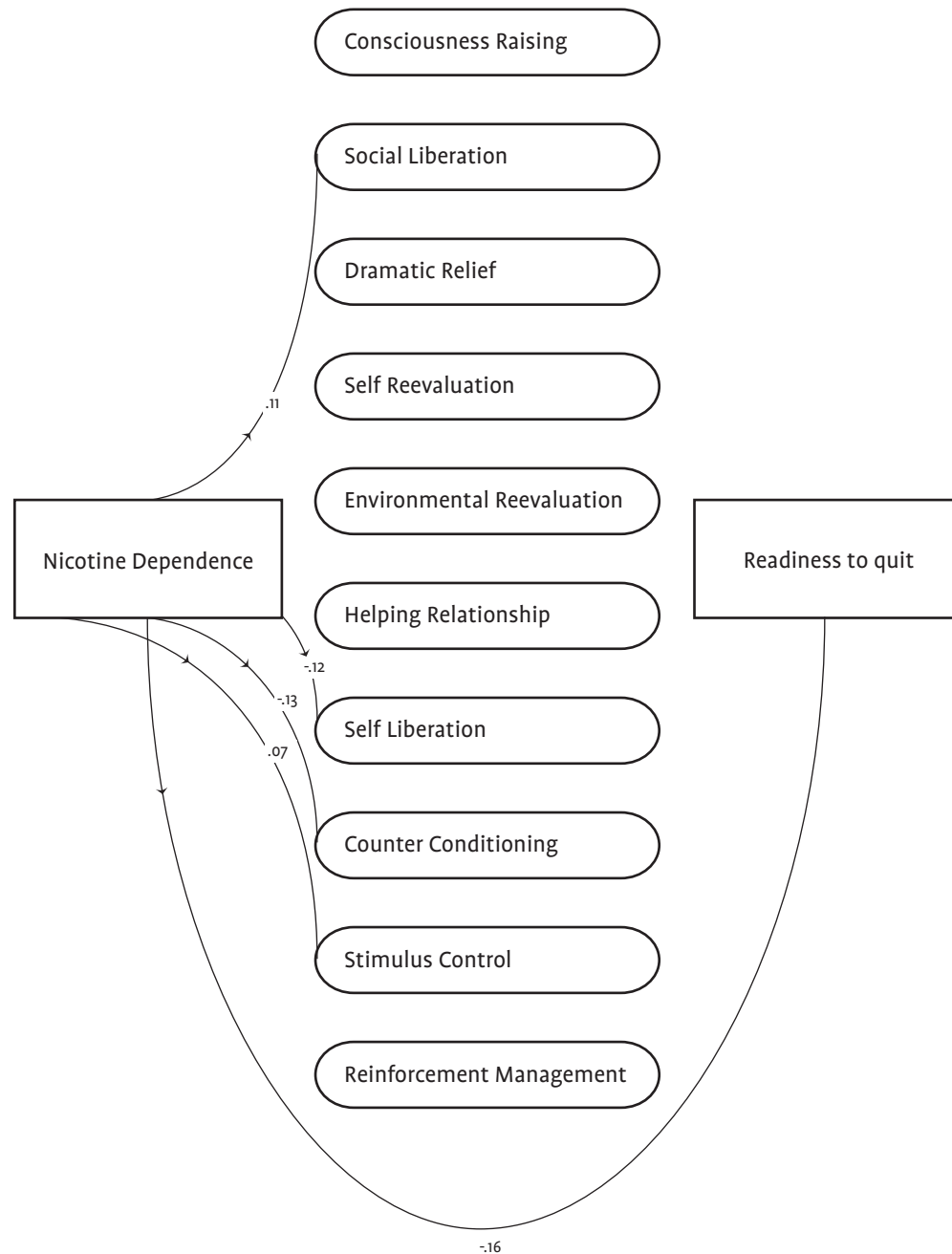
The findings of the present study show that among adolescents, self-reported nicotine dependence is a strong correlate of readiness to quit, while the association between the processes of change and readiness to quit is limited. After the association of the processes of change with readiness to quit had been accounted for, nicotine dependence remained negatively associated with readiness to quit.

The findings indicate that adolescents' perceived engagement in the processes of change within the different stages of the stages of change construct was similar to that found among adults, with precontemplators engaging less in the different processes of change than contemplators, and contemplators engaging less in the different processes as compared to preparers (Herzog, Abrams, Emmons, Linnan, & Shadel, 1999; Kleinjan, Van den Eijnden, Dijkstra, Brug, & Engels, 2006). In addition, adolescents' mean scores on the processes of change were similar to those among adults (Herzog et al., 1999), indicating that adolescents' perceived degree of engagement in processes of change is comparable to that of adults.

Despite these findings, the present study shows that, in adolescents, the processes of change are only marginally associated with readiness to quit.

Within our sample, three out of the ten processes, i.e., self-liberation, counter conditioning, and social liberation, were associated with readiness to quit. The processes of self liberation (i.e., adolescents' choice and commitment to change and the belief in their ability to change) and counter conditioning (i.e., adolescents' efforts to replace smoking with alternatives) were positively and most strongly associated with stage of change. Contrary to what was expected, social liberation (i.e., adolescents' realization that the social norms are changing in the direction of supporting non-smoking) was found to be negatively associated with stage of change. A possible explanation for this negative association might lie in cognitive dissonance. Cognitive dissonance is experienced when two or more cognitions are inharmonious in relation to one another, which results in motivational tension (Festinger, 1957; Wicklund & Brehm, 1976). Adolescents might experience cognitive dissonance because they continue to smoke cigarettes despite their knowledge of the negative health effects and the changing social norm regarding smoking.

Figure 2 Structural Equation Model analysis: Standardised regression weights of nicotine dependence and Stages of Change with Processes of Change as mediating variables



The more adolescents realize that societal norms are changing in favour of non-smoking, the more they may feel inclined to justify their smoking behaviour. Dissonance reduction mechanisms may therefore affect potential readiness to change in a negative manner.

There are several possible explanations for the limited associations between the processes of change and readiness to quit. One explanation could lie in the measurement of readiness to quit by the stages of change construct. In their paper on adult smokers, Herzog et al. (1999) reasoned that the absence of associations between the processes of change and the different stages of change could be explained by the notion that the stages of change algorithm might not adequately measure readiness to quit. It should be noted that the stages of change model has recently been criticized for its use of arbitrary cut-off points to differentiate between the stages (Sutton, 2001; West, 2005). Especially among adolescents, the criteria of intending to quit within one month (preparation) or within six months (contemplation) may not adequately capture adolescents' eventual and perhaps vague intentions of quitting sometime in the future. Within our sample, 74.7% of the adolescent smokers were classified as precontemplators, and within the daily smokers subgroup 81.2% were in the precontemplation stage, meaning they did not intend to quit within six months. Several studies among adult smokers found distributions of approximately 40% of the smokers in precontemplation, 40% in contemplation, and 20% in preparation (Velicer, Fava, Prochaska, Abrams, Emmons, & Pierce, 1995; Pallonen, 1998). Thus, readiness to quit among adolescents seems to be remarkably lower compared to that among adults.

Adolescent smokers on average have relatively short smoking careers and concrete plans to quit may not yet have been established. In his study on exploring perceptions of smoking cessation among adolescents, Balch (1998) found that many participants considered it important to quit eventually, but did not consider it serious or urgent. The stages of change construct might be more useful within adolescent populations, when it distinguishes different levels of precontemplation to enable more variance within the construct of readiness to quit. Several studies among adults have already suggested that within the large group of precontemplators, several subtypes exist (Anatchkova, Velicer, & Prochaska, 2006; Crittenden, Manfredi, Warnecke, Cho, & Parsons, 1998; Dijkstra, De Vries, and Roijackers, 1999; Dijkstra & De Vries, 2000; Norman, Velicer, Fava, & Prochaska, 2000; Velicer et al., 1995). These subtypes are described based on the degree in which they vary in their perceived pros and cons of smoking, and their temptations to smoke. Further research is necessary to establish whether subtypes exist within the precontemplation stage of smoking cessation among adolescents and, in addition, whether the use of these subtypes increases the ability of the stages of change construct to differentiate between the differences in adolescent smokers' readiness to quit.

Another explanation for the limited association between the processes of change and readiness to quit may lie in previous findings indicating a difference between adults and adolescents in their use of the processes of change across the stages of change (Pallonen, 1998). Adults tend to emphasize the experiential processes at the early stages, and to depend on the behavioural processes at the later stages, whereas adolescents appear to rely more on the behavioural processes, even at the early stages of change. These findings,

however, cannot account for the lack of associations between the behavioural processes and readiness to quit, indicating that the processes of change in their present form might not be entirely appropriate as indicators of adolescents' readiness to quit.

Considering that within the Transtheoretical model, the processes of change can be seen as proximal indicators of behaviour change (Prochaska et al., 1992a), the finding of a negative association between nicotine dependence and readiness to quit, while controlling for the processes of change, underlines previous conclusions on nicotine dependence as being an important factor in the process of smoking cessation among adolescents (Prokhorov et al., 2001; Horn et al., 2003).

Remarkably, and contrary to what was expected, not all of the associations found between nicotine dependence and the processes of change were negative. The higher the self-reported nicotine dependence, the more respondents reported to make use of the processes of social liberation and stimulus control. In case of social liberation, this positive association could be explained by frequency of smoking. Daily smoking adolescents are thought to be more at risk of developing, or having developed, a tobacco dependency (Colby, Tiffany, Shiffman, & Niaura, 2000a), and in addition, a daily smoker might be more often confronted with the changing social norms supportive of non-smoking. In case of stimulus control it was expected that higher nicotine dependence would result in fewer efforts to engage in avoidance of stimuli that bring out smoking. A possible explanation for the found positive association might be that smokers who have a higher perceived engagement in stimulus control are more convinced of their dependence on nicotine. Self-liberation was the only process found to play a mediating role between dependency and readiness to quit. Less dependence on nicotine was associated with a higher perceived commitment to act or belief in the ability to change smoking behaviour, which in turn was associated with a higher readiness to quit. This implies that in order to increase adolescents' readiness to quit smoking, it is important to decrease nicotine dependence, because lower levels of nicotine dependence show a relationship with making a commitment to change smoking behaviour.

This study is one of the first to provide insight into the impact of the processes of change on the process of smoking cessation and into the specific role, relative value, and the mechanisms by which nicotine dependence may influence this process in adolescents, using a large nation-based sample. In interpreting the findings of the present study, however, one should bear an important limitation in mind. The cross-sectional design makes it impossible to draw conclusions concerning the causality of the associations between the different variables. Research with longitudinal designs will therefore be needed to gain more insight into the direction of the associations found in this study.

In conclusion, the findings of the present cross-sectional study showed that, although adolescent smokers do engage in the processes of change as defined by the Transtheoretical model, there is only a limited association between these processes and readiness to quit. In addition, this study identified that nicotine dependence has a significant impact on the process of smoking cessation, over and above the processes of

change. The findings of this study emphasize previous conclusions on the occurrence of nicotine dependence in adolescents (DiFranza et al., 2000), and indicate that nicotine dependence among adolescents plays a profound role in the process towards smoking cessation. To increase successful smoking cessation, it is advised that adolescents' nicotine dependence be targeted.

¹ *Footnotes*

It should be stated that within the studies by Herzog et al. (1999) and Segan et al. (2002; 2004) the short-form measure of the processes of change was used, and in addition, that the first two studies mentioned did not assess all of the 10 processes of change.

5 Associations between the transtheoretical processes of change, nicotine dependence, and adolescent smokers' transition through the stages of change

Based on
Kleinjan, M. Brug, J. Van den Eijnden, R.J.J.M. Vermulst, A.A. Van Zundert, R.M.P. & Engels, R.C.M.E. (2008). Associations between the transtheoretical processes of change, nicotine dependence and adolescent smokers' transition through the stages of change. *Addiction*, 103, 331-338

Abstract

Aims

To examine the significance of the transtheoretical processes of change in predicting transition through the stages of change in adolescent smokers, as well as the relative role of nicotine dependence in predicting stage transitions.

Design

In grades 9 and 10, adolescents' stage of change, the use of processes of change and nicotine dependence were assessed (T1). Stage transitions were assessed one year later (T2). Response rate was 73.2%.

Setting

Twenty-five secondary schools throughout the Netherlands participated in the present study.

Participants

Respondents were 721 adolescents who were classified as smokers at T1 and consequently completed the paper-and-pencil questionnaire at T2. Measurements: Stages of change and processes of change were assessed according to the original transtheoretical measures. Nicotine dependence was measured using a newly developed multidimensional scale consisting of 11 items.

Findings

Few associations were found between the processes of change and stage transitions. Nicotine dependence contributed significantly to the explanation of adolescents' transition from preparation to action, after adjustment for processes of change. No evidence for a moderating effect of nicotine dependence in the relation between the processes of change and stage transitions was found.

Conclusions

Processes of change do not seem significant in explaining adolescents' stage transitions. As an alternative for promoting the use of the processes of change for intervention purposes in adolescents, it might be more useful to focus on treating nicotine dependence.

Introduction

The Transtheoretical model (TTM: Prochaska, DiClemente, Norcross, 1992a) is a widely applied and frequently used model to study determinants of smoking cessation, also among adolescents (Pallonen, 1998; Prokhorov, Hudmon, De Moor, Kelder, Conroy, & Ordway, 2001; Hoepfner, Velicer, Redding, Rossi, Prochaska, Pallonen, & Meier, 2006). The basis of the TTM is formed by five sequential stages of change (Prochaska et al., 1992a), which are defined in terms of an individual's past behaviour and plans for future action. These stages are precontemplation (not planning to quit within six months), contemplation (planning to quit within six months, but not within the next month), preparation (planning to quit within one month and having made a prior quit attempt in the past year), action (having quit within the past six months), and maintenance (having quit for more than six months).

According to the TTM, movement through the different stages of change is facilitated by ten processes of change (Prochaska et al., 1992a, Prochaska, Norcross, Fowler, Follick, & Abrams, 1992b). These processes consist of overt as well as covert activities and experiences that individuals can engage in, in order to attempt to change risk behaviours. The processes of environmental reevaluation, self-reevaluation, consciousness raising, social liberation and dramatic relief, are thought to be most frequently used during the contemplation and preparation stages of change and have been classified as experiential (cognitive-affective) processes. The processes of reinforcement management, counter-conditioning, stimulus control, self-liberation and helping relationship are supposed to occur most frequently during the action and maintenance stages of change and are classified as behavioural processes (Prochaska et al., 1992a, Rosen, 2000) (see Table 1). Theoretically, the processes of change could be used to tailor interventions.

Despite its popularity, however, several concerns about the validity of the TTM have been expressed. One of these concerns is that the stages of change construct might not reflect real stages, but rather segments of an underlying continuum (Sutton, 2001). In addition, the ordering of the stages, the stability of the stages, the classification system to define stages, and the qualitative differences of the stages have also been a subject of debate (Sutton, 2000; West, 2005). Furthermore, in adults, outcomes regarding the effectiveness of the processes of change in predicting stage transitions or the value of the processes of change as guidelines to tailor smoking cessation interventions have not been convincing (Sutton, 2005).

Recently, efforts have been made to assess the psychometric properties of the processes of change in order to validate its use as an assessment tool in adolescent samples (Hoepfner et al., 2006). In that study it was concluded that, besides serving as an adequate assessment tool, the processes of change could also be used for intervention purposes in adolescents. Until today, however, the usefulness of the processes of change as concepts to guide intervention development for adolescent smokers has hardly been tested and the impact of the processes of change on stage transitions among adolescents is largely unknown.

The first important goal of the present study is to provide a critical examination of the relations between the TTM's processes of change and the stage transitions among adolescent smokers using a longitudinal design. It is expected that the experiential processes will be mainly important in predicting forward transitions out of the precontemplation stage and contemplation stage, and that the behavioural processes will be more important in prediction of transitions from preparation into action.

Previously, it has been found that nicotine dependence is an important factor in the process of smoking cessation among adolescents (Prokhorov et al., 2001; Horn, Fernandes, Dino, Massey, & Kalsekar, 2003). Therefore, our second objective is to examine more closely the role of nicotine dependence, in relation to the processes of change, in predicting adolescent smoking cessation. Based on findings by Farkas and colleagues (1996) and Abrams and colleagues (2000), demonstrating that variables indicative of addiction are better predictors of abstinence at follow-up than the TTM's stages and processes of change, we expect that nicotine dependence will be a better predictor of transition into the action stage (i.e., smoking cessation) compared to the processes of change. In addition, because precontemplators are generally more dependent and more likely to continue to smoke despite internal and external environmental influences than contemplators and preparers (Velicer, Rossi, DiClemente, & Prochaska, 1996), it is plausible that higher levels of nicotine dependence are associated with fewer efforts to engage in strategies to influence or control the environment, i.e. the processes of change. It is therefore hypothesized that the relation between the processes of change and stage transitions will be stronger for respondents reporting lower levels of dependence.

Method

Procedure and Sample

In 2004 (T1) a total of 25 secondary schools participated in the study, resulting in 6,750 respondents aged 13-18 years ($M = 14.8$, $SD = .88$). In 2005 (T2), 4,940 respondents were included again (response rate 73.2%) (Van de Ven, Van den Eijnden, & Engels, 2006a). Students were asked to complete a self-administered written questionnaire, distributed by an instructed teacher during classes in grades nine and ten at T1, and grades ten and eleven at T2. Students were informed that the data would be processed anonymously, i.e., respondent specific codes were used to link the data from one point in time to the next. Respondents who indicated they had smoked during the past month were labeled as smokers and had to answer questions on smoking demographics, smoking history, smoking behaviour, potential predictors of smoking, etc. A total of 850 of the 4,940 respondents (17.2 %) indicated at T1 that they had smoked at least once in the past month. Respondents with more than 6 missing values on the items of either the processes of change or nicotine dependence were excluded, leaving a longitudinal sample of 721 smokers.

Sample Characteristics

Of the 721 respondents included both in T1 and T2, 54.5% was female. Moreover, 34.0% received a preparatory vocational training, 16.2% a junior general secondary training, 33.8% a senior general secondary education, and 12.8% received a university preparatory training. The mean age at T1 was 15.0 years ($SD = 0.84$). On average respondents smoked 32.8 cigarettes per week ($SD = 41.2$) at T1, and 50.9 cigarettes per week ($SD = 45.4$) at T2. At T2, 140 respondents reported to have quit smoking.

Measures

Processes of Change. The processes of change were assessed by using the original 40-item measure as developed by Prochaska et al. (1988; 1992a). Respondents were asked to indicate their use of the ten different processes of change (for a description see Table 1). Items could be scored on a 5-point scale ranging from (1) never, to (5) often, and followed the question: "How often did the following occur in the last four weeks?". Reliabilities of the scales were found to be satisfactory with Cronbach's alphas ranging from .80 to .92. Principal factor analysis with oblimin rotation and the number of factors fixed at 10, showed pattern loadings consistent with the TTM's theory.

Stages of Change. The stage of change was assessed using a 9-point ordinal scale ranging from 1. "I am planning to quit within the next 10 days" to 9. "I am planning to never quit and not planning to cut down" (Dijkstra, Tromp, & Conijn, 2003). Respondents were categorized into the different stages of change consistent with the approach as described by Prochaska et al. (1988; 1992a), i.e., those respondents who agreed to plan to quit within the next month, and who indicated to have made at least one 24 hour quit attempt in the past year,

Table 1 Description of the Processes of Change

Experiential Processes	Description
Consciousness Raising (CR)	Increasing knowledge and information about one's smoking
Social Liberation (SoL)	Awareness, availability, and acceptance of alternative, problem-free lifestyles in society
Dramatic Relief (DR)	Experiencing and expressing feelings about one's smoking
Self-Reevaluation (SR)	Considering feelings and thoughts about the self in relation to one's smoking
Environmental Reevaluation (ER)	Considering how smoking affects one's environment

Behavioural Processes	Description
Helping Relationship (HR)	Trust others and being open about one's smoking
Self-Liberation (SeL)	Choosing and commitment to act or belief in ability to change
Counter-Conditioning (CC)	Replacing smoking with alternatives
Stimulus Control (SC)	Avoidance or dealing with stimuli that bring out smoking
Reinforcement Management (RM)	Rewarding oneself or being rewarded by others for changing smoking behaviour

were in preparation, whereas those who agreed to plan to quit within the next 6 months or within the next month without a prior quit attempt in the past year, were categorized in contemplation. All respondents who indicated that they were not planning to quit within the next six months were in precontemplation. Respondents indicating to have quit at T2 were categorized into the action stage.

Nicotine Dependence. Self-reported nicotine dependence was measured by a newly developed 11-item multidimensional scale based on both the modified Fagerström Tolerance Questionnaire (mFTQ: Prokhorov, Pallonen, Fava, Ding, & Niaura, 1996) and the Hooked on Nicotine Checklist (HONC: DiFranza et al., 2000; O'Loughlin et al. 2002a). This scale was validated (Kleinjan, Van den Eijnden, Van Leeuwe, Brug, Otten, & Engels, 2007) and Cronbach's alpha was 0.87.

Attrition Analyses

Of the 6,750 respondents at T1, 4,940 were included again at T2. Respondents lost to follow-up were compared to the remaining respondents on the variables gender, age, education and smoking status using independent sample t-tests and chi-square tests. Analyses showed that respondents lost to follow-up were more likely to be boys [$\chi^2(1, N = 6734) = 16.83; p < .001$], older [$t(6691) = 3.89; p < .001$], to have general secondary training [$\chi^2(3, N = 6581) = 143.38; p < .001$], and to be smokers [$\chi^2(1, N = 6750) = 33.70; p < .001$]. A multivariate logistic regression analysis including these independent variables showed all significant associations between these variables and loss to follow-up (Nagelkerke $R^2 = .02$). These differences can to a large extent be explained by the fact that most respondents lost to follow-up were in the last year of a lower educational level at T1, and were graduated at T2 and had therefore left school.

Strategy for Analyses

To examine the relation between processes of change and specific stage transitions as specified by the TTM, we applied logistic regression analysis using the software package MPLUS 4.1 (Muthen & Muthen, 1998-2007a). Before applying logistic regression analysis, the missing data in the raw data matrix (with missing data between 1.4 and 4.7%) were

estimated with the Expectation-Maximization (EM) algorithm in SPSS.

To assess the moderating effects of nicotine dependence, we computed product terms of nicotine dependence with each of the ten processes of change. To avoid multicollinearity problems, the independent variables were centered before the interaction terms were computed. Logistic regression analyses were performed with the independent variables and the interaction terms in one run.

Because the data have a multilevel structure, the possibility exists that the individual respondents are not independent within schools. To correct for the potential non independence (complexity) of the data, the TYPE=COMPLEX procedure in MPLUS is used. This procedure corrects the standard errors of the parameter estimates for dependency leading to unbiased estimates (Kuntsche & Jordan, 2006)

Results

Stages of Change

At T1, 69.2% of the respondents were classified as precontemplators, 13.0% as contemplators, and 17.7% as preparers. At T2, 64.5% of the respondents were classified as precontemplators, 7.0% as contemplators, 8.4% as preparers, and 20% of respondents had moved into the action stage. A total of 6.0% (N=29) of the precontemplators at T1 reported a transition to contemplation at T2, a total of 8.8% (N=8) of the contemplators at T1 reported a transition to preparation at T2, and 25.8% (N=32) of preparers at T1 reported a transition to action at T2.

Processes of Change in relation to Stages of Change

In line with the TTM, we found that at T1, smokers in the four different stages of change varied in the extent to which they engaged in eight of the ten processes of change (Table 2). For all processes of change it was found that precontemplators engaged less in the processes compared to contemplators and contemplators less than preparers. Helping relationship and social liberation were the only processes that did not differ between

Table 2 Stages of Change and Processes of Change: Cross-sectional Analyses at T1

Introduction	Means in Stages of Change (SD)			F-value
	Precontemplators (N=484)	Contemplators (N=91)	Preparers (N=124)	
CR	2.05 ^a (0.91)	2.52 ^b (1.04)	2.55 ^b (1.04)	F(2, 696) = 9.51***
SoL	2.57 (1.00)	2.51 (1.17)	2.80 (0.97)	F(2, 696) = 1.34
DR	1.68 ^a (0.73)	1.99 (1.00)	2.13 ^b (0.93)	F(2, 696) = 15.06***
SR	1.67 ^a (0.86)	1.89 (0.98)	2.13 ^b (0.87)	F(2, 696) = 13.09***

Introduction	Means in Stages of Change (SD)			
ER	1.73 ^a (0.94)	2.00 (1.07)	2.20 ^b (1.17)	F(2, 696) = 4.07*
HR	3.45 (1.27)	3.46 (1.26)	3.53 (1.11)	F(2, 696) = 0.08
SeL	2.29 ^a (0.94)	2.85 ^b (1.08)	3.29 ^b (1.10)	F(2, 696) = 26.03***
CC	2.01 ^a (0.89)	2.45 ^b (1.02)	2.69 ^b (1.02)	F(2, 696) = 17.53***
SC	1.25 ^a (0.60)	1.33 ^a (0.72)	1.60 ^b (0.95)	F(2, 696) = 13.60***
RM	1.79 ^a (0.92)	2.02 ^b (0.96)	2.23 ^b (1.12)	F(2, 696) = 15.14***

Note: Means in the same row that do not share superscript differ at $p < .05$ using Scheffe's post-hoc tests. For abbreviations, see Table 1.
* $p < .05$; ** $p < .01$; *** $p < .001$

precontemplators, contemplators and preparers. Pearson correlations between the ten processes of change ranged from 0.03 to 0.61 (Table 3), indicating mostly moderate associations between the different processes of change.

Table 3 Correlations between Processes of Change (N=721)

	1	2	3	4	5	6	7	8	9	10
1.CR	1									
2.SeL	.55***	1								
3.DR	.53***	.44***	1							
4.CC	.42***	.47***	.47***	1						
5.SC	.35***	.30***	.48***	.42***	1					
6.HR	.19***	.25***	.04	.17***	.03	1				
7.ER	.38***	.34***	.44***	.42***	.45***	.14***	1			
8.SoL	.31***	.29***	.27***	.28***	.26***	.41***	.46***	1		
9.SR	.38***	.32***	.54***	.38***	.55***	.07	.57***	.40***	1	
10.RM	.34***	.30***	.43***	.35***	.48***	.20***	.49***	.36***	.61***	1

Note: For abbreviations, see Table 1
* $p < .05$; ** $p < .01$; *** $p < .001$

Processes of Change in relation to the specific stage transitions

As shown in Table 4, there were no significant differences in processes of change between precontemplators who progressed to contemplation and precontemplators who did not progress to contemplation. With the exception of stimulus control, there were also

no significant differences in process use between contemplators who progressed to preparation and contemplators who did not progress to preparation. Counter conditioning was the only process that significantly differed between preparers progressing to action, compared to preparers that did not progress towards action.

Table 4 Comparison of mean scores on processes of change between progressors and non-progressors

		Precontemplation- Contemplation		Contemplation- Preparation		Preparation- Action	
		Mean (SD)	t (df = 482)	Mean (SD)	t (df = 89)	Mean (SD)	t (df = 122)
CR	No Transition	2.05 (0.93)	-0.75	2.47 (0.98)	-0.97	2.50 (0.98)	-0.85
	Transition	2.18 (0.67)		3.03 (1.60)		2.69 (1.20)	
SoL	No Transition	2.56 (1.01)	-0.31	2.51 (1.15)	0.10	2.73 (0.89)	-1.35
	Transition	2.62 (0.80)		2.46 (1.49)		3.00 (1.13)	
DR	No Transition	1.67 (0.73)	-0.85	1.99 (1.00)	-0.02	2.10 (0.93)	-0.60
	Transition	1.80 (0.75)		2.00 (1.06)		2.21 (0.94)	
SR	No Transition	1.66 (0.85)	-1.03	1.90 (0.99)	0.20	2.13 (0.86)	0.02
	Transition	1.83 (0.93)		1.82 (0.83)		2.13 (0.92)	
ER	No Transition	1.73 (0.94)	0.08	1.98 (1.05)	-0.55	2.15 (1.08)	-0.72
	Transition	1.72 (0.88)		2.21 (1.38)		2.35 (1.43)	
HR	No Transition	3.46 (1.27)	0.37	3.48 (1.25)	0.52	3.53 (1.07)	0.03
	Transition	3.37 (1.18)		3.21 (1.45)		3.52 (1.23)	
SeL	No Transition	2.29 (0.95)	-0.06	2.82 (1.03)	-0.45	3.31 (1.07)	0.39
	Transition	2.31 (0.88)		3.09 (1.65)		3.23 (1.18)	
CC	No Transition	1.99 (0.88)	-1.35	2.50 (1.03)	1.62	2.58 (0.97)	-2.02*
	Transition	2.23 (0.91)		1.86 (0.71)		3.00 (1.10)	
SC	No Transition	1.25 (0.60)	-0.93	1.37 (0.74)	4.46***	1.49 (0.78)	-1.67
	Transition	1.35 (0.61)		1.00 (0.00)		1.90 (1.29)	
RM	No Transition	1.78 (0.93)	-0.91	2.03 (0.98)	0.26	2.24 (1.18)	0.24
	Transition	1.93 (0.77)		1.93 (0.85)		2.19 (0.96)	

Note: For abbreviations, see Table 1
* $p < .05$; ** $p < .01$; *** $p < .001$

Precontemplation to Contemplation. Logistic regression analyses using MPLUS showed none of the processes of change to be significantly related to a forward transition from precontemplation to contemplation (see Table 5). The total variance explained by the processes of change in the transition from precontemplation to contemplation was 5.8%.

Contemplation to Preparation. Results of the logistic regression analysis concerning the association between the processes of change and transition from contemplation to preparation were found unstable and are therefore not reported. The instability of the outcomes are most likely due to the low number of transitions (N=8) and the number of independent variables (N=11) in relation to the observations (N=91).

Preparation to Action. Of the ten processes of change, one was significantly related to a change from preparation to action, i.e., smoking cessation (Table 5). A greater engagement in counter-conditioning was related to a greater likelihood of smoking cessation one year later. The total variance explained by the processes of change in action change was 28.7%.

Contribution of Nicotine Dependence in addition to the Processes of Change.

Nicotine dependence did not contribute to predicting a transition from precontemplation to contemplation (Table 5). However, nicotine dependence did contribute significantly to predicting a transition from preparation towards action. Having higher levels of nicotine dependence was directly significantly associated with a lower probability of smoking cessation one year later. Counter-conditioning remained significant as well. By including nicotine dependence in the model the total explained variance increased from 28.7% to 33.7%.

Table 5 Odd ratios (OR) and 95% confidence intervals (CI) of Processes of Change and Nicotine dependence on transitions from precontemplation to contemplation and preparation to action

	Precontemplation-Contemplation (N=484)		Preparation-Action (N=124)	
	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)
CR	1.09 (0.76-1.59)	1.10 (0.75-1.61)	1.37 (0.51-3.65)	1.41 (0.51-3.92)
SoL	0.75 (0.49-1.14)	0.75 (0.50-1.21)	1.59 (0.85-2.99)	1.80 (0.96-3.35)
DR	0.91 (0.52-1.58)	0.90 (0.54-1.51)	1.08 (0.68-1.75)	1.16 (0.70-1.92)
SR	1.32 (0.74-2.37)	1.32 (0.73-2.38)	0.39 (0.12-1.32)	0.40 (0.13-1.26)

	Precontemplation-Contemplation (N=484)		Preparation-Action (N=124)	
	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)
ER	0.68 (0.35-1.34)	0.68 (0.34-1.34)	1.51 (0.93-2.43)	1.40 (0.90-2.19)
HR	1.27 (0.84-1.93)	1.27 (0.83-1.93)	0.74 (0.50-1.09)	0.77 (0.53-1.10)
SeL	0.90 (0.57-1.42)	0.91 (0.59-1.40)	0.57 (0.25-1.35)	0.51 (0.21-1.21)
CC	1.18 (0.83-1.66)	1.19 (0.84-1.68)	2.38** (1.40-4.05)	2.08* (1.21-3.58)
SC	1.12 (0.64-1.96)	1.10 (0.61-2.00)	1.28 (0.71-2.28)	1.19 (0.65-2.20)
RM	1.13 (0.78-1.64)	1.12 (0.78-1.62)	0.71 (0.46-1.11)	0.90 (0.58-1.39)
Nicotine Dependence		1.01 (0.94-1.09)		0.88* (0.88-0.98)

Note: Model 1 includes the regression analysis with the Processes of Change as independent variables, while model 2 also includes nicotine dependence as an independent variable. For abbreviations, see Table 1. * p < 0.01, ** p < 0.001

Interaction effects of Nicotine Dependence

No evidence for a moderating effect of nicotine dependence in the relation between the processes of change and the specific transitions as described by the TTM was found.

Processes of Change in relation to general motivation change and behaviour change

Because a limited number of respondents reported to have made a forward stage transition as specified by the TTM, it was decided to additionally differentiate between two key aspects of the stages of change construct, i.e., undergoing a motivational change and actually changing behaviour (Brug, Conner, Harre, Kremers, McKellar, & Whitelaw, 2004). Respondents who moved forward from precontemplation at T1 to contemplation or preparation at T2, or from contemplation at T1 to preparation at T2 were considered to have undergone a change in motivation (N=67). Respondents moving from the precontemplation, contemplation, or preparation stage at T1 into the action stage at T2 were considered to have changed their behaviour, i.e., quit smoking (N=140). Outcomes regarding the impact of the processes of change on motivation change and behaviour change are consistent with the results reported for the specific stage transitions, namely precontemplation-contemplation and preparation-action.¹

Discussion

This study failed to find strong effects supporting the TTM's notion that the processes of change are important in facilitating progression towards smoking cessation among adolescents. In addition, it could not be confirmed that experiential processes are more influential in explaining transitions from the precontemplation stage, and that the behavioural processes are more influential in explaining transitions from the preparation stage into action. Our findings are in line with several studies among adults, challenging the importance of the use of these processes in accomplishing motivational or behavioural changes (Herzog, Abrams, Emmons, Linnan, & Shadel, 1999; Segan, Borland, & Greenwood, 2002; Segan, Borland, & Greenwood, 2004).

Several explanations have been postulated for the lack of power of the processes of change in predicting subsequent stage progression. One explanation, as discussed in the introduction, is that the stages of change algorithm might not be an adequate measure to capture a person's motivation to quit (Sutton, 2000; 2001; West, 2005). One reason mentioned for the lack of validity concerns the seemingly arbitrary cut-off points that are used to classify smokers into the stages of change (Sutton, 2001). Herzog (2007) found that adolescent smokers do not seem to think about smoking cessation within the context of fixed time frames. Moreover, compared to adults, adolescents are less prepared to quit and many adolescents consider it important to quit eventually, but did not consider quitting serious or urgent (Pallonen, 1998; Balch, 1998). The construct of motivation to quit in adolescents appears to be different from that in adults, and may therefore require a different approach. It could be reasoned that because of lower levels of motivation to quit in adolescents, the stages of change construct may require further distinction among precontemplators as suggested by Dijkstra, Bakker and De Vries (1997). This coincides with findings by Herzog and Blagg (2007), who compared a variety of items measuring motivation to quit smoking and found that more than half the precontemplators as defined by the stages of change were contemplating cessation, and many precontemplators intended to quit. Because motivation to quit in adolescents does not appear to be optimally measured by assessing specific plans, it is conceivable that indicators of motivation to quit for this specific group should be focusing more on insubstantial plans, for example assessing to what extent one is planning to quit right now, soon, somewhere in the future, or not at all. A combination measure of this sort may be more appropriate to evaluate adolescents' plans to quit.

The present study found support for the hypothesis that nicotine dependence contributes significantly to the explanation of adolescents' smoking cessation, while adjusting for the processes of change. This finding is in line with studies among adults suggesting that variables indicative of addiction may make better predictors of abstinence at follow-up, compared to the processes of change and variables indicative of motivation and intention to change behaviour (Farkas et al., 1996; Abrams et al., 2000).

An interesting finding was the absence of an interaction between the processes of change and nicotine dependence in explaining stage transitions. Irrespective of adolescents' level of nicotine dependence, the relationship between the processes of change and stage transitions remains limited, indicating that, with the exception of counter-conditioning,

the utilization of the processes of change strategies are ineffective in changing adolescent smoking behaviour.

In our opinion, instead of focusing on influencing strategies such as the processes of change, future research and intervention development should focus more on the specific role of dependency and habitual factors in adolescents' process of smoking cessation. Among adults, nicotine replacement therapy (NRT) has proven an important smoking cessation adjunct. The use and efficacy of NRT in adolescents has, however, hardly been investigated (Patten, 2000) and is rather controversial (Ginzel et al., 2007). Nevertheless, considering that within this and other studies (Prokhorov et al., 2001; Horn et al., 2003), nicotine dependence was found to be a strong predictor of smoking cessation; clinical trials regarding the safety, feasibility and efficacy of NRT use in lowering levels of dependence in adolescents seem warranted.

Some limitations of the present study should also be addressed. First, because adolescent self-reports to assess their smoking status were used which were not biochemically validated, the possibility of under- or over-reporting exists (Patrick et al., 1994). Several studies among adolescents have, however, assessed self-reported smoking and quitting behaviour to be valid and reliable (Dolcini, Adler, & Ginsberg, 1996; Stanton, McClelland, Elwood, Ferry, & Silva, 1996). Secondly, because of the relatively small proportion of respondents making the specific stage transitions as described by the TTM, it is difficult to evaluate how well the findings of this study are generalizable to the adolescent smoking population at large. However, analyzing the association between the processes of change and a general motivation change and a change towards action resulted in few significant associations as well. It has been argued by some that the distinction between a motivational and volitional stage is the key contribution of a stage model (Armitage & Conner, 2000). If processes of change would indeed be important catalysts of progression towards cessation, relations between the processes of change and both motivation change and behaviour change would certainly be expected.

A final limitation might be the interval between the measurement waves. It is possible that the relation between the processes of change and stage progression is rather intermediate and can not be adequately detected using a design with a one-year interval follow-up (Herzog et al., 1999). Herzog, Abrams, Emmons, and Linnan (2000) revealed, however, that when motivation to quit was measured by using a contemplation ladder, as opposed to the stages of change, processes of change did predict increases from lower levels to higher levels of motivational readiness to quit at a one-year follow-up. These results suggest that processes of change might be useful indicators of increases in motivation to quit if the stages of change are not used as the measure of motivation to quit.

To conclude, the TTM has been very influential in the adult smoking cessation field (Herzog et al., 1999), and is now finding its way into adolescent smoking cessation research as well. Although it would be premature to completely denounce the importance of the processes of change in explaining smoking cessation, it is important to note that

the critical assumption that the processes of change guide the process towards smoking cessation has not been adequately supported by several prospective studies. This is the first time that the relations between processes and stages of change and smoking cessation are studied in a nationwide prospective, relatively large sample of juvenile smokers. Although adolescents report to engage to some extent in the cognitive and behavioural processes of change, these processes do not seem to play an important role in progression towards cessation. Our findings indicate that, as an alternative for promoting the use of the processes of change for intervention purposes in adolescents, it might be more useful to focus on the treatment of nicotine dependence.

Footnotes

¹ Aside from the results mentioned for the specific stage transitions it was also assessed whether results would differ when using the hierarchical constructs of experiential processes and behavioural processes in explaining stage transitions as opposed to the 10 separate processes of change. Logistic regression analyses showed no relations between these hierarchical constructs and transitions from precontemplation to contemplation and preparation to action or general motivational changes and behaviour changes. Detailed description of these analyses can be obtained from the first author.

6 Excuses to continue smoking: The role of disengagement beliefs in smoking cessation

Based on
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Abstract

Background

The aim of the present study was to investigate the role of disengagement beliefs in smoking cessation. The association of disengagement beliefs with forward transition through the Transtheoretical stages of change and self-reported quitting were examined, with and without adjusting for processes of change.

Methods

A longitudinal survey was conducted among Dutch smokers, resulting in 367 respondents who completed two questionnaires, one at baseline and one at 8 months follow-up. Disengagement beliefs, readiness to quit, actual quitting and the processes of change were assessed

Results

The findings showed that disengagement beliefs were negatively associated with forward stage transition and actual quitting. Processes of change only partly mediated these associations.

Conclusions

Adhering to disengagement beliefs seems to be an inhibitor of progression towards smoking cessation and actual quitting, also after adjustment for processes of change.

Introduction

Health education programs, mass media campaigns and nowadays even the slogans depicted on cigarette packages warn smokers for the harmful health effects of smoking. Despite all these efforts, many people continue to smoke. Because of the well-known negative health consequences of smoking and the high resistance of smokers to change, it can be assumed that some form of cognitive dissonance reduction occurs in smokers, especially those not willing to quit (Chapman, Wong, & Smith, 1993). Cognitive dissonance is experienced when an individual has two or more cognitions that are dissonant in relation to one another, which results in motivational tension (Festinger, 1957; Wicklund & Brehm, 1976). Smokers can be expected to experience cognitive dissonance because they continue to smoke cigarettes despite their knowledge of the hazardous effects (McMaster & Lee, 1991).

Dissonance reduction in the form of denial or distortion of threatening information may affect potential readiness to change in a negative manner. Bandura labelled this denial or distortion of threatening information as disengagement (Bandura (1986; Bandura, Barbaranelli, Caprara, & Pastorelli, 1996). In smokers, disengagement can emerge in the form of certain beliefs that are used as excuses or justifications for continuing smoking. For example, smokers may downplay the effect of smoking on health, or they may point out the dangers of other lifestyles. Smokers do indeed hold more of these cognitive dissonance-reducing beliefs than ex-smokers do, which may indicate that successful cessation is accompanied by the shedding of dissonance-reducing beliefs (Chapman, Wong, & Smith, 1993).

Several studies have found that holding disengagement beliefs is related to the readiness to quit smoking and to undertaking quit attempts. Smokers who were motivated to quit adhered to significantly fewer beliefs (Johnson, 1968; Olshavsky & Summers, 1974), and disengagement beliefs at baseline were found to be associated with the likelihood of undertaking a quit attempt in the future (Dijkstra, De Vries, Kok, & Roijackers, 1999; Dijkstra & Brosschot, 2003; Dijkstra, 2003). Disengagement beliefs may prevent smokers from seriously thinking about or considering the consequences of their behaviour, and could therefore lead to stagnation in the progression towards quitting. In a cross-sectional study by Oakes, Chapman, Borland, Balmford, and Trotter (2004) on self-exempting beliefs (a construct similar to disengagement beliefs, i.e., beliefs about personal immunity to health effects, scepticism about medical evidence, normalizing dangers of smoking because of the abundance of risks and beliefs that smoking is worth probable health damage), the ability of these beliefs to predict readiness to quit was explored, using a modified version of the stage of change model. Self-exempting beliefs were found to be related to interest in quitting, but some types of beliefs had greater influence than others on the progression towards cessation. Beliefs that smoking is worth probable health damage were most closely negatively related to readiness to quit and thereby the only significant discriminator between the smoker categories of precontemplators, contemplators and preparers.

The present study further explored the role of disengagement beliefs in the continuation of smoking behaviour. In this longitudinal study we more closely examined the association between disengagement beliefs and smoking cessation. Results of previous studies already showed that disengagement beliefs are associated with both readiness to quit (Olshavsky & Summers, 1974; Dijkstra et al., 1999; Dijkstra & Brosschot, 2003; Dijkstra, 2003; Oakes et al., 2004) and quit attempts (Dijkstra et al., 1999; Dijkstra & Brosschot, 2003; Dijkstra, 2003). The remaining question however, is how adhering to disengagement beliefs lowers the readiness to quit and results in less quitting? To explore this issue, using a longitudinal design we first assessed if disengagement beliefs are associated with forward transitions through the different stages of behavioural change and with actual cessation. Furthermore, we explored if these associations remained after statistical adjustment for processes of change and to what extent such processes may mediate the associations of disengagement beliefs with forward transition through the stages of behaviour change and actual cessation.

Over the years several models to assess behavioural change have been postulated. In the area of substance abuse, the stage of change model has become increasingly influential for assessing motivations to alter behaviour (Connors, Donovan, & DiClemente, 2001; Stephens, Cellucci, & Gregory, 2004). This stage model defines five stages toward successful behavioural change. The stages are defined in terms of an individual's past behaviour and his or her plans for future action, and represent a temporal dimension in which shifts occur in readiness to quit smoking (Prochaska, DiClemente & Norcross, 1992a). The first stage is precontemplation, in which the smoker is unaware or under-aware of the risks of smoking, and shows no readiness to quit in the near future. The next stage is the contemplation stage, in which the smoker is thinking about the risks of smoking and considers change. Intending to take action and small behavioural changes are indicative of the next stage, i.e., the preparation stage, and in the action stage the smoker has recently quit smoking. The final stage is the maintenance stage, in which the smoker works to prevent relapse and which is reached when non-smoking was sustained for more than six months (Prochaska et al., 1992a).

Certain processes are known to act as predictors of progress across the stages of change (Prochaska et al., 1992a; Prochaska, Norcross, Fowler, Follick & Abrams, 1992b). These processes of change are overt as well as covert activities and experiences that individuals engage in, in order to attempt to change risk behaviours. In addition they can facilitate understanding of how shifts occur in readiness to change. Each of the separate processes includes distinct methods and interventions that contribute differentially to the completion of the different stages of behaviour change (Prochaska et al., 1992a). The processes of change can be grouped into two higher-order factors, i.e. cognitive-affective processes and behavioural processes (Prochaska, Velicer, DiClemente, & Fava, 1988; Kristeller, Rossi, Ockene, Goldberg, & Prochaska, 1992; O'Connor, Carbonari & DiClemente, 1996). The processes of environmental evaluation, self-evaluation, consciousness raising and dramatic relief, tend to be used most frequently during the contemplation and preparation stages of change and can be classified as cognitive-affective processes,

whereas the processes of reinforcement management, counterconditioning, stimulus control and helping relationship occur most frequently during the action and maintenance stages of change and can be classified as behavioural processes (Prochaska et al., 1992a; Rosen, 2000; See Table 1). Engaging in processes of change is expected to instigate change in smoking, whereas engaging in disengagement beliefs will lead to continuation of smoking. It is further expected that disengagement beliefs precede the processes of change, and that processes of change precede movement across the stages of change and actual smoking cessation. Smokers are considered to perceive a fairly constant threat by knowing they are susceptible to possible health damage due to smoking. This threat will become less worrisome when disengagement beliefs are used to deny or distort this knowledge or the information that gives rise to this knowledge. Because of the lowered threat, the need for engaging in a threat-related process of change becomes more obsolete. For example, the process of consciousness raising may be promoted by perceived threat, because threatening knowledge or information increases the need for reassessing one's smoking behaviour. Adhering to strong disengagement beliefs lowers the perceived threat, and may thereby decrease the need for reassessment of one's smoking. Adhering to more disengagement beliefs is assumed to prevent engagement in the different processes of change. Another example of a cognitive-affective process is dramatic relief; the process of dramatic relief is in itself a parameter of threat. When the threat is removed by disengagement beliefs, a confrontation with the adverse effects of smoking will lead to less dramatic relief. The behavioural processes of reinforcement management, counterconditioning, stimulus control and helping relationship are different from the cognitive-affective processes, for they are most frequently used during the action and maintenance stages of change and therefore mostly regarded as aids not to smoke. The use of these processes in smokers is directed by acute threat. Acute threat causes fear and therefore a motivation to stop or reduce smoking. Strong disengagement beliefs decrease the threat and by this the necessity of the use of processes that help to stop or to reduce smoking.

The first goal of the present longitudinal study is to examine if disengagement beliefs are related to less forward stage transition through the stages of change and, in addition, to assess whether disengagement beliefs are related to actual quitting. Engaging in disengagement beliefs is expected to be associated with less forward stage transition and less actual quitting (hypothesis 1).

The second goal is to assess whether there is a negative relation between the degree of disengagement beliefs one has about smoking and the activities and experiences one is engaged in when attempting to quit smoking i.e., the processes of change (hypothesis 2).

The final goal of the present study is to assess if the processes of change are positively related to forward stage transition and actual quitting and, if that is the case, to assess if the processes of change mediate the relation between disengagement beliefs and forward stage transition, and the relation between disengagement beliefs and actual quitting (hypothesis 3).

Table 1 Sample items for the Processes of Change

Processes	Description	Sample item
Environmental evaluation	Considering how smoking affects one's environment	I notice that more people disapprove of smoking
Self-evaluation	Considering feelings and thoughts about the self in relation to one's smoking	I feel disappointed in myself because of my need to smoke
Consciousness raising	Increasing knowledge and information about one's smoking	I remember information about quitting smoking
Dramatic relief	Experiencing and expressing feelings about one's smoking	Information about the consequences of smoking frightens me
Reinforcement management	Rewarding oneself or being rewarded by others for changing smoking behaviour	I reward myself if I don't smoke
Counterconditioning	Replacing smoking with alternatives	I replace smoking by something else
Stimulus control	Avoidance or dealing with stimuli that bring out smoking	I avoid places where people smoke
Helping relationship	Trust others and being open about one's smoking	I ask people who are near to me to help me not to smoke

Method

Recruitment

Smokers were recruited by means of advertisements in local newspapers throughout the Netherlands. Smokers who were not planning to quit, smokers who were planning to quit, and ex-smokers were asked to participate on a voluntary basis in a research project on smoking and smoking cessation. The group of ex-smokers was not included in this study. A chance to win one of ten bonus prizes of \$100 was offered to participants who would complete the two questionnaires. After participants had registered at the University by means of a phone call (N=800), the T1 questionnaire (including a pre-paid envelope to return the questionnaire) was sent to them. At T1, 423 smokers responded. A total of 19 participants were excluded because they were cigar or pipe smokers, as well as one person who was under aged (15 years old). Furthermore, after casewise listing of residuals in logistic regression analyses on model variables, seven outliers were omitted from the

analyses, leaving a total of 396 respondents at T1. Subsequently, eight months later the second questionnaire (T2) was sent, and was returned by 367 participants (93% of the 396 T1 respondents).

Measures

The demographic variables measured were gender, age and education level. Educational level was categorized as low, medium or high. Schooling systems in the Netherlands refer to vocational training as low, advanced vocational training as medium, and college/university training as high.

Smoking and quitting behaviour was assessed in terms of the number of years smoked, the number of cigarettes smoked per day, the number of quit attempts and the duration of the longest quit attempt. Actual quitting was measured by the question: "Have you quit smoking or are you currently engaged in a quit attempt?" (Yes/No).

Biochemical verification of the self-report quitting behaviour was not conducted for several reasons. First, an increase in non-response and dropout was expected had biochemical verification been required and, secondly, the present study was considered to be one of low demand. Hence, several studies indicated that self-reported smoking behaviour can be considered valid (Velicer, Prochaska, Rossi, & Snow, 1992).

Disengagement beliefs. Disengagement beliefs were assessed using a scale consisting of twelve items. This scale has been tested and validated in earlier studies (Dijkstra et al., 1999; Dijkstra & Brosschot, 2003). The items consisted of reasons or excuses why it would be okay to smoke, regardless of the well-known harmful health effects. Examples of items are: "I know heavy smokers who live long" and "I have to die of something". The items could be scored on a 5-point scale ranging from I do not agree (1) to I do agree (5) and were constructed such that the respondent had to finish the sentence: "Smoking can make me ill, but...". Cronbach's alpha was .84. Table 2 shows the results of the Factor Analysis (PCA) and the mean and standard deviation (SD) of the 12 items of the disengagement beliefs scale.

Stages of change. The stages of change were measured by asking respondents to indicate if and when they planned to stop smoking on a nine-point ordinal scale ranging from 1 ("I am planning to quit within the next 10 days") to several levels ("Planning to quit within one month", "planning to quit within six months", "planning to quit within one year", "planning to quit within five years", "planning to quit within ten years", "planning to quit somewhere in the future but not within the next 10 years", "planning to never quit but planning to cut down") to 9 ("planning to never quit and not planning to cut down"). Preparers were those respondents who agreed on planning to quit within the next ten days or the next month, whereas those who agreed on planning to quit within the next 6 months were designated as Contemplators. Precontemplators were those respondents who were planning to quit within the next year or the next five years but not in the next six months, those who agreed to quit somewhere in the future but not within 5 years,

or those who had plans never to quit at all (Dijkstra, Bakker, & De Vries, 1997; Dijkstra, Roijackers, & De Vries, 1998; Dijkstra, Tromp, & Conijn, 2003).

Table 2 Pattern Matrix, Means and Standard Deviations for Disengagement Beliefs

Smoking can make me ill, but...	Factor loading	Mean	SD
Pollution is just as unhealthy	.72	3.47	1.43
There are lots of risks in life	.68	3.70	1.30
Everything is unhealthy	.67	3.08	1.40
You have to die of something	.66	2.47	1.44
Everyone acts unhealthy sometimes	.64	3.76	1.22
Not everyone gets sick smoking	.63	4.13	1.04
Know heavy smokers that lived long	.62	3.77	1.26
Medical science will invent something	.60	2.46	1.22
Rather a short/good life than a long/boring life	.55	3.13	1.45
If it were really bad, it would be forbidden	.52	2.38	1.43
I live healthy otherwise	.47	3.58	1.18
Health is not the only thing in life	.42	2.50	1.44
% Variance	36.40		

Note. Factor Analysis by Principal Component Analysis

Processes of change

The processes of change were assessed by four cognitive-affective and four behavioural processes of the processes of change. The cognitive-affective processes used are: Environmental Evaluation (6 items), Self-Evaluation (3 items), Consciousness Raising (6 items), and Dramatic Relief (3 items). The behavioural processes of change are: Reinforcement Management (5 items), Counterconditioning (5 items), Stimulus Control (7 items), and Helping Relationship (5 items). The items could be scored on a 5-point scale ranging from (0) never to (4) often and followed the question: "How often did the following occur in the last four weeks?". Examples of the items used to measure the processes of change are shown in Table 1. The reliabilities of the scales were found to be good to excellent (Cronbach's alpha ranges from .74 to .93).

Attrition Analysis

Of the 396 respondents at T1, 7% did not fill out the questionnaire at T2, leaving 367 participants in the prospective study cohort. Dropouts were compared with remaining

respondents on the variables gender, age, education, disengagement beliefs, stages of change, processes of change and number of cigarettes a day using logistic regression. Dropout was significantly predicted by stage of change; odds ratio (OR) 1.75, $p < 0.05$, 95% confidence interval (CI) 1.09-2.82. Further analyses using Chi-square values showed that participants in the preparation and precontemplation stage dropped out more frequently, than participants in the contemplation stage. In addition, higher scores on self-evaluation, consciousness raising and stimulus control significantly predicted dropout (OR = 1.43, 95% CI = 1.07-1.91, $p < 0.05$ for self-evaluation; OR = 1.49, 95% CI = 1.08-2.07, $p < 0.05$ for consciousness raising, and OR 1.95, 95% CI = 1.10-3.47, $p < 0.05$ for stimulus control). Respondents who scored higher on evaluating feelings and thoughts about their own smoking, who more actively increase their knowledge and information about smoking, and who reported more avoidance of or dealing with stimuli that bring out smoking, were more likely to drop out.

Sample Characteristics

Of the 367 respondents included in T1 and T2, 71.1% was female; 21.8% had a low education, 45.7% had a medium education, and 31.9% of the respondents had a high education. The mean age was 43.78 years (SD = 13.5, range 16-80). On average respondents smoked 19 cigarettes a day (SD = 9.7, range 1 - 60). At T2, 103 respondents reported at least one attempt to quit smoking and 34 respondents reported to have actually quit smoking. At T1, there were 290 respondents classified as precontemplators, 43 as contemplators, and 34 as preparers. At T2, 280 respondents were classified as precontemplators, 32 as contemplators, and 20 as preparers. A total of 34 respondents had moved into the action stage at T2 and 1 respondent moved to the maintenance stage. Seventy-one respondents reported forward stage transition and 43 respondents reported backward stage transition.

Statistical Analyses

To explore if disengagement beliefs differed between stages of change, ANOVAs were conducted. To examine whether disengagement beliefs are associated with forward stage transition, logistic regression analyses were conducted to estimate ORs with 95% CIs for forward stage transition. Stage transitions are considered forward if a respondent moves from one stage at T1 to a latter stage at T2. Analyses were carried out for precontemplators, contemplators and preparers taken together as one group, and in addition, separate analyses were done for the group of precontemplators only. The reason to analyze the group of precontemplators as a separate group is partly based on previous research that found that smokers who hold self-exempting beliefs are more likely to be in the precontemplation stage of change (Oakes et al., 2004). Disengagement beliefs can be considered a fundamental process that may prevent the smoker from seriously thinking about or considering the consequences of his or her behaviour; therefore, the group of precontemplators is particularly likely to engage in disengagement beliefs. The distinction between precontemplators, contemplators and preparers as one group and the precontemplators as a separate group, was also made when conducting the logistic regression analyses to assess whether disengagement beliefs significantly predict actual quitting at T2.

For examination of the relation between disengagement beliefs and the processes of change, Pearson correlations were computed. To assess whether the relationship between disengagement beliefs and respectively forward stage transition and actual quitting is mediated by processes of change, mediation analyses were conducted according to the method described by Baron and Kenny (1986). First, forward stage transition (dependent variable) was regressed on disengagement beliefs (independent variable). Second, the mediator was regressed on disengagement beliefs (the mediator being one of the processes of change). Finally, forward stage transition was regressed on both disengagement beliefs and the mediator variables. Mediation was considered to exist if the conditions proposed by Baron and Kenny (1986) were met. Disengagement beliefs should therefore be associated with both forward stage transition and the mediator, the mediator should be associated with forward stage transition, and disengagement beliefs may no longer be associated with forward stage transition after the mediator has been controlled for. Partial mediation was indicated when the association of disengagement beliefs with forward stage transition decreased, but had not fully disappeared after adding the mediator. To test whether the explained variance significantly increased after adding the mediator, and to establish whether the decrease of the effect of disengagement beliefs was large enough to indicate (partial) mediation, model chi-square values of the model including disengagement beliefs were deducted from the model chi-square values of the model including both disengagement beliefs and the mediator. If the remaining value was higher than 3.84 ($p = 0.05$), the increase of explained variance was considered significant (& Van den Bercken, 2003). Mediation analyses were carried out for precontemplators, contemplators and preparers at T1 taken together, and separately for the group of precontemplators at T1. The same procedure was employed to assess mediation of the processes of change in the relationship between disengagement beliefs and actual quitting. In the prospective analyses, gender, age and education were entered as covariates. The relation between the number of cigarettes per day and respectively forward stage transition and actual quitting appeared to be non significant; therefore, the number of cigarettes smoked per day was not entered as a covariate in the prospective analyses.

Results

Stages of Change and Smoking Related Cognitions and Characteristics

Smokers in the three stages of behavioural change differ in the extent to which they adhere to disengagement beliefs (see Table 3). Scheffe's post-hoc analyses showed that precontemplators adhere significantly stronger to disengagement beliefs than contemplators.

Smokers in the three stages of behavioural change also differ in the extent to which they engage in the eight processes of change included in this study (Table 3). For self-evaluation, consciousness raising, reinforcement management, stimulus control and helping relationship, post-hoc tests showed less engagement in precontemplators than in contemplators, and also less in precontemplators than in preparers. For environmental evaluation, dramatic relief and counterconditioning, differences were shown between

precontemplators and preparers, i.e., precontemplators showed less engagement in the processes than did preparers. Furthermore, the difference between the stages of change with regard to the number of cigarettes smoked per day appeared to be significant; this indicates that precontemplators smoked more cigarettes in one day than preparers. With respect to quit attempts, precontemplators reported fewer attempts to quit than contemplators and preparers did. Smokers in the three stages of behavioural change did not differ in the number of years smoked and duration of the longest quit attempt.

Table 3 Stages of Change and Smoking Related Cognitions and Characteristics: Cross sectional analyses

	Means in stages of change (SD)				F
	Precontemplators	Contemplators	Preparers		
Disengagement Beliefs	3.31 ^a (0.77)	2.66 ^b (0.78)	3.10 (0.72)		14.56***
Environmental Evaluation	1.84 ^a (0.86)	2.05 (0.92)	2.38 ^b (0.86)		6.55*
Self Evaluation	1.17 ^a (1.09)	2.54 ^b (1.20)	2.56 ^b (1.05)		47.49***
Consciousness Raising	1.39 ^a (0.95)	2.91 ^b (0.86)	3.00 ^b (0.89)		84.91***
Dramatic Relief	1.11 ^a (0.86)	1.45 (0.74)	1.90 ^b (1.01)		13.13***
Reinforcement Management	0.40 ^a (0.46)	0.74 ^b (0.73)	0.80 ^b (0.86)		14.00***
Counter Conditioning	0.72 ^a (0.64)	0.96 (0.81)	1.13 ^b (0.99)		6.38*
Stimulus Control	0.25 ^a (0.42)	0.55 ^b (0.61)	0.75 ^b (0.68)		22.08***
Helping relationship	0.40 ^a (0.49)	1.05 ^b (0.77)	0.78 ^b (0.65)		30.94***
Cigarettes per day	19.66 ^a (9.80)	18.23 (8.83)	15.48 ^b (9.15)		2.94*
Years smoked	26.0 (12.8)	25.4 (12.1)	24.3 (14.5)		0.25
Quit attempts	2.06 ^a (2.25)	4.05 ^b (4.04)	4.00 ^b (3.42)		16.32***
Longest quit attempt in days	241.6 (754.6)	304.5 (549.6)	561.7 (1253.05)		2.30

Note. Means in the same row that do not share superscript differ at $p < .05$ using Scheffe's post-hoc tests
* $p < .05$. ** $p < .01$. *** $p < .001$

Prediction of Forward Stage Transition and Actual Quitting

For the total group of smokers, findings from a logistic regression analysis showed that smokers who strongly adhered to disengagement beliefs at T1 showed significantly less

forward stage transition (see Table 4). Strong disengagement beliefs at T1 were also associated with a lower probability of actual quitting at T2.

Correlations between Disengagement Beliefs and Processes of Change

In the total sample, disengagement beliefs were significantly correlated to six of the eight processes of change. Only environmental evaluation and counterconditioning did not significantly correlate with disengagement beliefs (see Table 5). The more smokers adhered to disengagement beliefs, the less likely they were to engage in self-evaluation, consciousness raising, dramatic relief, reinforcement management and stimulus control and the fewer helping relationships they perceived.

Processes of Change as Mediators

Forward stage transition

For the total sample of smokers at T1, disengagement beliefs were significantly associated with forward stage transition (see Table 4; Nagelkerke $R^2 = 0.07$). The conditions for complete mediation were only met for consciousness raising (Table 4). Adding consciousness raising to the model significantly increased the explained variance (Nagelkerke $R^2 = 0.13$; $\chi^2(1, N = 360) = 11.98, p < 0.01$)¹ and the relation between disengagement beliefs and forward stage transition was no longer significant ($p = 0.08$). Self-evaluation, stimulus control and helping relationship partially mediate the relation between disengagement beliefs and forward stage transition. Adding self-evaluation to the model resulted in a significant increase (Nagelkerke $R^2 = 0.08$; $\chi^2(1, N = 361) = 5.28, p < 0.05$). Disengagement beliefs, however, remained significantly associated with forward stage transition (Table 4). Similar results were found for stimulus control and helping relationship, i.e., Nagelkerke $R^2 = 0.10$ ($\chi^2(1, N = 355) = 5.93, p < 0.05$) and Nagelkerke $R^2 = 0.12$ ($\chi^2(1, N = 356) = 9.65, p < 0.05$), respectively. The processes of dramatic relief and reinforcement management were not found to be mediating factors in the association between disengagement beliefs and forward stage transition.

Table 4 Prediction of Forward Stage Transition and Quitting by Disengagement Beliefs and the Processes of Change

Variable	Forward Stage Transition		Actual Quitting			
	All stages	Precontemplators	All stages			
	OR	95% CI	OR	95% CI	OR	95% CI
Step 1 Disengagement beliefs	0.53***	0.36-0.76	0.47**	0.29-0.75	0.62*	0.40-0.98
Step 2 Disengagement beliefs	0.69	0.45-1.04	0.58*	0.35-0.95	0.79	0.47-1.31
Consciousness Raising	1.61***	1.23-2.12	1.72**	1.19-2.49	1.47*	1.04-2.07
Disengagement beliefs	0.63*	0.42-0.96	0.55*	0.33-0.90	0.74	0.45-1.23
Self-Evaluation	1.34*	1.04-1.71	1.44*	1.06-1.97	1.29	0.94-1.76
Disengagement beliefs	0.53***	0.36-0.78	0.50**	0.31-0.80		
Dramatic Relief	1.03	0.76-1.39	1.28	0.88-1.87		
Disengagement beliefs	0.55**	0.38-0.81	0.50**	0.31-0.81		
Reinforcement Management	1.42	0.90-2.24	1.90	0.95-3.80		
Disengagement beliefs	0.56**	0.38-0.82			0.68	0.42-1.09
Stimulus Control	1.92**	1.18-3.15			2.02**	1.12-3.62
Disengagement beliefs	0.57**	0.39-0.84			0.68	0.43-1.09
Helping relationship	2.06***	1.33-3.19			1.74*	1.02-2.99

Notes. OR = odds ratio; CI = confidence interval

* $p < .05$. ** $p < .01$. *** $p < .001$

Table 5 Intercorrelations Between Processes of Change and Disengagement Beliefs at T1

	1	2	3	4	5	6	7	8	9
1. Disengagement Beliefs	–	-.02	-.35***	-.39***	-.24***	-.13*	-.08	-.13*	-.15**
2. Environmental Evaluation	.06	–	.48***	.44***	.57***	.31***	.17**	.19***	.24***
3. Self-Evaluation	-.24***	.45***	–	.83***	.63***	.39***	.25***	.36***	.38***
4. Consciousness Raising	-.32***	.41***	.78***	–	.64***	.44***	.28***	.38***	.43***
5. Dramatic Relief	-.19**	.52***	.65***	.65***	–	.41***	.21***	.29***	.27***
6. Reinforcement Management	-.12*	.25***	.36***	.42***	.40***	–	.54***	.50***	.59***
7. Counterconditioning	-.04	.11	.24***	.24***	.20***	.50***	–	.60***	.32***
8. Stimulus Control	-.10	.10	.32***	.32***	.29***	.45***	.54***	–	.35***
9. Helping Relationship	-.05	.21***	.28***	.28***	.21***	.50***	.26***	.28***	–

Note. Correlations above diagonal represent the total sample; correlations below diagonal represent the group of precontemplators exclusively

* $p < .05$. ** $p < .01$. *** $p < .001$.

Quitting

The relation between disengagement beliefs and quitting was found to be significant (Table 4; Nagelkerke $R^2 = 0.04$). Mediation analyses showed three processes of change that completely mediated the relation between disengagement beliefs and quitting (see Table 4). Adding consciousness to the regression equation resulted in a non-significant association between disengagement beliefs ($p = 0.36$) and quitting and a significant increase in the explained variance to Nagelkerke $R^2 = 0.07$ ($\chi^2(1, N = 362) = 5.95, p < 0.05$). Similar results were found for stimulus control and helping relationship, i.e., Nagelkerke $R^2 = 0.07$ ($\chi^2(1, N = 357) = 5.97, p < 0.05$) and Nagelkerke $R^2 = 0.06$ ($\chi^2(1, N = 358) = 4.82, p < 0.05$) respectively, and the association between disengagement beliefs and quitting disappeared ($p = 0.11$ and $p = 0.11$). In the relation between disengagement beliefs and quitting no mediation effect was found for self-evaluation.

Precontemplators only

In precontemplators exclusively, adhering strongly to disengagement beliefs was related to less consciousness raising, self-evaluation, dramatic relief and reinforcement management (see Table 4). Disengagement beliefs were also associated with forward stage transition (see Table 4; Nagelkerke $R^2 = 0.11$). Having stronger disengagement beliefs at T1 was related to a lower likelihood of forward stage transition. In precontemplators,

stronger disengagement beliefs were not significantly associated with actual quitting (OR = 0.65, CI = 0.34-1.25, $p = 0.20$).

In precontemplators, mediation analyses showed two processes of change that partially mediated the relationship between disengagement beliefs and forward stage transition (see Table 4). Adding consciousness raising and self-evaluation to the model resulted in a significant increase in the explained variance, with respectively Nagelkerke $R^2 = 0.16$ ($\chi^2(1, N = 284) = 8.17, p < 0.05$) and Nagelkerke $R^2 = 0.14$ ($\chi^2(1, N = 284) = 5.06, p < 0.05$). However, disengagement beliefs remained a significant predictor of forward stage transition (see Table 4). In precontemplators, dramatic relief, reinforcement management, stimulus control and helping relationship did not have a mediating role in the relation between disengagement beliefs and forward stage transition.

Discussion

Our findings indicate that having stronger disengagement beliefs seems to be an inhibitor of the readiness to quit smoking. We found that disengagement beliefs are associated with forward stage transition and stronger disengagement beliefs are indicative of less actual quitting over the following eight months. These results correspond with findings from previous studies showing negative relations between both disengagement beliefs and readiness to quit (Olshavsky & Summers, 1974; Dijkstra et al., 1999; Dijkstra et al., 2003; Dijkstra, 2003; Oakes et al., 2004) and quit attempts (Dijkstra et al., 1999; Dijkstra et al., 2003; Dijkstra, 2003).

In addition, stronger disengagement beliefs in the total sample were associated with less engagement in processes that facilitate quitting smoking i.e., self-evaluation, consciousness raising, dramatic relief, reinforcement management, stimulus control and helping relationship. There was, however, no significant association between disengagement beliefs and two processes, namely environmental evaluation and counterconditioning. An explanation for the absence of an association between disengagement beliefs and environmental evaluation may be that disengagement beliefs are mostly related to one's own health ("it's not all that bad"). It is therefore possible that disengagement beliefs are not related to the evaluation of the effect of one's smoking on the environment. In case of counterconditioning, it was suggested earlier that increased use of counterconditioning is a direct result of quitting, and that once a smoker quits he or she is forced to replace smoking with something else (Segan, Borland, & Greenwood, 2002). Because of the proposed direct relation between counterconditioning and quitting, once a smoker makes use of counterconditioning, he or she is probably already considerably determined to quit and therefore no longer susceptible to disengagement beliefs.

Some evidence was found for a mediating role of the processes of change in the association of disengagement beliefs with forward stage transition and actual quitting.

This mediating role was, however, not very substantial. After controlling for almost all processes of change, an assumed distal construct like disengagement beliefs remains directly associated with forward stage transition. Consciousness raising was the only process that fully mediated this relation. Additional analyses suggested that all processes of change together explained about 16% of the variance in forward stage transition (Nagelkerke R^2), while disengagement beliefs alone account for 7% of the variance. Previous research by Herzog, Abrams, Emmons, Linnan, and Shadel (1999) on the utility of the processes of change in predicting movement through the stages of change, reported that the processes of change were not predictive of progressive movement through the stages of change. In our study, however, we found that specific processes of change were related to forward stage transition. Furthermore, Segan, Borland, and Greenwood (2002, 2004) found no relationship between use of the behavioural processes of change and making and sustaining a quit attempt. In the present study the relation between disengagement beliefs and actual quitting was mediated by three processes of change. Having disengagement beliefs seems to prevent consciousness raising, stimulus control and helping relationship processes, and less engagement in these processes in turn prevents actual quitting. It must be noted however, that we tested the predictive ability of the processes of change across the whole spectrum of the stages of change, whereas the studies by Segan et al. involved only smokers in the preparation phase (Segan et al., 2002), and smokers in the contemplation phase and preparation phase (Segan et al., 2004).

In our study, results for precontemplators only, showed some differences compared to the results for the total sample consisting of precontemplators, contemplators as well as preparers. First, there was no significant relationship between adhering to disengagement beliefs and actual quitting and, secondly, consciousness raising was only a partial mediator and there was no partial mediation of stimulus control and helping relationship. These differences might be explained by the lack of readiness or motivation to change that is characteristic for smokers in the precontemplation stage. It will be less likely that precontemplators will quit eight months later than smokers in the contemplation and preparation stage, who have already started to consider behavioural change or have already taken steps in the direction of quitting. The absence of stimulus control and helping relationship as partial mediators might be explained by the more frequent usage of these behavioural processes in the later stages of change. In this group it is less likely that these processes play a large role in the precontemplation stage or that they have a mediating function in the relation between disengagement beliefs and forward stage transitions. In addition, our data may have limited statistical power to detect a significant relation between disengagement beliefs and actual quitting or a mediating role of the processes of change in precontemplators.

The findings of the present longitudinal study indicate that smokers tend to adhere to disengagement beliefs and that strong adherence to disengagement beliefs inhibits them from making progression towards cessation and actual quitting. In order to motivate smokers to quit, it seems important to challenge their disengagement beliefs. In the study by Oakes et al. (2004) on self-exempting beliefs it was reported that it is essential to

make the relative risks of smoking more salient to smokers; interventions should aim at improving knowledge by making the facts more credible, or by using genuinely new facts in order to challenge the beliefs and change the balance of worth away from smoking. Challenging the disengagement beliefs of smokers by increasing their awareness is, however, a difficult task. In agreement with the cognitive dissonance theory (Festinger, 1957), there is a chance that the improved knowledge and introduction of new and/or more credible facts will give rise to perceived threat and thereby to an even stronger adherence to disengagement beliefs. It is therefore important to find a way of challenging disengagement beliefs without increasing the perceived threat in such a way that it results in a higher need for disengagement beliefs. A way to achieve this may be to use arguments that directly challenge disengagement beliefs and that undermine them, i.e., debunk the myth. For instance, the argument of knowing smokers aged 80 years that are in good health could be challenged by the counterargument that, for example, for every smoker aged 80 years, two aged 60 years have already died.

Taking the results of the present study into account, it seems worthwhile to combine the challenging of disengagement beliefs with an attempt to increase engagement in those processes of change that have shown to be of importance in the progression towards cessation and actual quitting. It has already been suggested that an effective way to convince people to accept recommendations is to combine the offer of threatening information with efficacy messages which offer responses that appear easy to accomplish (Witte & Allen, 2000). Defensive reactions to threatening information or fear appeals can be prevented by offering behaviour recommendations and alternatives (Das, De Wit, & Stroebe, 2003). Encouraging smokers to engage in consciousness raising, stimulus control and helping relationship after challenging their disengagement beliefs by providing debiasing information, may therefore be an effective method to encourage smoking cessation. Future research addressing this research topic is, however, still needed.

The present study had some limitations. First, the method of recruitment may have led to a selective sample of smokers, related to the motivation to participate. In the recruitment procedure, however, care was taken to minimize a selection bias by mentioning explicitly that participants did not have to quit smoking or remain quitted to join the study. Furthermore, it was stated that their answers were not related to their chances of winning one of the prizes, that all data would be confidential and that they had the opportunity to withdraw from the study whenever they wanted to, without any further obligations. A second limitation is that the group of precontemplators was relatively large compared to the group of contemplators and preparers. This could be at the cost of the generalizability of the results to the smoking population at large. However, results from another Dutch study (Stivoro, 2005) showed that among Dutch smokers 70% was in the precontemplation stage, 18% in the contemplation stage, and 12% in the preparation stage; this representative Dutch sample shows a similar distribution to the sample used in the present study, and indicates that in the Netherlands the group of precontemplators is relatively large compared to the group of contemplators and preparers. In conclusion, the present longitudinal study showed a clear relationship between

disengagement beliefs and future plans to quit smoking, as well as actual cessation. We explored these relations further by taking into account possible mediators of these relationships, i.e., the processes of change. This study aimed to enhance the understanding of having disengagement beliefs in relation to smoking cessation, and its findings may be useful for the development of interventions to challenge the beliefs that are held by many smokers.

Footnotes

- 1 The χ^2 -value represents the model chi-square values of the model including disengagement beliefs deducted from the model chi-square vales of the model including both disengagement beliefs and the mediator.

7 Adolescents' excuses to continue smoking:
The role of disengagement beliefs and nicotine
dependence in smoking cessation

Based on
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Abstract

Adult smokers were found to reduce cognitive dissonance regarding their smoking behaviour by adhering to excuses or justifications to continue smoking, also known as disengagement beliefs. These beliefs were found to be an important barrier with regard to smoking cessation practices. Neither the occurrence of disengagement beliefs, nor its effect on motivation to quit and actual smoking cessation have been studied among adolescent smokers. Therefore, this prospective study among a sample of 363 adolescents examined the extent to which adolescents adhere to disengagement beliefs, and the relations between disengagement beliefs and adolescents' motivation to quit smoking, motivation change and smoking cessation. The association and interplay between disengagement beliefs and level of nicotine dependence was also assessed. Results showed that the degree to which adolescent smokers adhere to disengagement beliefs was similar to that of adults, if not stronger. Higher levels of dependence coincided with stronger adherence to disengagement beliefs. Further, when controlling for nicotine dependence, disengagement beliefs were strongly associated with motivation to quit, but only marginally significantly associated with smoking cessation one year later. Nicotine dependence was the strongest predictor of smoking cessation at follow-up.

Introduction

Despite increasing smoking prevention efforts and the well-known harmful health effects of smoking, a significant proportion of adolescents still initiate a smoking habit and, subsequently, continue to smoke. Once started smoking, adolescents are considered at risk of developing symptoms of dependence, even within short periods of time. Adolescents who are merely experimenting and smoke sporadically, are still at risk of developing nicotine dependence (DiFranza et al., 2000). The occurrence of dependence symptoms in adolescent smokers was found to be a precursor of daily smoking (DiFranza et al., 2002a). Therefore, it is not surprising that around 75% of adolescent daily smokers continue to smoke during adulthood (Johnston, Bachman & O'Malley, 1992). The high prevalence of smoking among adolescents, together with the risk of onset of dependence and the negative health consequences of smoking, underscore the need to develop and implement smoking cessation programs for adolescents.

With regard to smoking cessation, adolescent smokers form a particularly difficult group. For instance, compared to adult smokers, adolescents are generally less motivated to quit smoking and show relatively low rates of 'spontaneous' quit attempts (Mermelstein, 2003; Pallonen, 1998). The relatively low motivation to quit among adolescents may be present because they do not seem to consider quitting as urgent (Balch, 1998). Adolescents for quitting are often relatively vague and far in the future (Mermelstein, 2003). Thus, compared to adults, smokers seem to be less interested in quitting and more resistant and unwilling to change their smoking behaviour. Additionally, similar to adults, adolescents' motivation to quit has been linked to the occurrence of symptoms of nicotine dependence, i.e., higher levels of nicotine dependence are related to a lower motivation to quit smoking (Fagan et al., 2007; Kleinjan, Van den Eijnden, Van Leeuwe, Brug, Van de Ven, & Engels, 2008b; Prokhorov, Hudmon, De Moor, Kelder, Conroy, & Ordway, 2001).

For adult smokers, it has been proposed that those who are highly resistant to quit, and continue to smoke despite their knowledge of the hazardous effects of smoking, experience forms of cognitive dissonance reduction (Chapman, Wong, & Smith, 1993; McMaster & Lee, 1991). Cognitive dissonance is usually experienced when an individual has two or more cognitions that are dissonant in relation to one another resulting in motivational tension (Festinger, 1957; Wicklund & Brehm, 1976). In adult smokers dissonance reduction was found to appear in the form of excuses or justifications for continuing smoking. These excuses or justifications for continuing smoking are referred to as disengagement beliefs (also known as self-exempting beliefs or permission giving beliefs). For example, to lower cognitive dissonance, a smoker might adhere to beliefs such as "I know heavy smokers that lived long", thereby ignoring the fact that smoking and age of death are negatively related (Dijkstra, 2008; Solomon & Manson, 1997). Having these beliefs may make it easier for smokers to disengage from the idea that it would be better to quit their smoking habit (Oakes, Chapman, Borland, Balmford, & Trotter, 2004). In adult samples, disengagement beliefs were found to have a significant negative effect on several aspects of smoking cessation, such as the motivation to quit, motivation change, the likelihood of undertaking a quit attempt and actual smoking cessation (Bandura, 1986;

Bandura, Barbaranelli, Caprara, & Pastorelli, 1996; Dijkstra, De Vries, Kok, & Roijackers, 1999; Dijkstra & Brosschot, 2003; Johnson, 1968; Kleinjan, Van den Eijnden, Dijkstra, Brug, & Engels, 2006; Oakes et al., 2004; Olshavsky & Summers, 1974).

Even though endorsement of disengagement beliefs seems to be an important predictor of a lack of motivation to quit and unsuccessful quitting attempts in adult smokers, it has not been studied to what extent adolescents adhere to disengagement beliefs and whether having disengagement beliefs is important in explaining adolescents' motivation to quit and actual smoking cessation. Since adolescents generally do not consider smoking cessation as urgent and continue to smoke even when aware of the negative consequences (Tewolde, Ferguson, & Benson, 2006), it is likely that disengagement beliefs indeed play a role. The first goal of the present study is, therefore, to establish whether adolescents adhere to disengagement beliefs and, if so, to what extent they engage in these beliefs in comparison to adults.

Levels of nicotine dependence are negatively associated with motivation to quit smoking in adolescents (Fagan et al., 2007; et al., 2008b; Prokhorov et al., 2001), and to actual cessation (Kleinjan, Brug, Van den Eijnden, Vermulst, Van Zundert, & Engels, 2008a; Horn, Fernandes, Dino, Massey, & Kalsekar, 2003). Thus, smoking continuation among adolescents can, at least in part, be explained by the magnitude of nicotine dependence. In addition, studies among adults found that heavier and more dependent smokers displayed more cognitive dissonance in the form of minimizing, denying, or avoiding information about the dangers of smoking (Halpern, 1994). Since adolescents are reported to be well informed about the relation between smoking and health problems (Tewolde et al., 2006), it seems plausible that, besides experiencing physical and psychological dependence symptoms, adolescent smokers experience a fairly constant threat, knowing that smoking makes them susceptible to possible health damage and other negative consequences. Subsequently, the threat of negative health consequences may be perceived as less worrisome when disengagement beliefs are used to deny or distort this knowledge. Therefore, it is expected that among adolescents, disengagement beliefs are associated with nicotine dependence levels and that, besides levels of nicotine dependence, disengagement beliefs play an important role in the continuation of smoking behaviour. To test these hypotheses, the second goal of our study is two-fold. First, to assess whether the adherence to disengagement beliefs is associated with nicotine dependence, motivation to quit, as well as with forward stage transitions and smoking cessation one year later. In line with adult studies, it is expected that higher levels of dependence will be associated with a greater adherence to disengagement beliefs (Dawley, Fleischer, & Dawley, 1985; Halpern, 1994), and that both nicotine dependence and disengagement beliefs are negatively related to the outcome variables (e.g., Dijkstra & Brosschot, 2003; Fagan et al., 2007; Horn et al., 2003; Kleinjan et al., 2006; Kleinjan et al., 2008a). Second, the interplay between nicotine dependence and disengagement beliefs in explaining motivation to quit, forward stage transitions and smoking cessation will be explored. Based on the assumption that both nicotine dependence and disengagement beliefs will be negatively related to the outcome variables, it is hypothesized that the

combination of being highly dependent and adhering strongly to disengagement beliefs will be more negatively related to the smoking cessation cognitions and practices as compared to being either highly dependent or adhering strongly to disengagement beliefs.

Method

Procedure and Sample

The present study uses data from the fourth and fifth wave of a larger longitudinal study that started in January 2003, focusing on psychological and environmental processes in relation to tobacco use among Dutch adolescents. Schools in four regions of the Netherlands were randomly selected and approached to take part. The main reason given for refusal to join this study was participation in other studies. The Medical Ethical committee (CMO Arnhem-Nijmegen) approved this study.

A total of 17 secondary schools participated in the fourth and fifth wave of the study. At the schools, respondents completed questionnaires in the presence of their teacher during school hours in grades ten and eleven. Respondent-specific codes were used to link the data from one time point to the next. To assure confidentiality, respondents received an unmarked envelope in which they had to return the completed questionnaires. At T1, data were collected for 3,508 respondents aged 15-18 years ($M = 15.9$, $SD = 0.79$). In November 2006 (T2), 2,504 respondents participated again (response rate 71.4%). Sickness, truancy, leaving school, and repeating class were noted by teachers as the primary causes for non-response at T2. Comparing the respondents lost at follow-up with the remaining respondents on the variables gender, age, education level, and smoking status showed that respondents lost at follow-up were more likely to be boys [$\chi^2(1, N = 3,504) = 5.40$; $p < 0.05$], older [$t(3,486) = -4.85$; $p < 0.001$], to have preparatory vocational training, junior general secondary training, [$\chi^2(3, N = 3,478) = 413.11$; $p < 0.001$], and to be smokers [$\chi^2(1, N = 3,506) = 48.70$; $p < 0.001$].

The questionnaire consisted of two sections: one for respondents who indicated that they had smoked at least once in the past month, and one for respondents who had not smoked during the past month. A total of 363 of the 2,504 respondents (14.5%) indicated at T1 that they had smoked at least once in the past month. Of the 363 respondents included at T1 and T2, 57% was female. Respondents were between 15 and 18 years old ($M = 15.9$, $SD = 0.78$). At T1 a total of 16.9% received preparatory vocational training, 10.6% junior general secondary training, 44.9% senior general secondary education, 26.5% received university preparatory training, and 1.4% reported to receive some other form of education.

Measures

Disengagement beliefs. Disengagement beliefs were assessed using a scale consisting of 12 items. This scale has been tested and validated in earlier studies (Dijkstra et al., 1999; Dijkstra & Brosschot, 2003). The items consisted of reasons or excuses why it would be okay to smoke, regardless of the well-known harmful health effects. Examples of items are: “I know heavy smokers who lived long” and “I have to die of something”. The items could be scored on a 5-point scale ranging from I do not agree (1) to I do agree (5) and were constructed such that the respondent had to finish the sentence: “Smoking can make me ill, but...”. Cronbach’s alpha was 0.88. Table 1 shows the means and standard deviations (SD) of the 12 items of the disengagement beliefs scale as measured among 363 adolescent smokers in the present study and, additionally, the means and SDs of these items as previously assessed among a sample of 367 adult smokers (see Kleinjan et al., 2006).

Table 1 Means and Standard Deviations (SD) for Disengagement Beliefs among Adolescent Smokers Compared to Adult Smokers

Smoking can make me ill, but...	Adolescents	Adults
	Mean (SD)	Mean (SD)
Pollution is just as unhealthy	3.27 (1.20)	3.47 (1.43)
There are lots of risks in life	3.92 (1.07)	3.70 (1.30)
Everything is unhealthy	3.44 (1.14)	3.08 (1.40)
You have to die of something	2.86 (1.38)	2.47 (1.44)
Everyone acts unhealthy sometimes	3.85 (1.04)	3.76 (1.22)
Not everyone gets sick smoking	3.97 (1.01)	4.13 (1.04)
Know heavy smokers that lived long	3.72 (1.22)	3.77 (1.26)
Medical science will invent something	2.69 (1.16)	2.46 (1.22)
Rather a short/good life than a long/boring life	3.42 (1.34)	3.13 (1.45)
If it were really bad, it would be forbidden	3.15 (1.24)	2.38 (1.43)
I live healthy otherwise	3.74 (1.05)	3.58 (1.18)
Health is not the only thing in life	3.03 (1.19)	2.50 (1.44)
Total score	41.06 (8.98)	38.54 (9.51)

Note: Results for adult smokers were previously published (Kleinjan et al., 2006)

Nicotine Dependence. Self-reported nicotine dependence was measured by a newly developed multidimensional scale based on both the modified Fagerström Tolerance Questionnaire (mFTQ; Prokhorov, Pallonen, Fava, Ding, & Niaura, 1996) and the Hooked on Nicotine Checklist (HONC; DiFranza et al., 2002a). This 11-item scale was validated in a study by Kleinjan, Van den Eijnden, Van Leeuwe, Brug, Van de Ven, & Engels (2007). Cronbach’s alpha of the total 11-item scale was 0.89.

Readiness to quit. Readiness to quit was assessed using a 9-point ordinal scale ranging from (1) “I am planning to quit within the next 10 days”, to (9) “planning to never quit and not planning to cut down” (Dijkstra, Tromp, & Conijn, 2003). Respondents were categorized into different stages of change consistent with the approach as described by Prochaska, DiClemente, & Norcross (1992a), i.e., precontemplation (not planning to quit within six months), contemplation (planning to quit within six months) and preparation (planning to quit within one month). In addition, based on a study by Dijkstra, Bakker, & De Vries (1997), another stage was distinguished, namely that of the immotives. Respondents who agreed to quit somewhere in the future but not within five years, and those who had no plans to quit at all were labelled as immotives. Respondents indicating to have quit at T2 were categorized into the action stage.

Forward stage transition. Respondents who moved forward from either the immotive, precontemplation or contemplation stage at T1 to an advanced stage other than the action stage at T2 were considered to have made a forward stage transition, thus to have increased their motivation to quit.

Smoking cessation. Respondents moving from the immotive, precontemplation, contemplation, or preparation stage at T1 into the action stage at T2 were considered to have undergone a change in action. Respondents were considered to be in the action stage when they indicated they were no longer smoking and had not done so during the past month (see also Kleinjan et al., 2008a). This distinction is based on studies on adolescent smoking cessation in which participants were considered to have quit smoking if they were current smokers at baseline, but had not smoked for 30 days at the time of the follow-up measurement (US Department of Health and Human Services, 1994; Zhu, Sun, Billings, Choi, & Malarcher, 1999).

Statistical Analyses. To compare the adherence to disengagement beliefs of adolescent smokers with that of adults, we compared the data derived from our current 363 adolescent smokers with earlier data derived from 367 adult smokers (Kleinjan et al., 2006). Both studies utilized the same disengagement beliefs measure. A t-test for independent samples was conducted to compare the scores on disengagement beliefs of both groups.

To explore whether disengagement beliefs differed between the different motivational stages, ANOVAs were conducted. To examine the relation between disengagement

beliefs, nicotine dependence and the outcome variables of motivation to quit, forward stage transition and smoking cessation, we first applied correlation analyses with the variables using the software package MPLUS 4.1 (Muthen & Muthen, 1998-2007a). MPLUS was used because of its ability to accommodate non-normality and ordinal variables without reliance on large samples (Kaplan, 2000). The outcome variable 'readiness to quit' is considered to be ordinal whereas the dependent variables 'motivational change' and 'smoking cessation' are binary variables (0 = no change, 1 = change). To establish the relative value of disengagement beliefs and nicotine dependence in relation to readiness to quit, regression analyses were performed in MPLUS. The relative value of disengagement beliefs and nicotine dependence in relation to forward stage transition and smoking cessation were assessed by applying logistic regression analyses, also within MPLUS. In all regression analyses, sex, age and education level were entered as covariates.

To assess any possible interaction effects, we computed a product term of nicotine dependence with disengagement beliefs. To avoid problems with multi-collinearity, the independent variables were centred before the interaction terms were computed. Logistic regression analyses in MPLUS were performed with the independent variables and the interaction terms in one run.

Before applying the analysis in MPLUS, the missing data in the raw data matrix (with missing data between 0.3% and 9.1%) were estimated with the Expectation-Maximization (EM) algorithm in SPSS.

Results

Smoking-Specific Demographics

On average respondents smoked 34 cigarettes per week ($SD = 36.5$, range 1-155). At T1, 54.3% of the respondents were classified as immotive, 21.8% as precontemplator, 6.6% as contemplator, and 17.4% as preparers. At T2, 33.9% of the respondents were classified as immotive, 24.2% as precontemplator, 7.2% as contemplator, and 7.2% as preparers. A total of 23.4% ($N=85$) had moved into the action stage at T2. Seventy-three respondents (20.1%) reported a forward stage transition, i.e. a motivational change (for more details, see Table 2).

Adherence to disengagement beliefs

As shown in Table 1, adolescent smokers' adherence to disengagement beliefs is comparable to that of adult smokers. It can be seen that the mean score on disengagement beliefs is higher among adolescents than among adults ($M = 41.06$ and $M = 38.54$, respectively); this difference was significant [$t(728) = 3.67$; $p < 0.001$]. Only the beliefs 'pollution is just as unhealthy', 'not everyone gets sick smoking' and 'I know heavy smokers that lived long' scored higher among adults. Beliefs most strongly adhered to by both adolescents and adults are: 'not everyone gets sick smoking', 'there are lots of risks in life', 'everyone acts unhealthy sometimes', 'I live healthy otherwise', and 'I know heavy smokers that lived long'. Beliefs with the lowest adherence among both adolescents and

adults were: 'You have to die of something' and 'Medical science will invent something'. Two beliefs that were rather strongly adhered to by adolescents, but not by adults were: 'if it were really bad, it would be forbidden' and 'health is not the only thing in life.' Thus, adults seem to adhere more strongly to beliefs that may be true in themselves but that ignore the fact that smoking and the occurrence of disease or the age of death have a negative relation. Adolescents, on the other hand, seem to adhere more strongly to beliefs that trivialize the value of health, or that allow them to relocate the responsibility for their health elsewhere.

Table 2 Distribution of the stages of readiness to quit at baseline by follow-up stages ($N = 363$)

	Stages of Change T2					
	Immotive	Precontemplator	Contemplator	Preparer	Action	Total
Stages of change T1	N	N	N	N	N	N
Immotive	97	35	8	8	49	197
Precontemplator	8	35	12	6	18	79
Contemplator	6	6	3	4	5	24
Preparer	12	12	3	8	28	63
Total	123	88	26	26	100	363

Correlations between the dependent and independent variables

Correlations as shown in Table 3 indicate that a stronger adherence to disengagement beliefs is associated with higher levels of nicotine dependence. In addition, disengagement beliefs are negatively related to readiness to quit and to smoking cessation. Nicotine dependence is marginally (negatively) associated with readiness to quit and strongly associated with smoking cessation.

Table 3 Correlations between disengagement beliefs, nicotine dependence, readiness to quit, forward stage transition, and smoking cessation

	1	2	3	4
1. Disengagement Beliefs	–			
2. Nicotine dependence	0.23***	–		
3. Readiness to quit	-0.22***	-0.11†	–	
4. Forward stage transition	0.02	0.05	-0.38***	–
5. Smoking cessation	-0.21**	-0.35***	0.18*	–

* p < 0.05; **p < 0.01; ***p < 0.001; †= 0.06, n = 363

Differences in Disengagement Beliefs and Nicotine Dependence between Motivational Stages
Smokers in the four stages of readiness to quit differ in the extent to which they adhere to disengagement beliefs (Table 4). Scheffe’s post-hoc analyses showed that immotives adhere significantly more strongly to disengagement beliefs than preparers. Smokers in the four stages of readiness to quit did not differ significantly in their level of nicotine dependence.

Readiness to Quit Regressed on Disengagement beliefs and Nicotine Dependence
Path analysis establishing the relative value of disengagement beliefs and nicotine dependence in relation to readiness to quit (controlled for sex, age and education level), showed disengagement beliefs to be associated with readiness to quit, while nicotine dependence was not (Table 5). The total variance explained was 13.8%.

Table 4 Disengagement Beliefs and Nicotine Dependence across the four stages of readiness to quit: cross-sectional analyses (N=363)

	Means in stages of change (SD)				
	Immotives	Precontemplators	Contemplators	Preparers	F
Disengagement Beliefs	42.33 ^a (9.26)	41.22 (7.70)	38.75 (5.69)	37.75 ^b (9.82)	4.86*
Nicotine Dependence	19.95 (6.94)	19.52 (5.81)	20.05 (5.35)	18.19 (6.68)	1.19

Note. Means in the same row that do not share superscript differ at p < 0.05 using Scheffe’s post-hoc tests
* p < 0.01

Forward stage transition regressed on Disengagement Beliefs and Nicotine Dependence
Assessment of the relative value of disengagement beliefs and nicotine dependence in relation to making a forward stage transition (controlled for age, sex and education level), showed that neither of the constructs was significantly related to forward stage transition (Table 5). The total variance explained was 4.9%.

Smoking cessation regressed on Disengagement beliefs and Nicotine Dependence
Results of the logistic regression analysis (controlled for age, sex and education level), showed that nicotine dependence predicted smoking cessation one year later (Table 5). Disengagement beliefs were marginally (negatively) related to smoking cessation. Whereas greater adherence to disengagement beliefs seems to be of some relevance in explaining smoking cessation, high levels of nicotine dependence were most strongly (negatively) related to actual smoking cessation. The total variance explained was 20.9%.

Table 5 Multivariate Regression Analyses Predicting Readiness to Quit, Forward Stage Transition and Smoking Cessation

	Readiness to Quit	Forward Stage Transition	Smoking Cessation
	B	OR (95% CI)	OR (95% CI)
Disengagement Beliefs	-0.21 **	1.00 (0.97-1.03)	0.97 (0.95-1.00) †
Nicotine Dependence	-0.06	1.01 (0.97-1.06)	0.91 (0.86-0.96)***

Note: OR = Odds Ratio; CI = Confidence Interval. Results are controlled for age, sex and education. Results for readiness to quit are cross-sectional. Results for forward stage transition and smoking cessation are longitudinal
* p < 0.05, ** p < 0.01, *** p < 0.001, † p = 0.05

No evidence was found for interaction effects between nicotine dependence and disengagement beliefs in relation to motivation to quit, motivation change and smoking cessation (data not in Tables).

Discussion

Similar to adult smokers, adolescent smokers adhere to excuses and justifications to continue smoking. By making the consequences of smoking less severe or by perceiving themselves to be less vulnerable to adverse health effects, adolescents appear to reduce cognitive dissonance and ‘permit’ themselves to continue to smoke despite the harmful health effects. Remarkably, adolescent smokers’ adherence to disengagement beliefs appears to be even stronger than that of adults.

As expected, having stronger disengagement beliefs is associated with higher levels of nicotine dependence. This is in line with results among adults that minimizing and denying information on the disadvantages of smoking was more prevalent among higher dependent smokers (Halpern, 1994). It has been suggested that whilst most adolescents start smoking for social reasons, eventually the majority will smoke for the pharmacological effects of nicotine (Benowitz & Henningfield, 1994). Even adolescents with an irregular and sporadic smoking pattern may experience nicotine withdrawal symptoms and craving when deprived of nicotine (Jacobsen et al., 2005; Rojas, Killen, Haydel & Robinson, 1998; Killen, Fortmann, Newman & Varady, 1991). Highly dependent smokers are considered to have a strong desire to preserve smoking and to avoid withdrawal symptoms. Therefore, in high dependent smokers, disengagement beliefs may be more strongly adhered to because they are a means to cope with dissonance produced by not quitting smoking.

Also consistent with studies among adults, disengagement beliefs were related to a lower motivation to quit smoking in adolescents (e.g., Kleinjan et al., 2006). We found that reported disengagement beliefs were significantly related to the motivation to quit smoking, while the level of nicotine dependence was not. However, when controlling for nicotine dependence, disengagement beliefs were only marginally significantly associated with smoking cessation one year later. Nicotine dependence was the strongest predictor of smoking cessation at follow-up. No evidence was found for interaction effects of disengagement beliefs and nicotine dependence in relation to the outcome variables. In sum, although cognitive dissonance in the form of disengagement beliefs seems to be higher among adolescent smokers than among adult smokers, disengagement beliefs do not contribute significantly to the explanation of adolescents' smoking cessation. A possible explanation for the lack of power of adolescents' disengagement beliefs in predicting smoking cessation is that adult smokers may be more likely to have an established smoking pattern. Having remained smoking despite years of education about the disease risks, adult smokers may have developed more stable dissonance reduction mechanisms for effectively withstanding the antismoking campaign. Thus, adolescents' adherence to disengagement beliefs mainly determines whether or not adolescents are motivated to quit smoking, whereas nicotine dependence mainly determines whether or not adolescents actually quit smoking.

Challenging adolescents' disengagement beliefs therefore seems mainly to be a means to increase their motivation to engage in a quit attempt. A study among adults showed that smokers who strongly adhered to disengagement beliefs had a low spontaneous quit rate (Dijkstra, 2008). However, this quit rate was significantly increased by providing persuasive information on the negative consequences of smoking. According to Dijkstra, disengagement beliefs may thus be viewed as "weak beliefs", since the inhibiting influence of disengagement beliefs on quitting was found to be overruled by giving persuasive information. Thus, one strategy to target disengagement beliefs among adolescent smokers may be to make the relative risks of smoking more salient. Therefore, smoking cessation programs for adolescents could aim at making the negative

consequences of smoking more salient and credible. However, providing persuasive information on the negative consequences of smoking may not have the same effect on adolescent smokers as on adult smokers.

Recent studies on adolescent neurological development indicate that adolescents are cognitively immature in the neurological processes related to decision making. Because of this, adolescents seem to be more inclined to engage in risky behaviours as compared to adults (Lopez, Schwartz, Prado, Campo, & Pantin, 2008; Steinburg, 2007). Also, adolescents were found to consider people their own age invulnerable to the serious health consequences of smoking (Balch, 1998). Indeed, most smokers do not experience health problems immediately after initiation, but are most likely to experience adverse health effects around 35-69 years of age (WHO, 2004). Nevertheless, young smokers are in fact susceptible to short-term health effects such as damage to the respiratory system (USDHHS, 1994). Among adolescent smokers it may therefore be useful to stress the less well-known short-term health consequences. Providing relevant and new de-biasing information on immediate negative health consequences might undermine the denial of information by using disengagement beliefs and inhibit adolescents' impulses to engage in smoking behaviour.

Whereas targeting of adolescents' disengagement beliefs seems an important aim to realize an increase in motivation to quit, it seems essential to overcome dependence in order to bring about prolonged smoking cessation. Besides targeting disengagement beliefs, it is suggested to also concentrate on approaches aiming to lower the levels of nicotine dependence in adolescent smokers. Although the use of nicotine replacement therapy (NRT) among adolescents remains controversial, among adolescent smokers NRT can be effective (Adelman, 2004; Ginzler et al., 2007; Moolchan et al., 2005). Moolchan and colleagues (2005) found that, compared with placebo, the combination of nicotine patch therapy combined with cognitive-behavioural intervention was effective in treating nicotine dependence among adolescent smokers who wanted to quit. In light of the importance of both disengagement beliefs as well as nicotine dependence in adolescents' smoking cessation practices, incorporating motivational interviewing techniques within NRT interventions may also prove useful. Interviewing (MI) is a client-centred, directive therapeutic style to enhance readiness to change behaviour by helping people to explore and resolve ambivalence (Miller, 1996). Being confronted with their own arguments to continue smoking in a respectful way, smokers may recognize their ambiguousness with regard to smoking. There is an increasing body of evidence that MI is an effective method to motivate behavioural change (Bien, Miller, & Borroughs, 1993; Rubak, Sandbaek, Lauritzen, & Christensen, 2005), including that of smoking cessation (Soria, Legido, Escolano, Lopez Yeste, & Montoya, 2006).

Limitations

The present study has some limitations. First, because the data are based on adolescent self-report of their own smoking intensity and frequency, under or over-reporting may have occurred (e.g. Patrick et al., 1994; Stein et al., 2002). However, self-reported smoking

behaviour measured with self-administered questionnaires was previously found to be reliable and valid comparison with methods such as biochemical validation (Dolcini, Adler, & Ginsberg, 1996; Hunter, Webber, & Berenson, 1980). Stanton and colleagues (1996b) found that smoking and information obtained from adolescents on smoking and quitting was reliable and had high internal consistency and validity. Second, attrition analysis of our sample indicates under-representation of lower educated adolescent male smokers. A lower educational level has been associated with higher levels of nicotine dependence and lower readiness to quit (e.g. Hu, Davies, & Kandel, 2006; John, Meyer, Rumpf, & Hapke, 2003). Nicotine dependence levels may lie somewhat lower in our sample than among the general adolescent smoking population, whereas the readiness to quit may lie somewhat higher. Caution in interpreting and generalizing the findings to the general adolescent smoking population is therefore warranted.

Conclusion

Despite these potential limitations, this study was the first to investigate the phenomenon of disengagement beliefs in an adolescent smoking population. Although adolescents report to adhere more strongly to disengagement beliefs as compared to adults, these beliefs do not seem to play an important role in explaining smoking cessation. Our findings indicate that, whereas challenging disengagement beliefs may increase the motivation to quit, the treatment of nicotine dependence might be more useful to establish smoking cessation.

8 Mechanisms of adolescent smoking cessation: The roles of readiness to quit, nicotine dependence, and smoking of parents and peers

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Abstract

Multiple levels of influence should be considered in interventions aimed at the adolescent smoker, including psychological, addiction, peer and parental influences. However, the mechanism by which these variables influence the process of smoking cessation in adolescents is not well elucidated. Therefore, this prospective study tested two models among 850 adolescent smokers, specifying the direct and indirect relations between adolescents' readiness to quit smoking, levels of nicotine dependence, and smoking behaviour of their parents and friends. One year later smoking cessation was assessed. Results showed that, among adolescent smokers, readiness to quit was positively associated with quit attempts, while nicotine dependence was inversely associated with successful cessation. Instead of a direct relation, parental and peers' smoking were inversely related to smoking cessation through nicotine dependence. The findings emphasize that interventions should be developed and tested within and outside the school setting, as well as within the family situation. In addition, the strong impact of nicotine dependence on successful cessation indicates that a more direct approach is needed to lower nicotine dependence among adolescents.

Introduction

Although primary and secondary preventions consist of approaches to reduce the prevalence of smoking, efforts related to adolescent smoking have mainly focused on preventing the initiation of smoking (e.g. Carvajal and Granillo, 2006; Vickers et al., 2002). However, there is little research on the predictors of smoking cessation among adolescents, and a sound theoretical basis for developing interventions aiming at adolescent smoking cessation is still lacking (e.g. Buttross and Kastner, 2003). To develop effective approaches to reduce juvenile smoking, more understanding of the mechanisms underlying smoking cessation in adolescents is needed. It is reported that multiple levels of influence should be considered in interventions designed to treat adolescent smokers, including addiction, psychological, peer, and parental influences (Center for Disease Control and Prevention, 1994; Fiore et al., 1996; Moolchan et al., 2000). Therefore, the present study tested a model specifying the direct and indirect relations between nicotine dependence, readiness to quit, and smoking in the social environment.

Dependence on nicotine is known to be a strong predictor of smoking cessation. Studies among adults revealed that nicotine dependence was an important impediment to cessation (e.g. Abrams et al., 2000; West et al., 2001). It is also reported that even irregular and sporadic smokers can experience symptoms of dependence (DiFranza et al., 2002a). The occurrence of dependence symptoms in adolescent smokers was found to be a precursor of daily smoking (DiFranza et al., 2002a) and a barrier to smoking cessation (Colby et al., 2000a; Prokhorov et al., 2001). Adolescent smokers reported withdrawal symptoms and feelings of craving during attempts to quit or reduce smoking, and higher levels of dependence symptoms in adolescents were associated with relapse to smoking (Bagot et al., 2007; Colby et al., 2000a; Horn et al., 2003).

Readiness or motivation to change behaviour is conceived as a proximal predictor of behaviour change in several cognitive-behavioural theories, such as the theory of planned behaviour (Ajzen, 1988), the theory of triadic influence (Flay and Petraitis, 1994) and the transtheoretical model (Prochaska et al., 1992a). These models imply that an individual's readiness to (try and) change is an immediate precursor of behaviour change and, specifically with regard to smoking, it is thought that interventions and treatments aiming at smoking cessation will only work if smokers are ready and motivated to quit (West, 2004). However, studies on adult smokers have shown that indicators of dependence were stronger predictors of abstinence at follow-up than the smoker's psychological readiness to quit (Farkas et al., 1996; Abrams et al., 2000). Nevertheless, there is general consensus that psychological readiness to quit plays an essential role in any theory of behaviour change (Fisher, 1996; Hughes, 1996; Pierce et al., 1996; Prochaska and Velicer, 1996; Shiffman, 1996; Stockwell, 1996; Sutton, 1996; West, 2004).

West (2004) stated that the success of smoking cessation depends on the balance between an individual's readiness to quit smoking and his/her level of dependence. Whereas a person's readiness to quit is likely to determine whether or not a person will try to quit, dependence on nicotine will likely determine how successful actual cessation will be (Shiffman, 1996, West, 2004).

The interplay between readiness to quit and nicotine dependence in adolescent smoking cessation is not well elucidated. Among adolescents, both readiness to quit and nicotine dependence are known to be precursors of cessation (Engels et al., 1998; Kleinjan et al., 2008a). Therefore, the first aim of this study is to examine the roles of readiness to quit and nicotine dependence in relation to adolescent smoking cessation, and to test whether differences in dependence influence the relationship between readiness to quit and smoking cessation.

Although individual characteristics (such as readiness to quit and nicotine dependence) are important predictors of smoking cessation, an individual rarely acts independently of their (social) environment. Consequently, smoking behaviour is likely to be determined by a combination of individual characteristics interacting with environmental conditions, e.g. smoking by significant others (Van Lenthe et al., 2005). It is reported that both parental and peer smoking are consistent predictors of adolescent smoking (e.g. Conrad et al., 1992; Flay et al., 1994). Adolescents who report a greater exposure to smoking by parents and peers were less likely to quit smoking (Burt and Peterson, 1998; Ershler et al., 1989; Hansen et al., 1985a; Zhu et al., 1999). However, the mechanisms by which parental and peers' smoking affect adolescent smoking cessation are largely unknown.

Having friends and parents who smoke may hinder the process of smoking cessation in adolescent smokers in various ways. For example, smoking parents and friends may offer cigarettes thus providing easy access to cigarettes (Tucker et al., 2002), or may act as cues that may continue to trigger the craving for cigarettes (Carter and Tiffany, 2001), or may be unable to provide appropriate encouragement and support to quit smoking (Hansen et al., 1985a). Moreover, it is known that, in adolescent smokers, parental and peer smoking is significantly associated with higher levels of nicotine dependence (Hu et al., 2006). Since nicotine dependence appears to be associated with adolescent smoking cessation (Kleinjan et al., 2008a), parental and peer smoking may also influence adolescent smoking indirectly through nicotine dependence. Furthermore, a recent study showed that parental smoking is associated with a lower readiness to quit (Van Zundert et al., 2007), which implies that parental smoking may also influence successful smoking cessation by affecting adolescent's readiness to quit. In an environment where parents and friends are smokers, adolescents may perceive themselves to be less ready to quit, e.g. due to dependence-enhancing factors, such as the offering of cigarettes and the presence of smoking cues. Therefore, the second aim of this study is to examine the pathways between parental and peer smoking, and both nicotine dependence and readiness to quit, in relation to smoking cessation.

To investigate the patterns of these relationships, two models are tested. In the first, the outcome variable is the number of quit attempts in the past 12 months. In the second model, the dependent variable is the actual smoking cessation for at least 1 month. In line with the idea that readiness to quit will determine whether or not a person will try to quit, and dependence on nicotine will be associated with how successful cessation will be, we expect readiness to quit to be more strongly related to the number of quit

attempts, and nicotine dependence to be more strongly related to successful smoking cessation. In addition, to test whether differences in dependence may shape differences in readiness to quit, as proposed by Shiffman (1996) and West (2004), we assess whether nicotine dependence has a moderating effect on the relation between readiness to quit and both the number of quit attempts and smoking cessation. Because it is reported that, among adolescents, a lower readiness to quit coincides with substantially higher levels of nicotine dependence (Prokhorov, 2001), it is expected that the relation between adolescents' readiness to quit and number of quit attempts, as well as actual smoking cessation, will be stronger for respondents reporting lower levels of dependence than for respondents reporting higher levels of dependence. With regard to smoking of parents and peers, it is expected that parental and peer smoking are related to higher levels of nicotine dependence and lower readiness to quit (Van Zundert et al., 2007), which in turn are hypothesized to be related to fewer quit attempts and a lower chance of successful smoking cessation.

Method

Procedure and Sample

The present study uses data from the third and fourth wave of a larger longitudinal study that started in January 2003, focusing on psychological and environmental processes in relation to tobacco use among Dutch adolescents. Following random selection from the telephone book, schools in four regions of the Netherlands were randomly selected and approached to take part. The main reason given for refusal to join this study was participation in other studies. At the time of the third wave (T1; November 2004) 25 secondary schools were included and data were collected among 6,750 respondents aged 13-18 (mean = 14.8, SD = 0.88) years. Similarly, at the time of the fourth wave (T2; 2005) 4,940 respondents participated again (response rate 73.2%). The primary causes for non-response (as reported by the teachers) were sickness, truancy, leaving school, and repeating a class; for details see Van de Ven et al., (2006b) and Otten et al., (2008). The local medical ethical committee (CMO Arnhem-Nijmegen) approved this study.

At T1, respondents (grades 9 and 10) completed questionnaires in the presence of their teacher during school hours; and again at T2 when in grades 10 and 11. Teachers received a letter containing instructions on how to administer the questionnaires. Pupils were informed that the data would be processed anonymously, i.e., respondent-specific codes were used to link the data from one time point to the next. To assure confidentiality, each pupil received an unmarked envelope in which they returned the completed questionnaires. In addition, pupils were informed that participation was not obligatory.

The questionnaire consisted of two sections: one for respondents who indicated that they had smoked at least once in the past month, and one for respondents who had not smoked during the past month. At T1, a total of 850 of the 4,940 respondents (17.2%) indicated that they had smoked at least once in the past month.

Of the 850 respondents included at T1 and T2, 54.7% was female. A total of 38.4% received preparatory vocational training, 16.7% junior general secondary training, 30.9% senior general secondary education, 13.4% received university preparatory training, and 0.6% reported some other form of education. At T1 the mean age was 14.99 (SD = 0.83) years.

Measures

Readiness to quit. This measure was derived from the original stages of change measure according to Prochaska et al. (1992a) and was similar to the stages of change derived scales as used by Dijkstra et al. (1998). On a 9-point scale, adolescents could rate their readiness to quit: 1) 'within the next 10 days' (16.2%), 2) 'within 1 month' (8.9%), 3) 'within 6 months' (6.9%), 4) 'within 1 year' (9.6%), 5) 'within 5 years' (8.2%), 6) 'within 10 years' (5.4%), 7) 'somewhere in the future but not within the next 10 years' (3.8%), 8) 'keep smoking but planning to cut down' (27.2%), 9) 'keep smoking and not planning to cut down' (14.0%). The items were recoded so that a higher score on this scale represented a higher readiness to quit.

Nicotine Dependence. Of the instruments available to measure nicotine dependence in adolescents, the Hooked on Nicotine Checklist (HONC; DiFranza et al., 2002b) and the modified Fagerström Tolerance Questionnaire (mFTQ; Prokhorov et al., 1996) are frequently used, are short and easily applicable in survey research, and can be considered the most practical measures to identify nicotine dependence in adolescents (for an overview see Kandel et al., 2005). However, the mFTQ and the HONC were found to measure different aspects of nicotine dependence in adolescents; the mFTQ mostly contains items indicative of symptoms that occur when dependence is more manifest, while the HONC contains items thought to be indicative of early symptoms. Taken together, these items enable to measure a wider range of nicotine dependence. Our group have developed and validated a multidimensional scale based on both the mFTQ and the HONC (Kleinjan et al., 2007); this latter study revealed that combining items of the mFTQ and the HONC resulted in 11 items forming three distinct dimensions: 1) behavioural aspects of physical tolerance, 2) craving, and 3) withdrawal during abstinence. The multidimensional model was subsequently tested in a second sample using confirmatory factor analyses. This model fitted the data satisfactorily and the measure showed good reliability. In addition, to test convergent validity, it was found that the three components of the combined scale are uniquely related to readiness to quit and number of previous quit attempts.

Behavioural aspects of physical tolerance were measured using four items assessing when, where, and how much one smokes. Answer categories for these four items varied (see Table 1). Items were coded so that a higher score represented a higher degree of dependence. In addition, because of the variation in the possible answer categories, scores were standardized to ensure that each item contributes an equal amount of weight to the scale. Craving was measured using four items assessing the frequency in which urges to smoke were experienced. Items could be scored on a 4-point scale ranging from 1 'never' to 4 'often'. Finally, withdrawal during abstinence was measured using three items assessing

the occurrence of several withdrawal symptoms, such as restlessness and trouble concentrating. These items could be scored on a 4-point scale ranging from 1 'never' to 4 'often'. Cronbach's alphas for the three subscales were 0.60 for behavioural aspects of nicotine dependence, 0.86 for craving, and 0.82 for nervousness during abstinence. For data on the nicotine dependence subscales see Table 1.

Table 1 Descriptions and characteristics of dependent and independent variables

Measurement	Response categories	Mean (SD)	Response frequencies
Behavioural aspects of physical tolerance			
1. How many cigarettes a day do you smoke?	1. Less than 1 a day 2. About 1-5 a day 3. About 6-10 a day 4. About 11-20 a day 5. About 21-30 a day 6. Over 30 a day	2.25 (1.22)	
2. Which cigarette would you hate to give up?	1. Any other cigarette 2. First in the morning	1.28 (0.44)	
3. How soon after you wake up do you smoke your first cigarette?	1. After 60 minutes 2. Within 31-60 minutes 3. Within 6-30 minutes 4. Within 5 minutes	1.71 (0.95)	
4. Do you smoke if you are so ill that you are in bed most of the day?	1. No 2. Yes	1.15 (0.35)	
Craving	1. 'Never' to 4 'Often'	1.35 (0.47)	
Withdrawal during abstinence	1. 'Never' to 4 'Often'	1.60 (0.88)	
Readiness to quit	1. 'Keep smoking and not cut down' to 9 'Within 10 days'	5.36 (2.92)	

Measurement	Response categories	Mean (SD)	Response frequencies
Number of quit attempts		0.58 (1.09)	
Parental smoking	1. No smoking parent 2. One smoking parent 3. Two smoking parents		1. 41.0% 2. 33.0% 3. 26.0%
Maternal smoking	1. Smoking mother 2. No smoking mother		1. 40.0% 2. 60.0%
Paternal smoking	1. Smoking father 2. No smoking father		1. 46.5% 2. 53.5%
Best friend smoking	1. Smoking best friend 2. No smoking best friend		1. 70.7% 2. 29.3%
Number of friends smoking	1. None 2. Less than half 3. Half 4. More than half 5. All		1. 2.9% 2. 27.0% 3. 19.5% 4. 43.3% 5. 7.2%
Smoking cessation			18.2%

Parental smoking. Two items were used to assess parental smoking behaviour: 1) Does your mother smoke? and 2) Does your father smoke? These items could be scored on a 7-point scale ranging from 1 'No, not at all', 2 'Yes, but less than one cigarette a day', to 7 'Yes, more than 31 cigarettes a day'. It is reported that when one or both parents smoke, their children will have a higher risk to either start smoking or stay smoking compared to children whose parents do not smoke (e.g. Harakeh et al., 2004; Vink et al., 2003b). Adolescents' proxy reports on parental smoking are considered to be valid indicators of parents' lifetime and current smoking status (e.g. Harakeh et al., 2006a).

Peer smoking. Two items were used to assess peer smoking status: 1) Does your best friend smoke? and 2) How many of your friends smoke? The first item could be scored on a 7-point scale ranging from 1 'No, not at all', 2 'Yes, but less than one cigarette a day', to 7 'Yes, more than 31 cigarettes a day'. The second item could be scored on a 5-point

scale ranging from 1 'None of them' to 5 'All of them'. Adolescents are typically part of a friendship network that includes several close friends (one of whom may be labeled a 'best friend') and a friendship group (Urberg et al., 1995). Close friendships and friendship groups overlap to some extent; best friends are usually members of the same friendship group, but most adolescents do not nominate all members of their friendship group as friends. It is reported that both the smoking behaviour of the best friend and the smoking behaviour within the peer group are longitudinally related to the smoking of adolescents themselves (e.g. Harakeh, 2007; Urberg et al., 1997).

Number of quit attempts. To assess the number of previously undertaken quit attempts, respondents were asked: 'How many times did you try to quit smoking in the past 12 months?' Respondents were divided into six categories ranging from 0 'Did not try to quit, not even once', to 5 'Tried to quit five times or more'. Respondents who, at T2, indicated that they no longer smoked were referred to the section of the questionnaire containing questions for non-smokers. Therefore, the number of quit attempts in the past were only assessed for those respondents at T2 who indicated to be current smokers (n = 695).

Smoking cessation. Respondents who were classified as smokers at T1 and who, at T2, indicated they were no longer smoking and had not done so during the past month were considered to have quit smoking (see also Kleinjan et al., 2008a). This distinction is based on studies on adolescent smoking cessation in which participants were considered to have quit smoking if they were current smokers at baseline but had not smoked for 30 days at the time of the follow-up measurement (Zhu et al., 1999; US Department of Health and Human Services, 1994).

Attrition Analyses

Of the 6,750 respondents at T1, 4,940 were included again at T2. The respondents lost to follow-up were compared with the remaining respondents on the variables 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 [$\chi^2(1, n = 6734) = 16.83; p < 0.001$], older [$t(6691) = 3.89; p < 0.001$], to have 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 analyses, including all of the above-mentioned constructs as independent variables, showed significant associations between these variables and loss to follow-up (Nagelkerke $R^2 = 0.02$). Although significant, the variance explained by these variables was limited, i.e., 2%. These differences can to a large extent be explained by the fact that most respondents lost to follow-up were in the final year of lower education at T1, and at T2 had graduated and therefore left school.

Strategy for Analyses

Descriptive statistics are given, and Pearson and Spearman correlations were computed for all variables included in this study, i.e., smoking of father and mother, smoking of best friend, number of friends who smoke, behavioural aspects of nicotine dependence, craving, nervousness during abstinence, readiness to quit, and smoking cessation (Table

1 and Table 2, respectively). To examine the relations between readiness to quit, nicotine dependence, parental smoking, peer smoking, and both the number of quit attempts and smoking cessation, we applied Structural Equation Modeling (SEM) using the software package MPLUS 4.1 (Muthén and Muthén, 1998-2007a). SEM was used because it allows to specify and test latent variable models combining two components: a) the measurement model that specifies relations between directly measured variables and latent constructs, and b) the structural model that specifies directional and nondirectional (i.e., correlational) relationships between the latent constructs. Because separate estimates of indicator-construct and construct-construct relationships were yielded by SEM analyses, obtained estimates of relations among constructs were freer from the effects of measurement error and construct-irrelevant variance (Tomarken and Baker, 2003). In addition, MPLUS was used because of its ability to accommodate non-normality and ordinal variables without reliance on large samples (Kaplan, 2000). To examine hypothesized relations among (or with) ordinal and nominal variables, MPLUS uses the weighted least squares (WLS) approach. This approach assumes that a continuous, normal latent process determines each observed ordinal or nominal variable. For more details on the WLS approach in relation to model estimation see Flora and Curran (2004). Furthermore, we would like to point out that MPLUS estimates the degrees of freedom for the WLS according to a specific formula (Muthén and Muthén, 1998-2007b), meaning that the chi-square statistic and the degrees of freedom presented within the result section differ from chi-square statistics as given in other frequently used programs for SEM.

The predictors were the manifest variable readiness to quit (treated as a categorical variable), the latent variable nicotine dependence (measured by 11 items loading on three latent dimensions, i.e. behavioural aspects of dependence, craving, and nervousness during abstinence), the latent variable of parental smoking (measured by two items assessing smoking of father and mother), and finally the latent variable of peer smoking (measured by two items assessing the smoking behaviour of the best friend and the total number of smoking friends). The dependent variables were the categorical variable of number of quit attempts within the first model and the binary variable smoking cessation (0 = no cessation, 1 = cessation) within the second model. Within these models, we took into account the correlation between the latent construct of nicotine dependence and the manifest construct readiness to quit, as well as the correlation between parental and peer smoking. Missing values (e.g. if adolescents indicated that one or both parents were not present) were estimated by maximum-likelihood using the EM algorithm according to Little and Rubin (2002) assuming ignorable missingness with missing at random (MAR).

The fit of the models was assessed by the following fit indexes: χ^2 , CFI (Comparative Fit Index), TLI (Tucker-Lewis Index), and RMSEA (Root-Mean-Square Error of Approximation). Due to the sensitivity of the Chi-square goodness-of-fit test to sample sizes, the fit indices CFI, TLI and RMSEA were used. Except for the values of RMSEA (which would be satisfactory if smaller than 0.08), goodness-of-fit values greater than 0.90 are considered an acceptable fit (Bentler and Bonett, 1980).

To assess the possible moderating effects of nicotine dependence, multigroup analyses

were conducted within MPLUS 4.1. In multigroup analyses, differences in the relationships between readiness to quit, and both number of quit attempts and smoking cessation, were tested between respondents with varying levels of dependence. This was done by constraining the betas to be equal and testing whether the model fit ($\Delta\chi^2$: Chi-square test for difference testing) was significantly better for the model in which the paths were allowed to differ between the different levels of nicotine dependence compared to the model in which the paths were constrained to be equal. Dividing the moderating variable in subgroups is a commonly preferred technique to detect moderating effects of non-parametric variables (Stone and Hollenbeck, 1989). In the present study, subjects were divided into one group high on dependence and another group low on dependence, using median split (for a similar strategy see Huver et al., 2007 and Van der Vorst et al., 2005; 2007).

Results

Smoking Characteristics

At T1, respondents smoked on average 31.5 cigarettes per week (SD = 40.5, median = 15), and at T2 smoked 49.7 cigarettes per week (SD = 45.4, median = 40). Table 1 presents data on the measurements made in the present study. With respect to parents, 41% of the respondents reported to have two non-smoking parents, 33% reported having one parent who smoked, and 26% reported that both parents were smokers.

Correlations between predictor variables and number of quit attempts and smoking cessation

Of the 695 respondents who did not quit smoking at follow-up, Spearman correlations showed that the number of quit attempts at T2 was negatively associated with maternal smoking and positively associated with the number of smoking friends, craving, nervousness during abstinence, and readiness to quit (Table 2). Smoking of the father and the best friend, and behavioural aspects of nicotine dependence were not significantly related to the number of quit attempts.

Smoking cessation at T2 was associated with all manifest aspects of parental smoking, friends' smoking, and nicotine dependence measured at T1 (n=850). The more parents and friends who smoked, and the larger the number of smoking friends, the less likely adolescents were to have quit smoking one year later. The associations between friends' smoking and smoking cessation were slightly stronger compared with the associations between parents' smoking and smoking cessation. In addition, higher levels of dependence were associated with lower cessation rates. Readiness to quit at T1 was associated with smoking cessation at T2. The higher the readiness to quit, the more likely adolescents were to have quit smoking one year later.

Table 2 Pearson and Spearman correlations between parental and friends' smoking, nicotine dependence, readiness to quit and smoking cessation

	1	2	3	4	5	6	7	8	9
1. Maternal smoking	–								
2. Paternal smoking	.40***	–							
3. Best friend smoking	.23***	.22**	–						
4. Number of friends smoking	.19***	.18***	.52***	–					
5. Behavioral aspects of nicotine dependence	.33***	.37***	.40***	.41***	–				
6. Craving	.22***	.21***	.36***	.42***	.59***	–			
7. Nervousness during abstinence	.19***	.22***	.24***	.25***	.49***	.56***	–		
8. Readiness to quit	-.17***	-.19***	-.15***	-.16***	-.26***	-.20***	-.11**	–	
9. Number of quit attempts	-.08*	.03	.02	.09*	.04	.22***	.16***	.13**	–
10. Smoking cessation	-.08*	-.07*	-.16***	-.15***	-.20***	-.20***	-.10*	.10**	–

* p < .05, **p < .01, *** p < .001; n = 850

Pearson correlations between parental and friends' smoking, and both nicotine dependence and readiness to quit, were significant, implying that if the best friend and the parents were smokers and if more friends were smokers, the higher the reported levels of nicotine dependence and the lower the levels of readiness to quit.

Total Model: Quit attempts

The model that best fitted the data concerning the outcome measure of quit attempts is shown in Figure 1 [$\chi^2=289.21$, $df = 60$, $p < 0.001$, $RMSEA = 0.07$, $CFI = 0.95$, $TLI = 0.98$]. The model shows that both readiness to quit and the latent variable nicotine dependence predicted the number of quit attempts one year later ($n = 695$, excluding successful quitters). Higher levels of nicotine dependence, as well as higher levels of readiness to quit, resulted in undertaking more quit attempts. In addition, the model showed that parental smoking was positively associated with nicotine dependence and negatively associated with readiness to quit. Peer smoking was also positively associated with nicotine dependence, but showed no significant association with readiness to quit.

Adding direct paths from parental smoking and peer smoking to quit attempts showed that these paths were not significant and did not result in a better model fit [$\chi^2=290.53$, $df = 59$, $p < 0.001$, $RMSEA = 0.08$, $CFI = 0.95$, $TLI = 0.98$], indicating that parental and peer smoking were related to the number of quit attempts through nicotine dependence and readiness to quit.

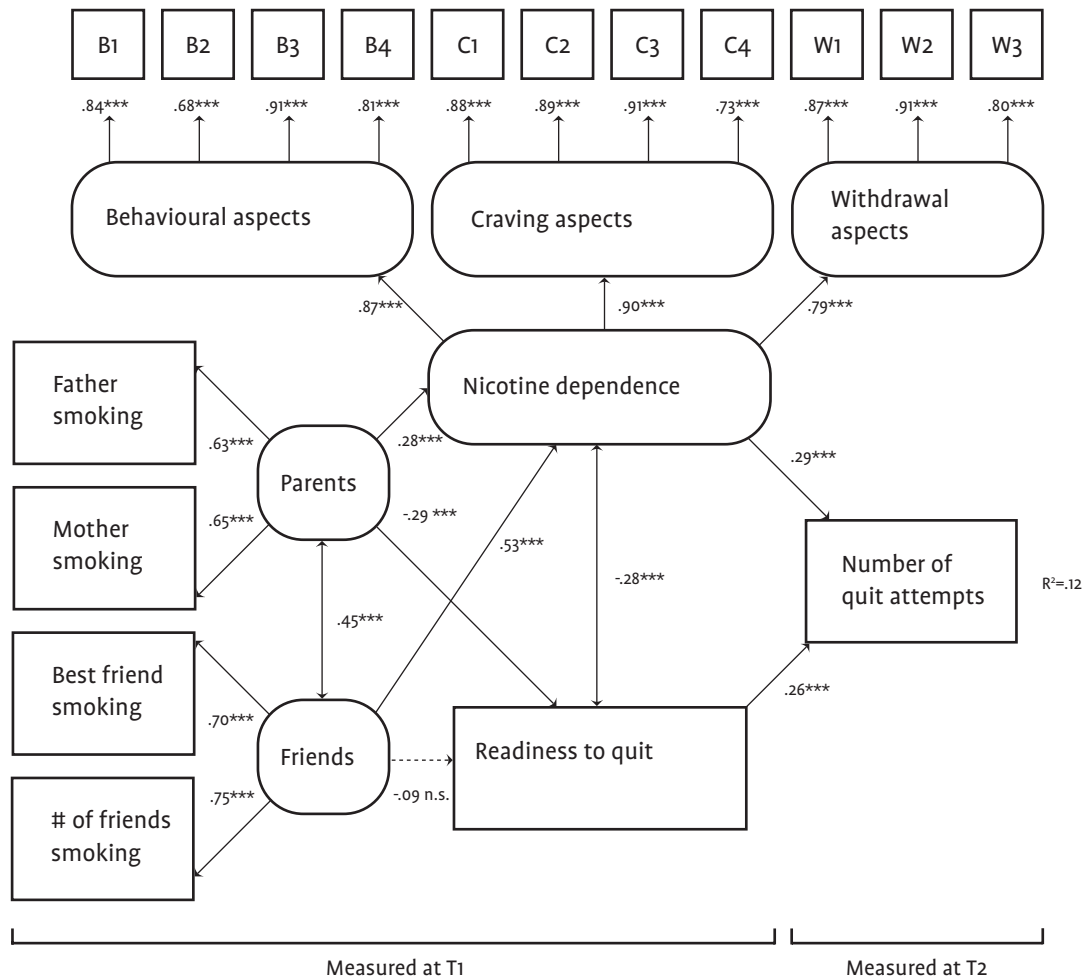
Total Model: Smoking Cessation

The model that best fitted the data concerning the outcome measure of smoking cessation is shown in Figure 2 [$\chi^2=287.42$, $df = 61$, $p < 0.001$, $RMSEA = 0.07$, $CFI = 0.96$, $TLI = 0.98$]. Figure 2 shows that if both readiness to quit and the latent variable nicotine dependence are included in the SEM analyses to predict smoking cessation, the association between readiness to quit and smoking cessation at 1-year follow-up is no longer significant. The negative relations between nicotine dependence and smoking cessation remained significant. In addition, the model showed that parental smoking and peer smoking were positively associated with nicotine dependence and negatively with readiness to quit. Direct paths from parental smoking and peer smoking to smoking cessation were non-significant and, consistent with the model explaining the number of quit attempts, did not result in a better model fit [$\chi^2=291.01$, $df = 60$, $p < 0.001$, $RMSEA = 0.07$, $CFI = 0.96$, $TLI = 0.98$], indicating that parental and peer smoking influence actual smoking cessation through nicotine dependence.

Nicotine dependence as a moderator for relations between readiness to quit, and number of quit attempts and smoking cessation

Multigroup analyses indicated that neither the relation between readiness to quit and number of quit attempts, nor the relation between readiness to quit and smoking cessation differed for the different levels of nicotine dependence. The Chi-square test for difference testing showed no differences in the relations between readiness to quit and both number of quit attempts and smoking cessation for respondents scoring highest on nicotine dependence compared with those scoring low on nicotine dependence [Chi-square tests for difference testing: $\chi^2(1, n = 588) = 2.85$, $p = 0.09$ and $\chi^2(1, n = 743) = 0.28$, $p = 0.60$, respectively].¹ Additionally, moderating effects of nicotine dependence were assessed by computing product terms of nicotine dependence with readiness to quit. Again, no evidence for a moderating effect of nicotine dependence in the relation between readiness to quit and the outcome variables was found.

Figure 1 Standardized estimates of the total model of number of quit attempts (n = 695).

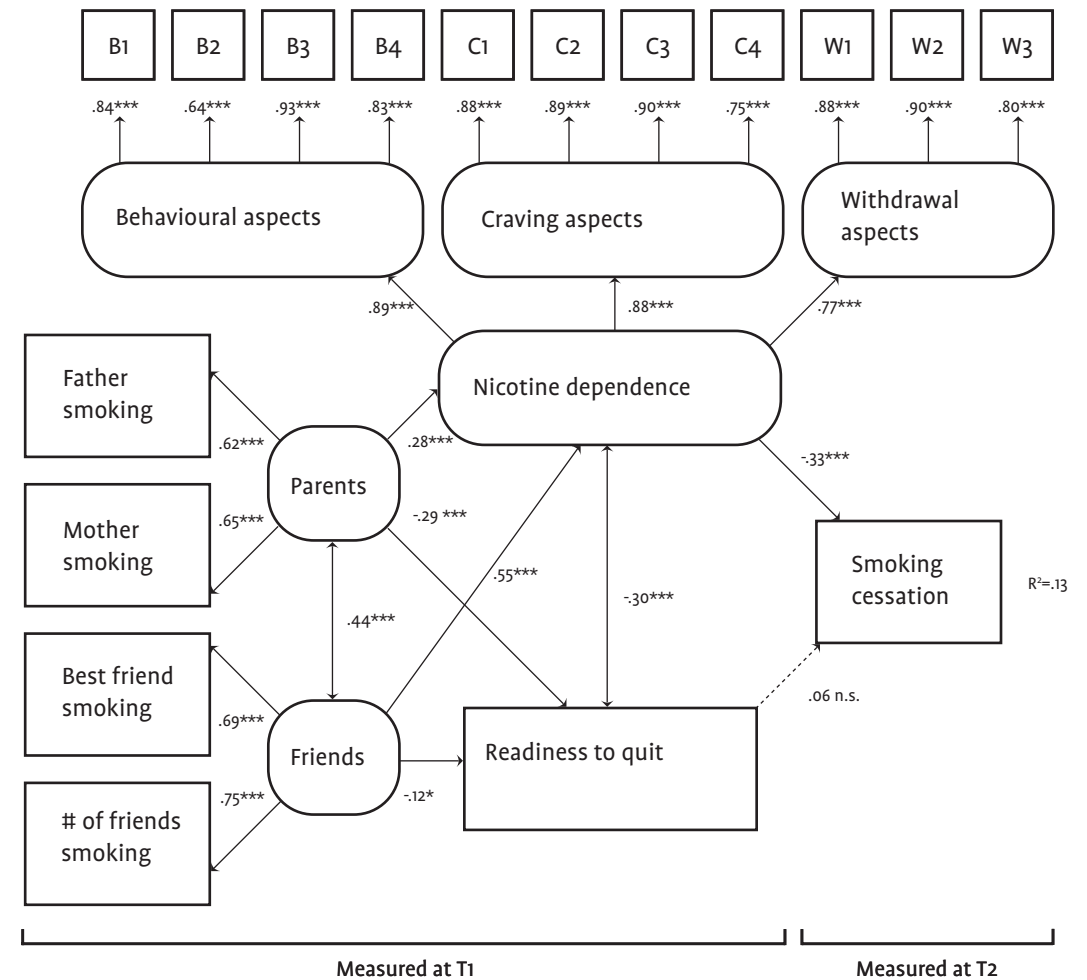


Fit indices: $\chi^2=289.21$, $df = 60$, $p < 0.001$, $RMSEA = 0.07$, $CFI = 0.95$, $TLI = 0.98$

Note: The items B1 to B4 correspond to the behavioural aspect items. C1 to C4 correspond to the craving items. W1 to W3 correspond to the withdrawal items

* $p < .05$; ** $p < .01$; *** $p < .001$; n.s. = not significant

Figure 2 Standardized estimates of the total model of smoking cessation (n = 850).



Fit indices: $\chi^2=287.42$, $df = 61$, $p < 0.001$, $RMSEA = 0.07$, $CFI = 0.96$, $TLI = 0.98$

Note: The items B1 to B4 correspond to the behavioural aspect items. C1 to C4 correspond to the craving items. W1 to W3 correspond to the withdrawal items

* $p < .05$; ** $p < .01$; *** $p < .001$; n.s. = not significant

Discussion

The present study aimed to elucidate the process of adolescent smoking cessation by examining the patterns of relationships between readiness to quit, nicotine dependence, and parental and peer smoking. First, consistent with the studies of Abrams et al. (2000) and of Farkas et al. (1996) conducted among adults, we found that, compared to readiness to quit, reported symptoms of nicotine dependence in adolescents were more strongly related to actual smoking cessation. In explaining the number of quit attempts in the past 12 months, however, readiness to quit remained a significant predictor even when the impact of nicotine dependence was corrected for. In agreement with studies among adult smokers by Shiffman (1996) and West (2004), our findings indicate that, among adolescent smokers, readiness to quit is most important in determining whether one will try to quit or not, whereas nicotine dependence seems to determine whether or not a quit attempt will be successful.

No support is found for the hypothesis that the relation between adolescents' readiness to quit and quit attempts or actual cessation are qualified by the level of dependence. Although similar to the results of Prokhorov et al. (2001), in the present study readiness to quit is negatively associated with nicotine dependence, the relations between readiness to quit and actual quitting do not vary within different degrees of dependence. Independent of their nicotine dependence levels, the enhancement of adolescents' readiness to quit smoking seems an important aim to realize an attempt to quit. In addition, it seems essential to overcome dependence in order to make cessation successful (West, 2004).

The present study indicates that a way to influence adolescents' readiness to quit, and subsequently their levels of dependence, is to target parental and peer smoking. Even though parental and peer smoking have been directly linked to the success of smoking cessation (Burt and Peterson, 1998; Ershler et al., 1989; Hansen et al., 1985a; Zhu et al., 1999), we found that the direct paths between parental and peer smoking, and the number of quit attempts and smoking cessation, are not significant. Instead of being directly associated, parental and peer smoking apparently affect adolescent smoking cessation by enhancing experienced nicotine dependence symptoms. Cessation attempts seem to be affected by parental and peer smoking by bringing about a lower psychological readiness to quit and enhancing experienced nicotine dependence symptoms.

When comparing peer and parental smoking in relation to readiness to quit and nicotine dependence, parental smoking seems more important with regard to adolescents' readiness to quit, whereas peer smoking seems more important with regard to nicotine dependence. The strong associations between parental smoking and readiness to quit may in part be explained by the effects of parental objections to smoking; for example, parents who smoke perceive less legitimate authority in prohibiting their children from smoking (Andersen et al., 2002). As a result, children of non-smoking parents may perceive more resistance to their smoking behaviour, which may increase their readiness to quit smoking. Another explanation might lie in the modeling of parental smoking behaviour; parental quitting was found to be associated with subsequent quitting in their children (Bricker et al., 2005; Farkas et al., 1999). Parental smoking cessation may

increase adolescents' readiness to quit because, for example, parents can provide helpful advice on smoking cessation. Additionally, the relatively stronger associations between peer smoking and nicotine dependence (compared to parental smoking and nicotine dependence) may be partially explained by the notion that, besides the pharmacological reinforcement by nicotine (such as feeling calmer or being more alert), adolescents with smoking peers also experience social reinforcement (Jones et al., 2004). It is reported that psychosocial influences (e.g. peer smoking) commonly precedes pharmacological incentives (McNeill et al., 1987), and that transitions to increased levels of smoking is linked to friends' encouragement and approval (Duncan et al., 1995; Flay et al., 1998).

Based on the above, encouragement of parental smoking cessation seems an effective method to influence the adolescent smoking cessation process. It was recently reported that, even if parents are active smokers, the use of smoking-specific parenting practices might still be useful in increasing their children's readiness to quit smoking (Van Zundert et al., 2007). Therefore, focusing on smoking-specific parenting practices might also be an effective way to increase adolescents' readiness to quit and to subsequently decrease their level of nicotine dependence. With regard to peer smoking, Stanton et al. (2006) found that one of the strongest predictors of being engaged in smoking cessation activities was whether students were actively influencing other students not to smoke, and that school lessons about smoking cessation increased smoking cessation activities. Participation of peers in school-based smoking cessation programs and more actively involving these adolescents in prompting and encouraging their peers to try and quit seems an effective method to eventually decrease levels of smoking (McGee and Stanton, 1994; Gillespie et al., 1995). In order to target both parental and peer influences, adolescent smoking cessation interventions should preferably be applied within and out of the school setting, as well as within the family situation. In addition, to optimize interventions, future studies are needed to further elucidate the mechanisms by which parental and peer smoking influence adolescents' readiness to quit smoking and their dependence on nicotine.

The present study has some limitations. First, because the data are based on adolescent self-report of their own smoking intensity and frequency, as well as those of their parents and friends, under or over-reporting may have occurred (e.g. Patrick et al., 1994; Stein et al., 2002). It should be mentioned, however, that in case of self-reported smoking behaviour, measurement with self-administered questionnaires was found to be as reliable and valid as 'unprejudiced' methods such as biochemical validation (Dolcini et al., 1996; Hunter et al., 1980). Stanton et al. (1996b) found that information obtained from adolescents on smoking and quitting was reliable and had high internal consistency and validity. Moreover, adolescents' proxy reports on parental smoking were found to be reliable indicators of parents' lifetime and current smoking status (Harakeh et al., 2006a). With regard to adolescents' reports on their friends' smoking behaviours, the debate continues as to whether it is appropriate to use these reports, as they may be distorted (e.g., Bauman and Ennett, 1996). However, it was found that adolescents' reports on their best friends' lifetime and current smoking and the self-reports of those best friends show

sufficient agreement, indicating that adolescents' proxy reports on their best friend's smoking seem to be a valid tool to measure the influence of the best friends' smoking (Harakeh et al., 2007)

Second, the relations between readiness to quit, nicotine dependence, and parental and peer smoking were all assessed at T1. The associations between these variables are cross-sectional and thus do not allow inferences about causality. Precursors of smoking cessation (e.g. parental and peer smoking and nicotine dependence) could be part of a chain of events that may have started early in childhood or adolescence, and may have changed over time. For example, peer smoking was found to predict the development of smoking intensity in adolescent novice smokers. Moreover, adolescents whose smoking escalated rapidly were found to be characterized by an earlier development of dependence and tolerance (Karp et al., 2005). Multiple measurements over time may help to provide a longitudinal perspective to gain more insight into the developmental pathways of nicotine dependence through parental and peer influences.

Third, attrition analysis of our sample indicated a possible under-representation of lower educated adolescent male smokers. A lower educational level has been associated with higher levels of nicotine dependence and lower readiness to quit (e.g. Hu et al., 2006; John et al., 2003). Therefore, in our sample, nicotine dependence levels may lie somewhat lower than among the general adolescent smoking population, whereas the readiness to quit may lie somewhat higher. Some caution in interpreting and generalizing the findings to the general adolescent smoking population is therefore warranted.

Fourth, our approach to measure nicotine dependence was limited to three dimensions of nicotine dependence. Therefore, other dimensions of nicotine dependence in adolescents may have fallen outside the scope of this study. Including other potentially important aspects of nicotine dependence, such as seeking emotional or sensory reinforcement (Johnson et al., 2005), may improve the fit of the models presented in this study or increase the explained variance in the outcome variables. In this study, however, we set out to test the significance of three important and well known dimensions of nicotine dependence derived from frequently used and well tested measures. Similarly, even though the present study explored individual characteristics, peers and family, the models are by no means exhaustive. Previously established indicators of smoking cessation practices, such as smoking specific cognitions (e.g. Van Zundert et al., 2008) are not taken into account, nor did we include factors on a more macro-environmental level, such as living in a certain neighbourhood or region, or the influence of specific cultural patterns. However, the present study tested two clearly specified and theoretically driven models, which were found to be robust and to have explanatory value. The explained variance of our longitudinal models are comparable to that of previous longitudinal studies investigating predictors of smoking cessation among both adults and adolescents (e.g. Abrams et al., 2000; Kleinjan et al., 2008a).

To conclude, using a nationwide sample of adolescent smokers, the present study indicated that parental and peer smoking interfere with both the psychological readiness

to quit and with nicotine dependence, which obstruct the ability to quit successfully. In line with Bandura (2004), we argue that, to be most effective, smoking cessation interventions should be applied in several settings simultaneously. In addition, since nicotine dependence was found to be the strongest and most proximate predictor of smoking cessation, besides targeting environmental factors and readiness to quit, it is recommended to also focus on more direct methods to lower the perceived levels of nicotine dependence in adolescents. Although the use and efficacy of nicotine replacement therapy (NRT) in adolescent smokers is controversial (Adelman, 2004; Ginzler et al., 2007), adolescents favour the use of NRT because, although they generally perceive smoking cessation as desirable, it often seems too difficult to achieve due to co-occurring withdrawal symptoms (Molyneux et al., 2006). Additionally, nicotine patch therapy combined with cognitive-behavioural intervention was found effective, compared with placebo, for treatment of nicotine dependence among adolescent smokers who wanted to quit (Moolchan et al., 2005). Because of the important role of nicotine dependence in hindering the ability to successfully quit smoking, more research on the efficacy and safety of NRT among adolescents seems warranted.

Footnotes

¹ Besides the results of the multigroup analyses for the 50% lowest vs. 50% highest levels of nicotine dependence, different distributions of dependence levels were also tested (75% lowest vs. 25% highest; 33% lowest vs. 33% highest; 60% lowest vs. 40% highest). Outcomes for these different distributions of dependence levels corresponded with the results reported, i.e., the relations between readiness to quit, and both the number of quit attempts and smoking cessation, did not differ for different degrees of dependence.

9 Predicting nicotine dependence profiles among adolescent smokers: The roles of personal and social-environmental factors

Based on
Kleinjan, M. Vitaro, F. Wanner, B. Brug, J. Van den Eijnden, R.J.J.M., & Engels, R.C.M.E.
Predicting nicotine dependence profiles among adolescent smokers: The roles of personal and social-environmental factors. (Submitted for Publication)

Abstract

Predictors of nicotine dependence symptom profiles were examined in a prospective study among a population sample of adolescent smokers ($n = 796$). In the first and second year of secondary education, personality traits and exposure to smoking in the social environment assessed (T1). Two and a half years later adolescents' nicotine dependence symptom profiles were assessed (T2). At T2, four distinct dependence symptom profiles were identified. Hierarchical multinomial logistic regression analyses were performed to predict adolescent's membership in the different dependence symptom profiles. The findings suggest that, while exposure to smoking in the social environment may promote the onset of nicotine dependence symptoms, further progression of dependence symptoms is more likely among adolescents who score higher on extraversion and neuroticism. The findings indicate that nicotine dependence is predicted by personal and environmental factors. These insights offer important directions for tailoring interventions that may prevent the onset and escalation of nicotine dependence. It is recommended that intervention programs more specifically target individuals with a high risk of developing more severe dependence symptom profiles.

Introduction

Tobacco is one of the most addictive of recreational substances. It is reported that clinical features of dependence can emerge even during the earliest phases of smoking initiation (DiFranza et al., 2000; O'Loughlin et al., 2003). Moreover, the occurrence of nicotine dependence symptoms among adolescent smokers forms an important barrier for smoking cessation (Prokhorov et al., 2001; Kleinjan et al., 2008a,b). More insight into the epidemiology and aetiology of nicotine dependence among adolescent smokers may therefore have important implications for smoking prevention and cessation interventions among adolescents.

The most commonly used self-report measures of nicotine dependence, such as the assessment proposed by the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association [APA], 1987, 1994) or the Fagerström Tolerance Questionnaire (FTQ: Fagerström & Schneider, 1989), are not designed to measure the earlier stages of nicotine dependence, but assume that a more established smoking pattern is required to yield the key features of nicotine dependence. These characteristics make them less appropriate to assess dependence symptoms among adolescents since among early smokers nicotine dependence symptoms may already be present, but have not reached a diagnosable level. Moreover, these measures generate a classification of low to high levels of dependence, implying that nicotine dependence varies only in severity and not necessarily in nature.

However, a recent study in an adolescent smoking sample found that, when using a measure specifically developed to assess multiple features of nicotine dependence among adolescent smokers, distinct nicotine dependence symptom profiles could be distinguished (Kleinjan et al., submitted). By measuring symptoms indicative of physical tolerance (when, where, and how much one smokes), craving, and withdrawal, it was shown that different patterns of symptoms were associated with increasing differences in severity of dependence. For example, it was found that the presence of physical tolerance appears to indicate more severe dependency than the presence of withdrawal symptoms alone (Kleinjan et al., submitted).

The identification of profiles in reference to nicotine dependence symptoms among adolescent smokers may provide some advantages over the use of counting symptoms to measure severity without taking the type of symptoms into account. First, the identification of different symptom profiles may enable a better understanding of the possible underlying genetic and psychosocial factors of nicotine dependence (Storr, Reboussin, & Anthony, 2005). Twin studies suggest that genetically-based differences in reaction to nicotine moderates the likelihood to take up smoking (Epstein, Grunberg, Lichtenstein, & Evans, 1989; Vink et al., 2004). Not everybody that is exposed to nicotine becomes dependent. Similarly, some are stimulated by nicotine, whereas others are calmed or even depressed by it (Pomerleau & Pomerleau, 1984). Such differences in nicotine effects may be reflected in distinct symptom profiles. Secondly, classification of symptom profiles may thus enable the tailoring of intervention efforts to specifically

target those symptoms most common among the different subtypes of adolescent smokers (Xian et al., 2007). To increase insight into the aetiology of nicotine dependence, as well as to design optimal ways of targeting nicotine dependence among adolescent smokers, it is essential to determine early predictors of nicotine dependence symptom profiles (Kleinjan et al., submitted).

According to the Diathesis Stress model (Zubin & Spring, 1977), the occurrence of problem behaviours or disorders is the result of the interaction between a vulnerable hereditary predisposition and precipitating events in the environment. Assuming that there are differences in the genetic basis of symptom profiles, different personality dimensions may predict nicotine dependence profiles. Personality has a strong genetic basis (Bouchard, 2004; Bouchard & Loehlin, 2001; Turkheimer, 2000), and personality traits are reported to be associated with the initiation and maintenance of smoking in both adolescents and adults (Cherry & Kiernan, 1976; Harakeh, Scholte, De Vries, & Engels, 2006b; Otten, Engels, & Van den Eijnden, 2008). More specifically, several studies have found that smokers tend to be more neurotic and more extravert than non-smokers. A possible explanation for this is that individuals scoring high on extraversion may smoke because they seek stimulation, and those scoring high on neuroticism may smoke to reduce tension and anxiety (Eysenck, 1980; Pritchard, 1991; Fowler et al., 1996). With respect to adult smokers, researchers have suggested that apart from smoking initiation and maintenance, personality traits such as neuroticism and extraversion may also be important in the development of dependence (Breslau, Johnson, Hiripi, & Kessler, 2001; McChargue, Cohen, & Cook, 2004). The first goal of the current study was therefore to examine the effect of extraversion and neuroticism on the development of nicotine dependence symptom profiles in adolescent smokers.

As posited by Social Cognitive Theory (Bandura, 1986), social environmental factors may also be important. With regard to smoking behaviour in adolescents, it was found that exposure to smoking by significant others is related to the development of nicotine dependence symptoms. Children had a higher risk to become nicotine dependent from adolescence to early adulthood when their mother had ever smoked, been a daily smoker or was dependent on nicotine (Hu, Davies, & Kandel, 2006; Lieb, Schreier, Pfister, & Wittchen, 2003). Having smoking peers was also associated with higher levels of nicotine dependence in adolescents (Hu et al., 2006; Audrain-McGovern et al., 2007; Kleinjan et al., in press). When drawing on the Diathesis Stress Model, on the other hand, smoking of parents and peers may also exacerbate or precipitate the links between personal dispositions and nicotine dependence according to a person-environment interactional perspective. Hence, the second goal of the proposed study was to examine the additive and interactive effect of having a smoking mother or having smoking friends in addition to the personality traits of extraversion and neuroticism.

To pursue these study goals, we tested a multi-causal model that incorporates both individual and environmental factors as possible predictors of nicotine dependence symptom profiles among adolescent smokers. A clearer understanding of these factors can provide an important foundation for and contribution to developing effective tailored intervention methods for targeting smoking among adolescents.

Method

Participants

The data of the present study pertain to a longitudinal study that started in January 2003, focusing on psychological and environmental processes in relation to tobacco use among Dutch adolescents. Schools in four regions of the Netherlands were randomly selected from the telephone book and approached to take part. The main reason given for refusal to join this study was participation in other studies. The present study pertains to two measurement waves, including a total of 25 schools. Data for the first wave (T1) were collected from January 2003 to May 2003, in the first and second year of secondary education. The completion rate was 89.7% among the total sample, resulting in 6,783 respondents aged 12-14 ($M = 12.88$, $SD = 0.76$). The second measurement wave (T2) described in this study took place approximately 2.5 years later in November 2005. A total of 4,270 respondents of the original 6,783 respondents participated again (response rate, 63%). Sickness, truancy, moving to another school, repeating class and leaving school after having graduated were noted by teachers as the primary causes for non-response. The medical ethical committee (CMO Arnhem-Nijmegen) approved this study.

At T1, a total of 219 of the 4,270 respondents (5.2%) indicated to smoke at least once a month. At T2, a total of 796 (18.6 %) indicated that they had smoked at least once in the past month. Of the 219 smokers at T1, 169 were also classified as smokers at T2 (77.2%). Of the 796 smoking respondents included in the present study, 56.8% was female. A total of 33.4% received preparatory vocational training, 21.3% junior general secondary training, 28.6% senior general secondary education, 15.7% received university preparatory training, and 0.9% reported to receive some other form of education.

Procedure

Respondents completed written, self-administered questionnaires in the presence of their teacher during school hours. Students were informed that the data would be processed anonymously, i.e., respondent-specific codes were used to link the data from one point in time to the next. To assure confidentiality, each student received an unmarked envelope which they used to return the completed questionnaires. In addition, respondents were informed that participation was voluntary.

Attrition Analyses

Of the 6,783 respondents at T1, 4,270 were included again at T2. The respondents lost at follow-up were compared with the remaining respondents on gender, age, education, and smoking status using multivariate logistic regression analyses. Logistic regression analysis with loss to follow-up (No/Yes) as dependent variable showed that respondents lost at follow-up were significantly more likely to be boys, to have general secondary training, and less likely to be smokers (Nagelkerke $R^2 = 0.06$)

Measures

Personality Dimensions of Extraversion and Neuroticism. The personality dimensions of extraversion and neuroticism assessed at T1 were each measured using six items.

The items assessing extraversion and neuroticism were part of the Quick Big Five, a well-validated instrument that aims to assess the factors of the Five Factor Model of personality (Vermulst & Gerris, 2005). Respondents were asked on a 7-point scale to what degree he or she possessed certain traits distinctive of either extraversion or neuroticism. Extraversion was measured by items such as being quiet, shy or withdrawn (Cronbach's alpha = 0.68). The items were recoded so that a higher score on this scale represented a higher level of extraversion. Neuroticism was measured by items such as being fearful, nervous or sensitive (Cronbach's alpha = 0.71). The scale scores were recoded to a variable differentiating between high levels of extraversion or neuroticism (i.e., scores 0.5 SD above the mean) and low levels of extraversion or neuroticism (i.e., all scores below the cut off of 0.5 SD above the mean).

Smoking Mother. Smoking status of the mother at T1 was assessed by asking: "Does your mother smoke?", and could be answered by either 'yes' or 'no'. At T1, 40.5% indicated that their mother is a smoker. Adolescents' proxy reports on parental smoking were found to be reliable indicators of parents' lifetime and current smoking status (Harakeh, Engels, De Vries, & Scholte, 2006a).¹

Smoking Friends. Smoking of friends at T1 was assessed by asking adolescents to estimate the proportion of smoking friends on a 5-point scale, ranging from 1 = 'none of my friends smoke' to 5 = 'all of my friends smoke' (Engels, Knibbe, Drop, & De Haan, 1997). Responses were recoded to a variable differentiating between having no smoking friends and having friends who smoke. At T1, 54.5% of the participants indicated to have smoking friends.

Nicotine Dependence. The different aspects of nicotine dependence were assessed at T2 for smokers only, using a newly developed multidimensional scale based on both the modified Fagerström Tolerance Questionnaire (mFTQ) and the Hooked on Nicotine Checklist (HONC) (Prokhorov, Pallonen, Fava, Ding, & Niaura, 1996; DiFranza et al., 2002b). The 11-item scale was validated in a previous study (Kleinjan et al., 2007). The HONC is specifically developed to be used among adolescent smokers whose dependence is still developing (Wellman et al., 2005). The mFTQ, on the other hand, is assumed to measure behavioural aspects and strength of physical dependence, and was not designed to measure the earlier stages of nicotine dependence (Kandel et al., 2005; O'Loughlin, Tarasuk, DiFranza, & Paradis, 2002c). The combination of the mFTQ and the HONC contains items thought to be indicative of early symptoms, as well as items presumably indicative of symptoms that occur when dependence is more manifest; taken together, these items enable the measurement of a wider range of nicotine dependence. In a previous study by Kleinjan and colleagues (submitted) it was shown that, based on the combined items, four distinct profiles of nicotine dependence could be identified among the adolescent smoking population. One profile was composed of adolescents who displayed low craving only. The second profile was composed of adolescents who displayed high craving and withdrawal. The third class was composed of adolescents displaying high cravings and physical tolerance. The fourth class displayed high scores on craving, physical tolerance and withdrawal. One year later nicotine dependence symptoms were assessed again

and it was found that the four nicotine dependence classes were relatively stable over time. The most stable classes were the 'high craving and physical tolerance' class and the 'overall high dependent' class. Very few adolescents transferred from the 'high craving and physical tolerance' class or the 'overall high dependent' class to the 'low cravings only' class or the 'high craving and withdrawal' class. The least stable class was the 'high craving and withdrawal' class, where adolescents had a relatively high chance of transferring to the 'high craving and physical tolerance' class and the 'overall high dependent' class. As for the 'low cravings only' class a large proportion transferred to the 'high craving and withdrawal' class. Furthermore, results showed that adolescent smokers in the 'low cravings only' class had the highest likelihood to be a non-smoker at the follow-up measure, followed by the 'high craving and withdrawal' class, 'high craving and physical tolerance' class, and the 'overall high dependent' class, respectively. These results indicate that the four qualitatively distinct profiles quantitatively differ with regard to severity of dependence, with the 'high craving and physical tolerance' class seeming more proximal to the 'overall high dependent' class, whereas the 'high craving and withdrawal' class seemed to be more proximal to the 'low cravings only' class. Descriptions of the 11 nicotine dependence items are given in Table 1.

Statistical Analyses

The analyses proceeded in two steps. The first step was based on the previous study by Kleinjan and colleagues (submitted) in which latent class analysis (LCA) was applied to examine whether empirically-derived classes of nicotine dependence could be identified within a population sample of adolescent smokers. The present study sought to replicate these results in a larger sample of adolescent smokers using the software package MPLUS 4.1 (Muthen & Muthen, 1998-2007a). Table 1 provides a detailed description of the items used at T2 to generate the latent classes. For a detailed description of the LCA procedure we refer to Kleinjan and colleagues (submitted).

Second, hierarchical multinomial logistic regression analyses using SPSS were performed to predict adolescents' membership in one of the nicotine dependence classes at T2. To account for uncertainty of membership in the subclasses, we used the posterior probabilities of being member in the respective subclass as weights in the multinomial regression analyses (Cote, Vailantcourt, LeBlanc, Nagin, & Tremblay, 2006; Otten, Wanner, Vitaro, Van den Eijnden, & Engels, resubmitted). In a first step, sex, age and education level as measured at T1, were included to predict class membership. In a second step, we included the personality dimensions of extraversion and neuroticism as predictors. In a third step, smoking of mother and friends were added as predictors.

Finally, in a fourth step the interaction terms of the personality dimensions with smoking of mother and friends were added. For each step, comparisons were made regarding the covariates' scores in the one class as compared to the other classes. However, when depicting the results, we will use the 'low cravings only' class as the comparison group for the 'high craving and withdrawal' class, the 'high craving and withdrawal' class as comparison for the 'high craving and physical tolerance' class, and the 'high craving and

physical tolerance' class as comparison for 'overall high dependent' class respectively. We chose to depict this limited number of statistical comparisons for reasons of interpretability and because the empirical patterns of results support the underlying severity dimension that the 'high craving and physical tolerance' class seems more proximal to the 'overall high dependent' class, whereas the 'high craving and withdrawal' class seems to be more proximal to the 'low cravings only' class.

Results

Identification of Nicotine Dependence Subclasses

Results from the LCA showed that the nicotine dependence symptom profiles identified by Kleinjan and colleagues (submitted) were replicated. The latent class membership statistics for the two nominal items, i.e. 'Which cigarette would you hate to give up?' and 'Do you smoke if you are so ill that you are in bed most of the day?' are described in Table 3, and the Latent Class profile for the continuous items is depicted in Figure 1. In the present study the 'low cravings only' class was estimated for 45.5%. The 'high craving and withdrawal' class was estimated for 16.0%. The high craving and physical tolerance class consisted of 23.3% of all smokers, whereas the 'overall high dependent' class consisted of 15.1%. An analysis of variance analysis showed that these results were not confounded by the duration of smoking, that is age of smoking initiation [$F(3, 796) = 2.48, p = n.s.$].

Table 1 Item descriptions of the nicotine dependence scale

Item	Response categories
Behavioral aspects indicative of physical tolerance	
B1: How soon after you wake up do you smoke your first cigarette	1. Within 5 minutes 2. Within 6-30 minutes 3. Within 31-60 minutes 4. After 60 minutes
B2: How many cigarettes a day do you smoke	1. Less than 1 a day 2. About 1-5 a day 3. About 6-10 a day 4. About 11-20 a day 5. About 21-30 a day 6. Over 30 a day
B3: Which cigarette would you hate to give up	1. First cigarette in the morning 2. Any other cigarette
B4: Do you smoke if you are so ill that you are in bed most of the day	1. No 2. Yes

Item	Response categories
Craving	
C1: Have you ever felt like you were addicted to tobacco	1. Never 2. Seldom 3. Sometimes 4. Often
C2: Do you ever have strong cravings to smoke	1. Never 2. Seldom 3. Sometimes 4. Often
C3: Have you ever felt like you really needed a cigarette	1. Never 2. Seldom 3. Sometimes 4. Often
C/W4: Do you smoke because it is really hard to quit	1. No, not at all 2. A little 3. Quite 4. Yes, very
Withdrawal	
At times that you tried to stop or weren't able to smoke, how often did you experience the following:	
W1: Trouble concentrating	1. Never 2. Seldom 3. Sometimes 4. Often
W2: Feeling irritable or angry	1. Never 2. Seldom 3. Sometimes 4. Often
W3: Feeling nervous, restless or anxious	1. Never 2. Seldom 3. Sometimes 4. Often

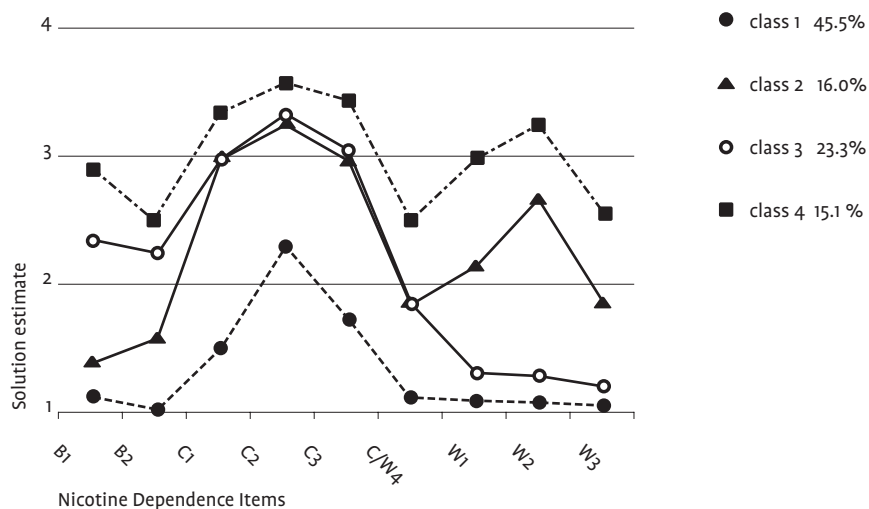
Note: C/W4 = Do you smoke now because it is really hard to quit? The answer to this item can be regarded as being a result of both craving and withdrawal symptoms

Table 2 Item response probabilities for the two nominal Behavioral aspects items

Item response probabilities ^a		
	Item B3	Item B4
Class 1	0.05	0.01
Class 2	0.21	0.05
Class 3	0.46	0.28
Class 4	0.64	0.52

Note. ^a Probability of responding to the answer category indicative of dependence
 Item B3 = Which cigarette would you hate to give up; Item B4 = Do you smoke if you are so ill that you are in bed most of the day. Class 1 = 'low cravings only'; Class 2 = 'high cravings and withdrawal'; Class 3 = 'high cravings and physical tolerance'; Class 4 = 'overall high dependent'

Figure 1 Latent class profiles at T2 for the four class model



Note: The items B1 and B2 correspond to the physical tolerance items as shown in Table 1.
 The items C1, C2, C3 and C/W4 correspond to the craving items as shown in Table 1.
 The items W1, W2, and W3 correspond to the withdrawal items in Table 1.
 Class 1 = 'low cravings only'; Class 2 = 'high cravings and withdrawal'; Class 3 = 'high cravings and physical tolerance'; Class 4 = 'overall high dependent'

Hierarchical Multinomial Logistic Regression Analyses.

Table 3 presents the outcomes of the hierarchical multinomial logistic regression analyses. No main effects were found for the personality dimensions of extraversion and neuroticism on the endorsement of the dependence profiles. The inclusion of the main effects of environmental smoking indicated that participants were more likely to be classified in the 'high cravings and physical tolerance' class than in the 'high cravings and withdrawal' class if they had a smoking mother ($odds = 2.00, p < 0.01$), whereas participants were more likely to be classified in the 'high cravings and withdrawal' class as opposed to the 'low cravings only' class if they reported to have smoking friends ($odds = 1.98, p < 0.01$). Further, although there was no main effect of the personality dimensions of extraversion and neuroticism, the inclusion of the interaction terms in step 4 of the personality dimensions x smoking of mother or friends indicated a significant interaction effect of having smoking friends regarding the link between extraversion and the likelihood of being classified in the 'high dependent' class as opposed to the 'high cravings and physical tolerance' class ($p < 0.05$), as well as the link between neuroticism and the likelihood of being classified in the 'high dependent' class as opposed to the 'high cravings and physical tolerance' class ($p < 0.05$). In addition, a significant interaction effect was found for having a smoking mother regarding the link between extraversion and the likelihood of being classified in the 'high cravings and physical tolerance' class as opposed to the 'high cravings and withdrawal' class ($p < 0.05$). Table 3 depicts only the significant interaction effects.

To interpret the interaction effects we repeated the analyses stratified by having a smoking friend and by having a smoking mother (Jaccard, 2001). Interpretation of the three interaction effects revealed that extraversion predicted likelihood to be classified in the highest dependence class only among adolescents with a smoking friend. Extraversion predicted higher likelihood of being classified in the 'high cravings and physical tolerance' than in the 'high cravings and withdrawal' class among adolescents with a mother who was a smoker. With regard to the interaction effect of neuroticism with smoking friends, it was found that the positive link between neuroticism and being in the 'high dependent' class as opposed to the 'high cravings and physical tolerance' class was stronger for adolescents who had no smoking friends.

Table 3 Multinomial logistic regression analysis predicting nicotine dependence subclasses

	Nagelkerke R ² Change	Reference Class		OR
Step 1	.084			
Sex		Class 1	Class 2	0.99
		Class 2	Class 3	0.69
		Class 3	Class 4	1.28
Age		Class 1	Class 2	1.26
		Class 2	Class 3	0.88
		Class 3	Class 4	1.09
Education		Class 1	Class 2	0.53***
		Class 2	Class 3	0.90
		Class 3	Class 4	1.11
Step 2	.010			
Extraversion		Class 1	Class 2	0.81
		Class 2	Class 3	1.32
		Class 3	Class 4	1.41
Neuroticism		Class 1	Class 2	1.20
		Class 2	Class 3	0.96
		Class 3	Class 4	1.42
Step 3	.056			
Smoking mother		Class 1	Class 2	0.74
		Class 2	Class 3	2.00**
		Class 3	Class 4	1.38
Smoking friends		Class 1	Class 2	1.98**
		Class 2	Class 3	1.01
		Class 3	Class 4	1.12
Step 4a	.010			
Neur x Friend		Class 3	Class 4	0.79*
Step 4b	.010			
Extrav. x Friend		Class 3	Class 4	1.29*
Step 4c	.010			
Extrav x mother		Class 2	Class 3	1.34*

* p < 0.05; ** p < 0.01; ***p < 0.001.

Note. Sex is coded such that 0 indicates boys and 1 indicates girls. Only significant interactions are included in the table. Class 1 = 'low cravings only'; Class 2 = 'high cravings and withdrawal'; Class 3 = 'high cravings and physical tolerance'; Class 4 = 'overall high dependent'

Discussion

Among adolescent smokers, there are individual differences in the susceptibility to nicotine dependence symptoms. In agreement with an earlier study (Kleinjan et al., submitted), the present study showed that four symptom profiles can be distinguished on the basis of items indicative of physical tolerance, craving and withdrawal symptoms. Furthermore, this study illustrated that personal as well as social-environmental factors predict these distinct profiles.

Even though the personality traits of neuroticism and extraversion were found to be predictive of smoking initiation and regular smoking in adolescents (Harakeh et al., 2006b; Otten et al., 2008), they do not seem to form independent risk factors for the development of dependence symptom profiles. On the other hand, inline with the Social Cognitive Theory (Bandura, 1986), the exposure to smoking by parents or friends forms an important risk factor for the development of future dependence symptoms. These findings corroborate previous findings suggesting that the social context is more strongly related to adolescent smoking as compared to personality traits (Otten et al., 2008; Byrne, Byrne, & Reinhart, 1993). However, in line with the Diathesis Stress Model (Zubin & Spring, 1977), personality traits did interact with the exposure to smoking behaviour of significant others in explaining differences in dependence symptom profiles. When combined with environmental exposure to smoking, extraversion seems to increase the risk to develop more severe dependence symptom profiles. The findings of the present study suggest that the presence of smokers in the direct social environment on itself poses a risk for the initial development of nicotine dependence symptoms, whereas being neurotic or extravert may predict for a further progression of dependence symptoms. Thus far, person-environment interactions were mostly investigated in relation to adolescent smoking initiation (Otten et al., 2008; Byrne, Byrne, & Reinhart, 1993) rather than smoking persistence. To our knowledge, this is the first study to look at person-environment interactions with regard to the incidence of specific nicotine dependence symptom profiles among adolescent smokers.

Implications

The identification of precursors of dependence symptom profiles may prove particularly helpful to differentially prevent or remedy nicotine dependence by targeting specific precursors of the different subtypes. The presence of smoking friends seems to coincide with the initial occurrence of craving and withdrawal symptoms. Being around smoking friends may enhance the exposure to smoking cues that trigger craving and withdrawal symptoms (Carter & Tiffany, 2001). Hence, interventions could aim at stimulating ways of instrumental support that the direct environment can provide to discourage smoking, such as not smoking in the presence of someone who is attempting to quit. Previous research indicated that instrumental support leads to the lower likelihood of substance use in adolescents (Brook, Brook, Gordon, Whiteman, & Cohen, 1990). Additionally, actions to prohibit smoking in social settings (such as school grounds, bars, restaurants and other public places) may be effective in decreasing smoking among adolescents.

Increased risk of physical tolerance seems to be linked to being extravert in combination with having a smoking mother and/or friends. Having a smoking mother and smoking friends may create more physical tolerance-enhancing circumstances, such as ample availability or offering of cigarettes and occasions to smoke. Because of their outgoing nature, extravert adolescents may be more vulnerable to social influence or more susceptible to adopt peer behaviours (e.g., showing similar behaviours and doing similar things is rewarding). Making extravert smokers aware of their increased vulnerability to social influences with regard to smoking and to the risk of developing a more severe dependence syndrome may encourage them to avoid (or to be particularly cautious) in risky social settings. The finding that adolescents who scored high on neuroticism and who had no smoking friends were more likely to be classified in the 'high dependent' profile, as opposed to the 'high cravings and physical tolerance' profile, seems counterintuitive at first hand. One possible explanation might be that adolescents who score high on neuroticism have fewer friends and thus are more likely not to have smoking friends. Previous research indeed found a positive association between both general and emotional loneliness and neuroticism (Saklofske & Yackulic, 1989). Another explanation might be the difference in withdrawal symptoms between the 'high dependent' profile and the 'high cravings and physical tolerance' profile. Smokers scoring high on neuroticism are thought more likely to experience anxiousness and nervousness when deprived of cigarettes. Having smoking friends may provide more smoking opportunities to ease withdrawal due to nicotine deprivation. Being a neurotic smoker and having no smoking friends may restrict the possibilities to relieve withdrawal, because friends might disapprove of the smoking behaviour, or that time spent with friends is more likely to take place in surroundings where smoking is not permitted.

To prevent classification in high dependence symptom profiles, it is recommended that intervention programs be designed to more specifically target individuals with a high risk of developing more severe dependence symptom profiles, e.g. individuals exposed to environmental smoking, particularly if they have an extravert personality. Tailoring the intensity and type of smoking treatment may be more effective for these high risk individuals compared to the more widely implemented general approaches.

Limitations

The present study has some limitations. First, the data are based on adolescent self-report of their own smoking, as well as those of their parents and friends. Under or over-reporting may thus have occurred (Patrick et al., 1994; Stein et al., 2002). However, self-reported smoking behaviour has been found to be reliable and valid compared with more 'objective' methods such as biochemical validation (Dolcini, Adler, & Ginsberg, 1996; Hunter, Webber, & Berenson, 1980; Prokhorov et al., 2000).

Second, attrition analysis indicated a possible under-representation of lower educated adolescent male smokers. Since a lower educational level has been associated with higher levels of nicotine dependence (Hu et al., 2006), caution is warranted when interpreting and generalizing the findings of the present study to the general adolescent smoking population.

Third, even though the present study explored individual characteristics, and peer and family factors, in the emergence of nicotine dependence symptoms, these predictors are by no means exhaustive. Personality traits other than Neuroticism and Extraversion were not taken into account, nor did we include a full spectrum of environmental factors, such as smoking of siblings or smoking in the media. However, the present study tested clearly-specified and theoretically-driven predictors, which were found to have explanatory value with regard to smoking behaviour among adolescents.

Fourth, some caution is warranted when describing the effect of parental smoking as solely an environmental risk factor. Maternal smoking may influence nicotine dependence through a modeling effect, but genetic transmission or perinatal factors triggered by maternal smoking may also be partly responsible for the development of specific symptoms.

Directions for Future Research

Increasing evidence suggests that nicotine dependence symptoms are substantially heritable (Audrain-McGovern et al., 2007; Koopmans, Slutske, Heath, Neale, & Boomsma, 1999; Vink, Willemsen, & Boomsma, 2005). Identification of nicotine dependence phenotypes may facilitate future research on genetic causes of behaviour, for example by testing the different phenotypes for an association with a particular genetic factor. As important genetic factors of nicotine dependence become identified, we can subsequently examine how these specific genetic factors interact with environmental influences in determining addictive behaviour. Identification of the specific genetic and environmental mechanisms that underlie the emergence of dependence symptoms among adolescent novice smokers will likely lead to a more refined understanding of the aetiology of nicotine dependence.

Conclusions

Despite the potential limitations, our findings help explain the emergence of variability in adolescent nicotine dependence profiles and may provide indications as to why some adolescents develop a full dependence syndrome and others do not. The present study provides into individual and environmental factors and mechanisms underlying the development of nicotine dependence symptom profiles in adolescents. These insights may prove important in the aim to more optimally tailor interventions that will prevent the onset and escalation of nicotine dependence in adolescents.

Footnotes

¹ We also conducted analyses including smoking behaviour of the father. However, smoking of the father at baseline was not significantly related to the nicotine dependence symptom profiles at follow-up. In addition, combining smoking behaviour of father and mother into one variable also showed no significant links to the outcome variable. To ease the interpretability of the results, we decided not to include smoking of the father in the final model.

10 Adolescents' smoking cessation:
The effects of craving and withdrawal
symptoms during abstinence and
ad libitum smoking

Based on
Kleinjan, M. Van den Eijnden, R.J.J.M. Brug, J., & Engels, R.C.M.E.
Adolescents' smoking cessation: The effects of craving and withdrawal symptoms
during abstinence and ad libitum smoking. (Submitted for publication).

Abstract

Craving and withdrawal symptoms as determinants of adolescent smoking cessation have not been investigated extensively. Moreover, across determinant studies, craving and withdrawal are often assessed retrospectively among current smokers. Yet, craving and withdrawal measured during abstinence may be better indicators of bio-psychological dependence and, therefore, stronger predictors of smoking cessation practices. The present study included 98 daily smoking adolescents to gain insight into the predictive value of different measures of craving and withdrawal symptoms on smoking cessation. First, craving and withdrawal symptoms were measured during a period of non-restricted (ad libitum) smoking. Second, craving and withdrawal symptoms were assessed directly after a 24 hour period in which respondents were instructed to remain abstinent. Results indicate that the levels of craving and withdrawal varied across the assessment situations of abstinence and ad libitum smoking. Furthermore, craving, but not withdrawal, predicted prolonged cessation assessed four months later, with craving measured during abstinence being a stronger predictor compared to craving measured during ad libitum smoking. In conclusion, when studying smoking cessation among adolescents, the measurement of craving in vivo seems preferable to the measurement of craving during ad libitum smoking.

Introduction

While adolescents mainly start smoking for social reasons, in time most of them will smoke for the pharmacological effects of nicotine (Benowitz & Henningfield, 1994). Similar to adult smokers, adolescents were found to experience that withholding nicotine ingestion is accompanied by withdrawal symptoms and craving (Jacobsen et al., 2005; Rojas, Killen, Haydel & Robinson, 1998). Rojas and colleagues found that, among adolescent smokers, the urge to smoke, or craving, was the most reported symptom. Other withdrawal symptoms reported by adolescents are dysphoric mood, insomnia, irritability, frustration, anxiety, difficulty concentrating, and restlessness (APA, 2000; Colby, Tiffany, Shiffman & Niaura, 2000a).

The role of craving, in addition to other withdrawal symptoms, as determinants of adolescent smoking cessation has not yet been extensively investigated. Craving is considered to be conceptually different from other withdrawal symptoms (Teneggi et al., 2002a). Craving is assumed to emerge earlier in the smoking history of cigarette smokers, and regular smokers report high levels of craving even while actively smoking (Corrigal, Zack, Eissenberg, Belsito, & Scher, 2002; Tiffany & Drobes, 1991). Even though adolescent smokers report to experience withdrawal symptoms while not engaging in formal quit attempts (Stanton, 1995), nicotine deprivation seems to be the primary cause of withdrawal symptoms. Craving, on the other hand, can be activated by environmental cues in addition to deprivation. Craving may thus be experienced even after physical withdrawal symptoms are no longer present. A study among adults found that smokers report substantial difficulties coping with craving, whereas less difficulty is reported for dealing with other withdrawal symptoms (Killen & Fortmann, 1997). These considerations suggest that craving and withdrawal symptoms might be controlled by separate biopsychological mechanisms (Teneggi et al., 2002a) and might have a differential impact on smoking cessation. Studies among adults indeed showed that craving, but not withdrawal, seemed to be prospectively associated with maintained abstinence (Curry & McBride 1994; Kenford et al., 1994; Killen & Fortmann, 1997). Therefore, the present study sets out to more closely examine the roles of experienced craving and withdrawal in explaining adolescents' smoking cessation.

Cross-sectional and longitudinal studies on factors influencing smoking cessation generally measure experienced craving and withdrawal symptoms retrospectively, or use single ratings for long periods of time (i.e., asking current smokers how often they experienced craving and withdrawal symptoms during a specific period of time in which they were either abstinent, not able to smoke, or actively smoking) (e.g. Stanton, 1995; Prokhorov et al., 2001). It has been suggested, however, that these methods are susceptible to biases, such as recall bias and bias related to availability of data (Engels & Bot, 2003; McCarthy, Piasecki, Fiore & Baker, 2006; Merinkangas, 2004). Moreover, adolescents generally tend to underestimate the difficulties of smoking cessation (MacDonald, 2004) and, because relatively few adolescent regular smokers attempt to quit on their own (Mermelstein, 2003), they may not yet have fully experienced craving and withdrawal symptoms. The measurement of craving and withdrawal among currently smoking adolescents may therefore not reflect the true nature of their biopsychological dependence and form a less robust determinant of smoking cessation. Even though

adolescent smokers were found to report feelings of craving and withdrawal symptoms while actively smoking as well as during abstinence (Stanton, 1995; Tiffany & Drobes 1991), most studies among both adult and adolescent smokers have found higher scores after a period of abstinence (Doherty, Kinnunen, Militello & Garvey, 1995; Killen et al., 1991; Killen & Fortmann, 1997; McNeill, West, Jarvis, Jackson, & Bryant, 1986). It is therefore plausible that the impact of craving and withdrawal symptoms on smoking cessation practices may be different when measuring these symptoms while actively smoking, compared to a period of abstinence in which these symptoms are present and fully experienced.

To examine this hypothesis, the present study included two different approaches to assess craving and withdrawal symptoms. First, craving and withdrawal symptoms were assessed during a period in which respondents were able to smoke ad libitum. Second, to enable the measurement within a naturalistic setting, craving and withdrawal symptoms were assessed among adolescent regular smokers instructed to remain abstinent for a period of 24 hours (for a similar method see Van den Eijnden, Spijkerman & Fekkes, 2003). We hypothesize that levels of craving and withdrawal symptoms are higher during abstinence as compared to a period of ad libitum smoking. Additionally, because previous studies have indicated that craving and withdrawal symptoms appear more frequently and tend to be stronger among adolescents who experience more symptoms of nicotine dependence (Bagot, Heishman & Moolchan, 2007; Prokhorov et al. 2001), we will also examine whether nicotine dependence is differentially related to craving and withdrawal during abstinence versus ad libitum smoking.¹ It is expected that for adolescents with high levels of dependence, craving and withdrawal scores during abstinence are higher. Furthermore, based on previous studies among adults, it is hypothesized that craving will be more strongly associated with prolonged cessation at follow-up as compared to withdrawal symptoms. Finally, it is expected that craving and withdrawal symptoms measured during abstinence will be more predictive of smoking cessation, as compared to craving and withdrawal symptoms measured during ad libitum smoking.

Method

Study Design and Procedure

To assess the role of craving and withdrawal symptoms in adolescent smoking cessation, and to establish whether craving and withdrawal assessed during abstinence have a differential impact on smoking cessation compared to assessment during ad libitum smoking, a short-term longitudinal study was conducted.

Respondents were recruited at six Dutch high schools during the breaks on regular school days. Respondents who were willing to participate had to fill out an application form with questions about their smoking habits. In order to participate, respondents had to smoke at least five cigarettes a day. To avoid the inclusion of non-smoking or irregular smoking participants who simply wanted to obtain the reward these criteria were not communicated to volunteers. Parents were informed by mail that their child was willing

to participate in a study on smoking and they were asked for informed consent. This study was approved of by the local Medical Ethical committee (CMO Arnhem-Nijmegen).

Selected respondents had to complete an online questionnaire (T1) through which information regarding their nicotine dependence level, craving and withdrawal symptoms was obtained. Five weeks later, participants received information on the procedure for the 24-hour period of abstinence. It should be noted that, generally, nicotine craving tends to be strongest within 6-24 hours after quitting, thereafter diminishing gradually (Maude-Griffin & Tiffany, 1996). In addition, withdrawal signs appear mostly within 6-12 hours after smoking cessation (Hughes, 1992). Following the 24-hour period of abstinence, participants completed the second assessment before the start of their school lessons. To verify that the participant had been abstinent, a self-administered saliva-based cotinine test was used (NicAlert ®; Nymox Corporation). The saliva NicAlert ® assay is reported to be a valid, highly sensitive and specific method for validating self-reported smoking status (Montalto & Wells, 2007). Saliva samples are a useful alternative to plasma samples to assess nicotine concentration, with the advantage of being non-invasive and easier to collect (Tenneggi et al., 2002b). The NicAlert ® test strip is divided into seven reactive chromographic levels of cotinine detection: from 0 (0-10 ng/ml, a non-smoker) to 6 (2000+ ng/ml, a heavy smoker). After consultations with the Nymox Corporation and taking into consideration the half-life of cotinine (~ 20 h), it was decided that adolescent daily smokers who had been abstinent for 24 hours should not exceed level 2 (30-100 ng/ml) on the saliva cotinine test to be included in the analyses. Directly after the cotinine tests were administered, questionnaires assessing experienced craving and withdrawal symptoms during abstinence had to be completed (T2). Four months later, participants were contacted again with questions about their smoking status during the past four months (T3). Respondents who completed all measurements were rewarded with 20 euro for their participation.

Participants

A total of 135 respondents participated at all three measurement times. Respondents with saliva cotinine scores exceeding level 2 (30-100 ng/ml) and respondents whose saliva test scores were inconclusive were excluded (n = 37). This left 98 respondents (55% was male) with a mean age at baseline of 15.8 (SD 1.28, range 13-18) years. Of these 98 adolescent daily smokers, 7.2% received preparatory vocational training, 31.6% junior general secondary training, 42.9% senior general secondary education, and 16.3% university preparatory training.

Measures

Craving. Craving for tobacco was assessed with five items that asked for the frequency of missing, desiring, thinking of, or longing for a cigarette; for example, "I desire smoking a cigarette" and "I miss a cigarette." (Dijkstra & Borland, 2003). In the ad libitum condition, respondents were asked how often they experienced these symptoms of craving (Cronbach's alpha 0.89). During abstinence, respondents were asked how often they experienced these symptoms of craving in the past 24 hours (Cronbach's alpha 0.94). Answers could be given on a 5-point scale, ranging from 'never' to 'very often.'

Withdrawal. Withdrawal symptoms were assessed using three items derived from the Hooked on Nicotine Checklist (HONC: DiFranza et al., 2002b). The HONC is a 10-item instrument that was designed to measure loss of autonomy over tobacco use in adolescents. Three items of the 10-item HONC ask about specific withdrawal symptoms that might be experienced by adolescent smokers. The 3-item withdrawal scale was validated in a study by Kleinjan et al. (2007) and was found to be a distinct dimension of nicotine dependence in adolescents. In the ad libitum condition, respondents were asked how often they experienced the following symptoms at times that they tried to stop or weren't able to smoke: 1. Trouble concentrating; 2. Feeling irritable or angry; 3. Feeling nervous, restless or anxious. During abstinence, respondents were asked how often they experienced these symptoms in the past 24 hours of abstinence. All these symptoms have previously been recommended as those that need to be assessed when measuring withdrawal from tobacco (Shiffman, West & Gilbert 2004b). Answers could be given on a 4-point scale, ranging from 'never' to 'often.' In the current study, the three withdrawal items were analysed separately.

Nicotine dependence. The level of nicotine dependence was assessed during ad libitum smoking using a short version of the modified Fagerström Tolerance Questionnaire (mFTQ; Prokhorov, Pallonen, Fava, Ding & Niaura, 1996). This 4-item scale has been validated among adolescents by Kleinjan et al. (2007). Chronbach's alpha at T1 was 0.61.

Prolonged cessation. At the four month follow-up, respondents who indicated that they had not smoked during the past month or longer were considered to be stable abstinent (US Department of Health and Human Services, 1994; Zhu, Sun, Billings, Choi, & Malarcher, 1999).

Strategy for Analyses.

Paired samples t-tests were used to examine whether levels of craving and withdrawal symptoms differed when measured during abstinence compared to ad libitum smoking. To assess whether adolescent smokers scoring high on nicotine dependence differed from those scoring low on nicotine dependence in craving and withdrawal symptoms during abstinence and ad libitum smoking, independent samples t-tests were used. Pearson correlations between the independent variables, and Spearman correlation between the independent variables and smoking cessation were calculated for the ad libitum smoking condition, as well as for the abstinence condition. Consequently, to test the hypothesis that craving and withdrawal symptoms measured during abstinence are more predictive of prolonged smoking cessation at follow up, as compared to craving and withdrawal symptoms measured during ad libitum smoking, a hierarchical logistic regression analyses was applied, first entering the independent variables measured during ad libitum smoking, and next entering independent variables measured during abstinence. In the logistic regression analyses, sex, age, and education level were entered as covariates. Before applying logistic regression analyses, the missing data in the raw data matrix (with missing data between 2.0 and 3.1%) were estimated with the Expectation-Maximization (EM) algorithm in SPSS.

Results

Smoking Characteristics

At T1, respondents reported to smoke on average 10.7 cigarettes per day (SD = 5.27, range = 5-25). During abstinence (T2), craving scores were significantly higher compared to ad libitum smoking (Table 1). Of the withdrawal scores, only trouble concentrating was significantly higher during abstinence, whereas no differences were found for feeling irritable or angry, and feeling restless, nervous or anxious (Table 1). Craving levels during abstinence were higher for the respondents scoring high on nicotine dependence than for those scoring low on nicotine dependence, whereas craving levels during ad libitum smoking were equal for both groups (Table 2). The same pattern was found with regard to trouble concentrating. Feeling irritable or angry did not differ with regard to nicotine dependence level in either the abstinence or the ad libitum condition. Feeling restless, nervous or anxious was significantly increased for those scoring high on nicotine dependence during both measurement conditions. A total of 10.2% reported at the four month follow-up to be abstinent from smoking for more than 30 days (M days = 44.3, SD = 22.8, range = 30-90).

Table 1 Comparison of mean levels of craving and withdrawal symptoms during ad libitum smoking and during abstinence

	During ad libitum smoking	During abstinence	t-value	df
Craving	Mean (SD) 3.25 (0.86)	Mean (SD) 3.60 (1.07)	-3.95***	96
Trouble concentrating	2.14 (1.08)	2.47 (0.99)	-2.99**	96
Feeling irritable or angry	2.53 (1.11)	2.40 (1.13)	1.16	96
Feeling restless, nervous or anxious	2.09 (1.09)	2.02 (1.00)	0.65	96

* p < 0.05; ** p < 0.01; *** p < 0.001; n = 98

Table 2 Comparison of mean levels of craving and withdrawal symptoms between respondents with high nicotine dependence scores and respondents with low nicotine dependence scores

	Nicotine dependence		t-value	df
	Mean (SD)	High Mean (SD)		
Craving				
During ad libitum smoking	2.96 (0.99)	3.33 (0.64)	-1.90	96
During abstinence	3.47 (1.10)	4.23 (0.62)	-3.85***	96
Trouble concentrating				
During ad libitum smoking	1.90 (0.90)	2.44 (0.96)	-2.17*	96
During abstinence	2.45 (1.00)	2.56 (0.96)	-0.41	96
Feeling irritable or angry				
During ad libitum smoking	1.86 (0.98)	2.12 (0.72)	-1.02	96
During abstinence	2.37 (1.15)	2.56 (1.03)	-0.64	96
Feeling nervous, restless or anxious				
During ad libitum smoking	1.61 (0.77)	2.06 (0.85)	-2.10*	96
During abstinence	1.91 (0.95)	2.56 (1.15)	-2.42*	96

Note: df = degrees of freedom; n = 98
* p < 0.05, ** p < 0.01, *** p < 0.001

Univariate correlations between predictors and smoking cessation

Pearson correlations showed that prolonged cessation was inversely associated with the level of nicotine dependence at baseline. Also, both craving during abstinence and craving during ad libitum smoking were found to be negatively associated with prolonged smoking cessation (Table 3). None of the withdrawal symptoms were significantly associated with smoking cessation at follow-up.

Table 3 Pearson and Spearman correlations between craving, withdrawal symptoms, readiness to quit, and prolonged cessation

	1	2	3	4	5	6	7	8	9
Ad libitum smoking									
1. Nicotine dependence	-								
2. Craving	.52***	-							
3. Trouble concentrating	.31**	.42***	-						
4. Feeling irritable or angry	.34***	.46***	.51***	-					
5. Feeling restless, nervous or anxious	.19	.39***	.55***	.54***	-				
Abstinence									
6. Craving	.47***	.61***	.41***	.46***	.46***	-			
7. Trouble concentrating	.23*	.27**	.46***	.28**	.32**	.35***	-		
8. Feeling irritable or angry	.19	.32**	.46***	.50***	.43***	.43***	.60***	-	
9. Feeling restless, nervous or anxious	.23	.25*	.42***	.33**	.47***	.41***	.45***	.39***	-
At four month follow-up									
11. Prolonged cessation	-.29**	-.22*	-.10	-.13	-.11	-.32**	-.10	-.06	-.09

* p < 0.05; ** p < 0.01; *** p < 0.001; n = 98

Hierarchical Logistic Regression analysis of craving and withdrawal symptoms during ad libitum smoking and abstinence in relation to prolonged cessation

Controlled for sex, age and education level, craving reported during ad libitum smoking was significantly related to smoking cessation at follow-up. When adding craving measured during abstinence, this latter variable added a significant amount of explained variance (13%) and remained the only significant predictor of smoking cessation at follow-up (Table 4). Hierarchical logistic regression analyses showed no significant results for the impact of withdrawal symptoms measured during ad libitum smoking or during abstinence on smoking cessation (data not shown).

Table 4 Odd ratios (OR) and 95% confidence intervals (CI) of craving during ad libitum smoking and craving during abstinence on prolonged cessation at four-month follow-up

	Prolonged cessation		
	Nagelkerke R ² Change	OR	(95% CI)
Step 1	0.16		
Sex		3.44	(0.77-15.39)
Age		2.27*	(1.05-4.92)
Education		0.28	(0.75-1.08)
Step 2	0.09		
Sex		3.86	(0.79-18.80)
Age		2.27*	(1.02-5.03)
Education		0.30	(0.70-1.28)
Craving during Ad libitum smoking		0.49*	(0.25-0.95)
Step 3	0.13		
Sex		6.65*	(1.16-37.95)
Age		1.91	(0.84-4.36)
Education		0.27	(0.06-1.27)
Craving during Ad libitum smoking		1.12	(0.46-2.75)
Craving during Abstinence		0.14*	(0.03-0.73)

* p < 0.05; ** p < 0.01; *** p < 0.001; n=98

Discussion

The present study gives rise to some interesting findings. First, the level of craving among adolescent smokers was higher when measured during abstinence than when measured during ad libitum smoking, whereas for withdrawal symptoms this was only found for trouble concentrating. Second, craving levels during abstinence were higher for respondents scoring high on nicotine dependence than for those scoring low on nicotine dependence, whereas craving levels during ad libitum smoking were equal for both groups. Third, craving, but not withdrawal symptoms, was associated with smoking cessation at follow-up. And finally, compared to craving during ad libitum smoking, craving during abstinence is a stronger predictor of smoking cessation.

Previous studies already reported the presence of craving and withdrawal symptoms during abstinence based on retrospective self-reports among current and former smokers (e.g. McNeill et al., 1986). Our result indicate that craving scores are significantly higher when reported during a period of induced abstinence, in comparison to self-reports of craving and withdrawal during ad libitum smoking. Results regarding withdrawal symptoms were less straightforward though, with no difference between abstinence and ad libitum smoking with regard to feeling irritable or angry, and feeling restless, nervous or anxious. The present study provides additional evidence that adolescent smokers are likely to suffer increasing craving and to some extent also withdrawal symptoms when they try to quit smoking. The measurement of craving, and to a lesser extent withdrawal, during abstinence seems to provide a more accurate estimation of adolescents' bio-psychological dependence, which is in agreement with Merikangas (2004) who suggested that the measurement of behaviour in vivo enhances the validity of the assessment.

The finding that craving, but not withdrawal symptoms, is prospectively related to successful smoking cessation is in line with previous findings among adults (Curry & McBride, 1994; Kenford et al., 1994; Killen & Fortmann, 1997). A possible explanation for why craving is more predictive of smoking cessation than withdrawal symptoms might be that craving is thought to reflect both the anticipation of relief from withdrawal symptoms that result from nicotine deprivation (Tiffany, 1990), as well as the anticipation of positive reinforcement through the release of dopamine (Wise, 1988). Moreover, the emergence of craving has also been explained by means of the cue-craving paradigm. studies have demonstrated that smokers show considerable physiological and subjective reactions to presentations of smoking related stimuli (e.g. Carter & Tiffany, 1999; Rohsenow, Niaura, Childress, Abrams, & Monti,). In other words, whereas withdrawal symptoms are mostly due to nicotine deprivation, craving can also be triggered by environmental cues and/or the absence of the release of dopamine. Therefore, craving may form a more fundamental and difficult problem during abstinence as compared to withdrawal symptoms. This notion is also reflected by the fact that previous studies have not been able to effectively and reliably proof nicotine replacement therapy (NRT) to relieve craving (Benowitz, 1993; Killen et al., 2001).

In a previous study among adolescent smokers in cessation treatment, Bagot and colleagues (2007) found that craving during abstinence was marginally associated with nicotine dependence, suggesting that craving might to some extent be driven by nicotine dependence. The present study took a closer look at the role of nicotine dependence in the occurrence of craving in a non-clinical sample and found that craving levels during abstinence were higher for respondents scoring high on nicotine dependence than for those scoring low on nicotine dependence, whereas craving levels during ad libitum smoking were equal for both groups. The occurrence of craving during abstinence thus seems to be, at least partly, brought forth by nicotine dependence. Consequently, adolescent smokers' levels of nicotine dependence can be seen as important indicators of the degree of craving that is expected to be experienced during abstinence. Since there are some indications that the combination of nicotine patch therapy combined with cognitive-behavioural intervention may be effective in treating nicotine dependence

among adolescent smokers who want to quit (Moolchan et al., 2005), research regarding the effects of decreasing nicotine dependence levels using NRT in combination with cognitive behavioural therapy to alleviate craving during abstinence seems warranted.

When controlled for craving during ad libitum smoking, craving during abstinence remained significantly related to smoking cessation. Craving during abstinence seems to form a more valid assessment of the psychophysiological effects experienced during nicotine deprivation and, additionally, a stronger indicator of prolonged smoking cessation. This finding provides potential implications for research on adolescent smoking cessation. When testing models of adolescent smoking cessation based on survey data, the validity of these models may partly depend upon whether adolescents have been smoking directly prior to filling out the questionnaires. More research is needed to understand potential threats to validity resulting from adolescents' smoking behaviour preceding participation in surveys on smoking.

When interpreting the results of this study, some limitations should be taken into account. As a result of the relatively small sample size, some of the non-significant associations may be due to limited power. Second, since the method of recruitment was based on voluntary participation this might have led to a selection bias. Highly dependent adolescents who know from experience that abstinence will cause them considerable distress might have been less motivated to participate. Third, apart from the measurement during abstinence, the data are based only on adolescents' self-reports of their smoking intensity and frequency, and quitting behaviour. Because cotinine levels were not assessed at T1 or at four-month follow-up, the possibility of under or over-reporting of smoking exists (e.g. McKennell, 1980; Patrick et al. 1994; Stein et al. 2002). However, measurements with self-administered questionnaires have been reported to be equally reliable and valid as methods such as biochemical validation (Dolcini, Adler & Ginsberg, 1996; Hunter, Webber & Berenson, 1980). Moreover, Stanton, McClelland, Elwood, Ferry and Silva (1996b) found that information obtained from adolescents on smoking and quitting was reliable and had sufficient internal consistency and validity. Finally, our approach to measure withdrawal was limited to three items assessing different withdrawal aspects. Therefore, other possible manifestations of withdrawal in adolescents, such as increased appetite and sleep disturbance, were outside the scope of this study.

To conclude, craving and withdrawal have been reported to be among the most important clinical phenomena related to smoking cessation, and assessment of craving and withdrawal needs continuing efforts (Shiffman et al., 2004b). The present study showed that levels of craving and (to some extent) withdrawal symptoms among adolescent smokers were higher during abstinence, and that craving during abstinence was most related to smoking cessation. Based on our findings we endorse the idea that, in smoking cessation research and treatment among adolescents, the measurement of craving during abstinence is preferable to the measurement during ad libitum smoking. Measurement during abstinence seems to provide a more accurate estimation of adolescents' bio-psychological dependence and may provide a useful indicator for treatment purposes.

Footnotes

- ¹ Different from the other chapters in this thesis, the term nicotine dependence in this chapter refers to the construct of dependence as assessed by a measure derived from the Fagerström Tolerance Questionnaire (Fagerström & Schneider, 1989). The Fagerström Tolerance Questionnaire is assumed to measure behavioural aspects of physical tolerance and does not include a direct assessment of craving and withdrawal symptoms.

11 General Discussion

Introduction

Despite a great number of programs aiming at the prevention of smoking onset, many adolescents continue to take up smoking. Among Dutch adolescents smoking rates remain high; moreover, because the chance of a successful cessation attempt diminishes the longer a person smokes, smoking cessation interventions for adolescents seem warranted. However, despite their importance, smoking cessation interventions and programs with a sound theoretical basis are almost absent, and research addressing adolescent smoking cessation is limited. More specifically, whereas there has been a dramatic increase in empirical research on and effective treatments for nicotine dependence among adult smokers, relatively little has been done regarding adolescent smokers (Kassel, 2000; Prokhorov et al., 1996; Wagner, 2000).

The present dissertation aimed to contribute to the development of future smoking cessation interventions and programs for adolescent smokers by means of two approaches. First, after addressing the conceptualization and measurement of nicotine dependence in adolescent smokers, we studied the manifestation and development of nicotine dependence symptoms among this group. Second, we focused on identifying important potential determinants and mechanisms of adolescent smoking cessation practices.

This concluding chapter summarizes the most prominent findings of these studies (see Table 1). In addition, limitations as well as implications for theory and practice are discussed, followed by recommendations for future research.

Summary of the main findings

Part 1 On the measurement and development of nicotine dependence in adolescence

Part 1 of this thesis aims to increase the understanding of the phenomenon of nicotine dependence exhibited by adolescent smokers. The notion that adolescents may be addicted to nicotine and, consequently, driven by compulsive drug-seeking behaviour, has long been under-estimated. Therefore, compared to the adult population, relatively little is known about nicotine dependence among adolescents, e.g. its conceptualization and measurement, as well as the epidemiology and aetiology of adolescent nicotine dependence. These specific topics were examined in Chapters 2 and 3, respectively.

Chapter 2 describes a cross-sectional study among 2,041 adolescent smokers aged 14-16 years. In this study, we addressed the question whether adolescent nicotine dependence consists of multiple distinct features and may therefore be better measured by an assessment tool with a multifactorial structure. More specifically, in line with the idea that nicotine dependence in adolescents is a multidimensional phenomenon, consisting of behavioural, physiological and psychological features (e.g. Colby et al., 2000b; Johnson et al., 2005; Stanton, 1995), we examined the possibility of devising a multidimensional scale for the measurement of nicotine dependence among adolescents, based on two well-tested and frequently used measures for adolescent nicotine dependence, namely the modified Fagerström Tolerance Questionnaire (mFTQ) and the Hooked on Nicotine

Checklist (HONC). The main findings showed that a combination of the items of the mFTQ and the HONC resulted in three distinct dimensions: behavioural aspects of physical tolerance, craving, and withdrawal symptoms. The multidimensional measure was subsequently replicated in a second sample using confirmatory factor analyses. Furthermore, we found that the three components of the combined scale were uniquely related to the convergent validity variables of readiness to quit and number of quit attempts. We concluded that nicotine dependence among adolescents consists of multiple features. Using this combination measure offers important advantages over the use of a single measure, since it captures more features of the overall construct of nicotine dependence among adolescents.

Chapter 3 reports on a longitudinal study that aimed to increase our understanding of the aetiology and epidemiology of nicotine dependence among adolescent smokers by examining the occurrence and development of distinct nicotine dependence symptom profiles. Using the multidimensional measure described in Chapter 2, we distinguished four distinctive subtypes of nicotine dependence among a population sample of adolescent smokers generally aged 14-16 years. The first profile was composed of adolescents who displayed low craving only, the second profile of adolescents who displayed high craving and withdrawal, and the third profile of adolescents displaying high cravings and physical tolerance. Adolescents classified in the fourth profile displayed high scores on craving, physical tolerance and withdrawal. These symptom profiles were found to be stable over time and, in addition, differentially associated with previously identified correlates of nicotine dependence, namely parental and peer smoking, depressive mood, and self-efficacy to refrain from smoking. Also, differences were found between the four subtypes with regard to smoking uptake and cessation. Results indicated that the 'high craving and physical tolerance' profile seems to be more closely related to the 'overall high dependent' profile, whereas the 'high craving and withdrawal' profile seems to be more closely related to the 'low craving only' profiles. We concluded that distinctive nicotine dependence profiles can be identified among adolescent smokers and, more specifically, that different patterns of symptoms are associated with increasing differences in severity of dependence.

Part 2 Identifying determinants and mechanisms of adolescent smoking cessation

The identification of variables that predict smoking cessation provides the basis for the development of effective interventions. Studies among adults underscored the relevance of addiction influences, as well as the importance of individual cognitions and strategies, and environmental factors (e.g. Abrams et al., 2000; Carter & Tiffany, 2001; Farkas et al., 1996; John et al., 2004; Velicer et al., 1996). Although some of these factors were shown to be also predictive of adolescent smoking cessation processes, multivariate analyses including a broad range of variables in one model (in order to reveal a set of independent predictors) are rare. Part 2 of the present thesis focuses on examining in greater detail the process of adolescent smoking cessation, by analyzing the impact of potential influential determinants and by investigating the possible mechanisms by which these factors explain adolescent smoking cessation practices.

Chapters 4 and 5 focus on examining the usefulness of one of the most prominent psychological models of behaviour change, namely the Transtheoretical model (TTM; Prochaska et al., 1992a), in explaining readiness to quit smoking and transitions towards actual smoking cessation among adolescent smokers. According to the TTM, people move through a series of distinct stages in the course of modifying their smoking behaviour (i.e., precontemplation, contemplation, preparation, action and maintenance). Theoretically, the movement through these stages is governed by the use of stage-specific strategies called processes of change. Although the model has been extensively criticized, the TTM remains widely used to study adult smoking cessation and, moreover, is gradually finding its way into the field of adolescent smoking cessation (see Ham & Lee, 2007; Hoepfner et al., 2006). Therefore, tests of the applicability of the TTM as a guide for adolescent smoking cessation are warranted. The first study on this subject (the cross-sectional study described in Chapter 4) showed that, among adolescents who were at least weekly smokers, the processes of change were only marginally associated with adolescents' readiness to quit smoking as measured by the stages of change construct. Controlling for the impact of the processes of change, nicotine dependence remained significantly associated with readiness to quit. Additionally, it was reported that readiness to quit smoking seems to be remarkably lower among adolescents compared to adults. Next, in the longitudinal study in Chapter 5, we looked at the significance of the processes of change in predicting transition through the stages of change in adolescent smokers, as well as the relative role of nicotine dependence in predicting stage transitions. In agreement with the cross-sectional results of Chapter 4, the processes of change did not seem relevant in explaining adolescents' stage transitions, whereas nicotine dependence contributed significantly to the explanation of adolescents' transition from preparation to action, after adjustment for differences in the processes of change. We concluded that the processes of change are (at best) of limited importance in explaining adolescents' readiness to quit smoking and transitions towards smoking cessation, while nicotine dependence appeared to be highly important in explaining adolescents' readiness to quit and the transition towards smoking cessation.

Among smokers, perceiving the consequences of smoking as less severe, or perceiving oneself as being less vulnerable to adverse health effects, can be seen as strategies to reduce cognitive dissonance. Adhering to these so-called disengagement beliefs may enable the continuation of smoking, despite knowledge about its harmful health effects. Chapter 6 describes a longitudinal study among 363 adult smokers, in which it is shown that the adherence to smoking-specific disengagement beliefs is negatively related to adult smokers' readiness to quit, changes in readiness to quit, as well as actual smoking cessation. In Chapter 7 we investigated whether adolescents also reduce cognitive dissonance regarding their smoking behaviour by adhering to disengagement beliefs. We found that adolescent smokers' adherence to disengagement beliefs was stronger than that of adults. The study showed that disengagement beliefs were mainly negatively associated with adolescents' readiness to quit, whereas nicotine dependence was the strongest predictor of actual smoking cessation at follow-up. We concluded that, although adolescents report to adhere more strongly to disengagement beliefs

than adults, these beliefs do not seem to play an important role in explaining smoking cessation.

The prospective study described in Chapter 8 focused on the mechanisms by which multiple levels of influence (including readiness to quit smoking, levels of nicotine dependence, and smoking behaviour of parents and friends), affect the process of smoking cessation in adolescents. It was shown that both readiness to quit and nicotine dependence were associated with undertaking quit attempts, while only nicotine dependence was inversely associated with successful cessation. Instead of a direct relation, it appeared that parental and peers' smoking mainly affects adolescent smoking cessation by enhancing experienced nicotine dependence symptoms. It is concluded that, among adolescent smokers, readiness to quit is most important in determining whether or not one will try to quit, whereas nicotine dependence seems to determine whether or not a quit attempt will be successful.

Because the occurrence of nicotine dependence symptoms were found to form a particular important barrier for adolescent smoking cessation, Chapter 9 focused on providing more insight into the development of the nicotine dependence symptom profiles as described in Chapter 3. Different individual and environmental determinants were included as possible early predictors of the distinct nicotine dependence symptom profiles. Results showed that exposure to the smoking behaviour of significant others constitutes a risk for the onset of nicotine dependence symptoms among smoking adolescents, whereas further progression of dependence symptoms was related to having a neurotic and/or an extravert personality. We concluded that the development of severe dependence symptom profiles is mainly due to an interaction between individual (hereditary) dispositions and the exposure to smoking in the social environment.

Finally, to better understand the psychological and physiological effects of smoking addiction on cessation, we conducted a study in which 98 daily smoking adolescents reported their craving and withdrawal symptoms during a period of non-restricted (ad libitum) smoking, as well as after 24 hours of smoking abstinence. Results indicated that the level of craving among adolescent smokers was higher when measured during abstinence than when measured during ad libitum smoking. Furthermore, craving, but not withdrawal, predicted prolonged cessation assessed four months later, with craving measured during abstinence being a stronger predictor compared to craving measured during ad libitum smoking. We concluded that adolescent smokers are likely to suffer increasing craving, and to some extent also withdrawal symptoms, when they try to quit smoking and that the measurement of craving in vivo seems preferable to the measurement of craving during ad libitum smoking.

Table 1 Summary of the main findings in the thesis

	Chapter
Nicotine dependence among adolescents is a multidimensional construct that includes several distinct features, namely behavioural aspects of physical tolerance, craving and withdrawal symptoms	2
Adolescent smokers can be characterized by different nicotine dependence symptom profiles, which are associated in different ways with smoking uptake and cessation	3
The processes of change, as defined by the Transtheoretical model, are not relevant in explaining the smoking cessation process of adolescent smokers	4, 5
Nicotine dependence is negatively related to the readiness to quit smoking, as well as prolonged smoking cessation, among adolescents.	4, 5, 7, 8
Even more than adult smokers, adolescents adhere to disengagement beliefs, which are negatively associated with their readiness to quit smoking, but are only marginally negatively related to actual smoking cessation	7
Readiness to quit smoking is positively related to undertaking quit attempts but not to prolonged smoking cessation, whereas nicotine dependence is strongly negatively related to both undertaking and persevering in a quit attempt	8
Smoking of parents and peers mainly negatively influences smoking cessation practices through nicotine dependence and readiness to quit	8
Severe nicotine dependence symptom profiles emerge from exposure to the smoking of others, and having extravert or neurotic personality traits	9
Craving measured during abstinence is a stronger negative predictor of smoking cessation among adolescents than craving measured during ad libitum smoking	10

Elaborating on the main findings concerning adolescent smoking cessation

The studies in this thesis focused for a large part on providing more insight into the process of adolescent smoking cessation. We found that the readiness to quit seems to play a relatively small role in determining the success of smoking cessation. Readiness to quit is mainly important in determining whether or not adolescent smokers make a quit attempt. Once a quit attempt is undertaken, the level of nicotine dependence seems the strongest correlate of success.

Readiness or motivation to quit

Generally, adolescent smokers are not particularly ready or motivated to quit smoking in the near future. Previous studies on adolescent smoking cessation indicated that, although a significant number of adolescents believe that quitting smoking is both desirable and achievable, many adolescents do not consider the need to quit as urgent (Amos et al., 2006; Balch, 1998; Balch et al., 2004). In our studies, the majority of adolescents (i.e., 70% or more) indicated that they do not consider quitting in the foreseeable future (i.e., within six months). A possible explanation for the low readiness to quit may lie in the notion that many adolescents seem to consider people their own age invulnerable to the serious health consequences of smoking (Balch et al., 2004). Another explanation may be that adolescents are less ready to quit smoking because they do not identify themselves as smokers, even though their actual smoking habits qualify them to be considered as regular smokers (Turner et al., 2005). There appears to be a considerable variation in adolescents' definitions of smoking status (Amos et al., 2006). Many adolescent smokers were found to distance their own 'youthful' smoking from that of adult smokers who had smoked for much longer and were therefore more likely to be addicted. Our own findings suggest that, to some extent, a low readiness to quit coincides with experienced nicotine dependence symptoms, adhering to excuses to continue smoking, and being exposed to smokers in the social environment. Perceiving lower levels of nicotine dependence, being less involved in making excuses that justify smoking, and a lack of exposure to smoking others seem to make it considerably easier to establish a commitment to change smoking behaviour.

Whereas adherence to disengagement beliefs is associated with a lower readiness to quit, and nicotine dependence appears to be strongly associated with both low readiness to quit and the transition to smoking cessation, both constructs were found to be unrelated to an increase of readiness to quit over time. According to the TTM, the increase of readiness to quit and the subsequent transition to smoking cessation are a result of engagement in active cognitive or behavioural strategies (i.e., the processes of change). However, we found very little evidence for the usefulness of the processes of change in explaining adolescents' readiness to quit or the transition from motivational stages to action. Although adolescents do report to engage in the different processes of change, the use of these processes is hardly associated with the readiness to quit and does not significantly influence the increase in readiness or the transition to cessation as postulated by the TTM. Furthermore, the engagement in the processes of change was

hardly related to adolescents' level of nicotine dependence, and nicotine dependence did not modify the relation between processes of change and stage transitions.

In sum, our findings regarding adolescents' readiness to quit signify that (1) readiness to quit is associated with nicotine dependence, disengagement beliefs, and exposure to smokers in the social environment, and (2) an increase in readiness to quit smoking mainly takes place independently of active behavioural change strategies, the level of nicotine dependence and the adherence to disengagement beliefs. This latter finding might indicate that other unobserved variables play a role in explaining an increase in readiness in adolescent smokers, such as external or situational influences. Instead of being governed by active strategies, the increase of adolescents' readiness to quit may occur in a rather unplanned or unprepared way.

Quit attempts and Smoking Cessation

Besides an increase in readiness to quit, it is plausible that the undertaking of a subsequent quit attempt may not necessarily be well prepared either. A study on the process of adolescents' smoking cessation showed that, on average, the first serious quit attempt is made approximately 2.5 months after smoking initiation, whereas the awareness of the difficulty of quitting occurred approximately 32 months after smoking initiation (O'Loughlin et al., 2008). Compared to adults, adolescents generally have a shorter smoking history and, therefore, may have less experience with undertaking quit attempts. Several longitudinal studies among adolescent smokers assessed the prevalence of self-initiated cessation and found them to be relatively low (Mermelstein, 2003). Because most adolescents have limited experience with undertaking quit attempts, they may underestimate the difficulties of persevering with smoking cessation (e.g., underestimate the occurrence of withdrawal symptoms and craving) and be overly optimistic about their chances to succeed. This view is consistent with our findings that readiness or motivation to quit was important in undertaking a quit attempt, whereas prolonged smoking cessation was mainly predicted by the levels of nicotine dependence. Moreover, the finding that craving measured during abstinence was a stronger predictor of smoking cessation than craving measured during ad libitum smoking, also indicates that adolescents may not be fully aware of the difficulties that follow quitting smoking. This underestimation might partly account for the high relapse rates among adolescent smokers, estimated to be as high as 90%-95%, thereby exceeding the failure rates among adult smokers (Grimshaw & Stanton, 2006; Mermelstein, 2003; Sussman, 2002).

It was long thought that adolescent smokers were unlikely to be dependent on nicotine and, if willing, should be able to stop smoking without much effort (Mermelstein, 2003). However, we now know that adolescents perceive their feelings of dependence as real and powerful (Balch et al., 2004) and that dependence is a major obstacle for smoking cessation. Our studies showed that perceived levels of nicotine dependence have some bearing on the readiness to quit, the undertaking of a quit attempt, as well as on prolonged smoking cessation. Moreover, compared to nicotine dependence, smoking-specific cognitions and the engagement in active cognitive and behavioural strategies seem to have limited explanatory power with regard to smoking cessation. When further scrutinizing

nicotine dependence, we showed that different patterns of dependence symptoms were associated with increasing differences in severity of dependence. For instance, the presence of physical tolerance appears to indicate more severe dependency than the presence of withdrawal symptoms alone. This is in line with the recently proposed Sensitization-Homeostasis Model which maintains that, at first, relieving physiologically-driven feelings of craving and withdrawal is the main motivator to continue smoking (DiFranza & Wellman, 2005). The craving and withdrawal symptoms that initially occur can be controlled by smoking approximately one cigarette every week. However, as tolerance increases, the duration of relief offered by each cigarette shortens progressively. If the smoker does not restrain consumption, withdrawal symptoms may be experienced as soon as 20 minutes after having smoked the last cigarette.

The results further suggest that exposure to smoking in the social environment may promote the onset of nicotine dependence symptoms, while further progression of dependence symptoms is more likely among adolescents who score higher on extraversion and neuroticism. Especially individuals that are exposed to environmental smoking and who have an extravert personality have a high risk of developing more severe dependence symptom profiles and may consequently be less likely to quit smoking.

Implications for Theory

Measurement of nicotine dependence

One goal of the present thesis was to gain more insight into the concept of nicotine dependence and its measurement among adolescent smokers. In the literature, the use of several instruments to assess nicotine dependence is reported, for instance the Hooked on Nicotine Checklist (HONC; DiFranza et al., 2002b), the Nicotine Dependence Syndrome Scale (NDSS; Shiffman et al., 2004a), the Wisconsin Inventory of Smoking Dependence Motives (WISDM-68; Piper et al., 2004), instruments based on definitions in the Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R or DSM IV; American Psychiatric Association [APA], 1987, 1994), alternative versions of the Fagerström Tolerance Questionnaire (FTQ; Fagerström & Schneider, 1989) and the Dimensions of Tobacco-Dependence Scale (DTDS; Johnson et al., 2005). Although only the HONC and the DTDS scale were specifically developed for adolescent smokers, most of the measures have been psychometrically validated for use among adolescent samples. However, the instruments mentioned above are either relatively long or intend to measure a single dimension of nicotine dependence. Extensive, time-consuming instruments are less suitable for research purposes that include the measurement of other constructs, because lengthy questionnaires may undermine an optimal response rate. Additionally, since nicotine dependence is increasingly viewed as a multidimensional phenomenon, measurements consisting of a single factor cannot be expected to reflect the multidimensional nature of the nicotine dependence construct (Cohen et al., 2002). The multidimensional measure presented in the present thesis contains only 11 items and measures multiple features of adolescents' nicotine dependence. In our view, this measure is practical in use, easy to apply and enables the measurement of a wide range of nicotine dependence symptoms.

The TTM

The TTM is a so-called multi-stage model and conceptualizes health behaviour change as a process comprising five distinct, qualitatively different stages, namely precontemplation (not planning to quit in the next six months), contemplation (planning to quit but not within the next month), preparation (planning to quit within the next month), action (having quit within the past six months), and maintenance (having quit for more than six months). Progression through the different stages of change is said to be guided by overt and covert strategies known as the processes of change (Prochaska et al., 1992a).

In the studies described in Chapters 4 and 5, respondents were categorized into the three different motivational stages of the stages of change construct consistent with the approach as described by Prochaska et al. (1992a). The results presented in Chapters 4 and 5 did not fulfil the requirements proposed in the TTM; the processes of change were not significantly associated with the stages of change, nor were they predictive of stage transitions and smoking cessation. In adults, results regarding the effectiveness of the processes of change in explaining stage transitions and smoking cessation have been contradictory; some studies claimed supporting evidence (Prochaska et al., 1992a; Prochaska et al., 2001), while others failed to support the significance of the processes of change in predicting forward stage movements (Herzog et al., 1999; Segan et al., 2002; Segan et al., 2004) or the value of processes of change as guidelines to tailor interventions in the context of smoking cessation (Carlson et al 2003; Quinlan & McCaul, 2000). However, it has been argued by Ogden (2003) that, whilst the majority of studies on social cognition models reported results that are both consistent as well as inconsistent with the predicted associations, researchers are inclined to conclude that the results provide support for a particular model rather than use their results to reject the model. In a review, Littell and Girvin (2002) illustrated that studies cited in support of the TTM often do not actually fully confirm the TTM's assumptions.

One explanation for the null findings in the present thesis is that the stages of change algorithm might not be an adequate measure to capture adolescents' readiness to quit. Herzog (2007) found that adolescent smokers do not seem to think about smoking cessation within the context of fixed time frames. Also, since the readiness to quit of adolescent smokers is lower than that of adults we suggest that the measurement of adolescents' readiness to quit may require a different approach. Because adolescents' readiness to quit might not be optimally measured by assessing plans with specific time limits, indicators of readiness to quit that aim at assessing more general or overall plans (e.g. assessing to what extent one is planning to quit right now, soon, somewhere in the future, or not at all), may be more appropriate to assess adolescents' readiness to change behaviour. Future research should test whether such a measure is more suitable for assessing readiness to change behaviour among adolescent populations.

A second explanation is that the stages of change are highly subject to change and therefore unlikely to be governed by conscious and deliberate behaviour change strategies, such as the processes of change. Hughes et al. (2005) found that plans to stop smoking are

unstable over short periods of time. It was concluded that, for many smokers, a measure of plans to quit represents only short-term intentions. For instance, a study among adult smokers reported that 41% endorsed a statement that “my motivation to quit changes from one day to the next” and 51% stated they did not plan their last quit attempt more than one week in advance (Werner, Lovering, & Herzog, 2004). Larabie (2005) also found that the majority of quit attempts undertaken within a general practice sample involved no prior planning or preparation. The TTM, however, assumes that individuals make stable and coherent plans and involve in conscious strategies in order to change their behaviour. The TTM does not allow for a moment-to-moment evaluation of motives to stop smoking nor does it take into account the dynamic nature of readiness in relation to the current situation. In addition, there is little or no consideration of the concept of dependence. Becoming dependent on nicotine is a process that operates mostly outside of conscious awareness and is not subject to decision-making rules (West, 2005). However, when it comes to smoking behaviours, nicotine dependence is clearly a crucial concept to consider.

Similar to earlier results found for adults, the present thesis showed that the evidence in support of the stages of change and processes of change as guidelines for the process of adolescent smoking cessation is not convincing. In our opinion assessment of the stages of change does not provide an adequate indicator of adolescents’ readiness to change and should not be used as an indicator of the likely success of a quit attempt. In addition, we do not recommend use of assessment of the processes of change to provide an indication of adolescents’ readiness to quit, or to use the processes of change as a guideline for intervention purposes.

An alternative model for adolescent smoking cessation

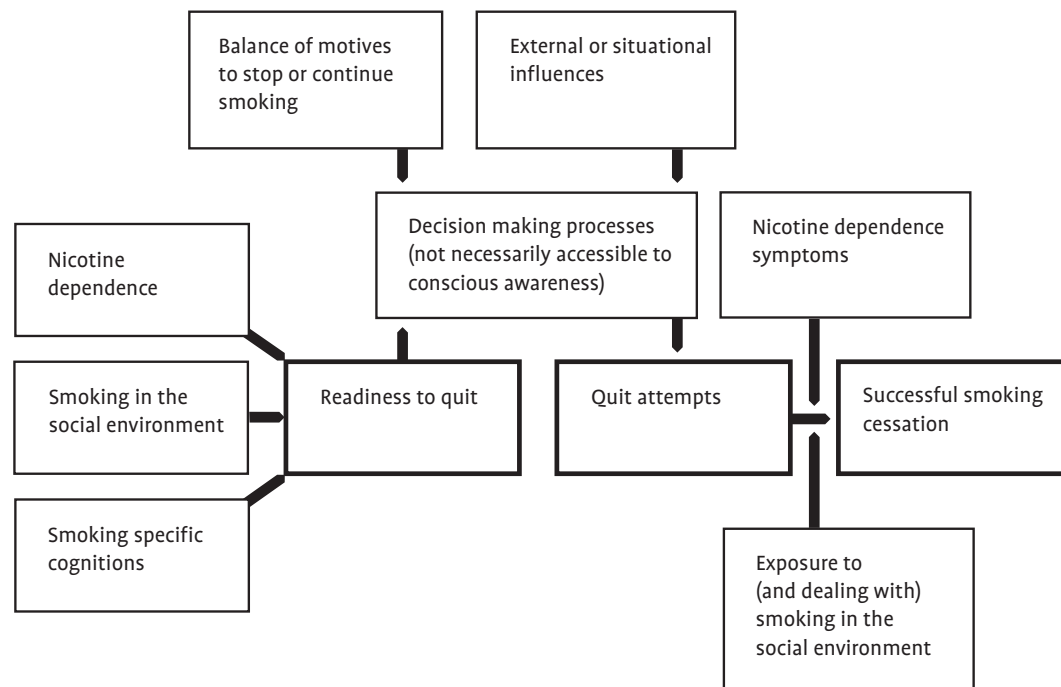
According to the above-mentioned literature on adult smokers, spontaneous increases in readiness may be followed by unprepared quit attempts. In the present thesis, since it was indicated that engagement in active strategies to quit smoking does not seem to facilitate an increase in readiness to quit or the transition to undertaking a quit attempt, the decision to try and quit may also occur in an unprepared way in adolescents as well. In a qualitative study on experiences of and attitudes towards addiction and smoking cessation, adolescent smokers reported that several of their previous quit attempts had not been intentional but were rather driven by ‘external’ constraints (Amos et al., 2006). Although our results indicated that being ready to quit seems a relevant factor with regard to making a quit attempt, the degree of readiness seems to play a relatively small role in predicting the success of a quit attempt. Several studies have explored the apparent discrepancy between the readiness or motivation to change and performing the actual goal behaviour (e.g. Orbell & Sheeran, 1998; Sheeran & Abraham, 2003). The weak relationship between motivation and the outcome behaviour is largely ascribed to having good intentions, but failing to act on them (Orbell & Sheeran, 1998; Gollwitzer, 1999). With regard to smoking cessation, it has been suggested that the ultimate practical objective of assessing motivation is the identification of smokers who are ready to make a quit attempt. Thereafter, it seems that overcoming dependence is what matters (West, 2004). This notion is in agreement with our findings among adolescent smokers, namely that

being ready to quit seems a relevant factor with regard to undertaking a quit attempt, but that having high levels of nicotine dependence was the strongest predictor of prolonged cessation. Based on the literature and results of the present thesis, the following sections will describe an alternative perspective to that of the TTM regarding the process of adolescent smoking cessation.

The first phase of the process of adolescent smoking cessation is the motivational phase. The level of readiness to quit seems to be partly determined by nicotine dependence, smoking-specific cognitions, and exposure to smokers in the social environment. Lower levels of dependence, lower adherence to disengagement beliefs, and less exposure to smokers in the social environment are associated with a higher readiness to quit. A higher readiness to quit is associated with a greater chance of undertaking a quit attempt. However, the decision to undertake a quit attempt does not necessarily have to be the consequence of deliberate planning, but may also be governed by external or situational influences (e.g., Amos, 2006; Larabie, 2005).

Once a quit attempt is initiated, both the occurrence of nicotine dependence symptoms and the social context are important factors in determining the success of the quit attempt. Bagot et al. (2007) showed that, among adolescent smokers in cessation treatment, craving was associated with relapse, whereas the present thesis showed that craving reported during abstinence was the strongest predictor of smoking cessation at follow-up. Previous research has indicated that friends’ smoking habits form a barrier to quitting smoking (O’Loughlin et al., 2002b). In addition, it was previously concluded from a meta-analysis that, when exposed to smoking-related cues (e.g. cigarettes or a person smoking a cigarette), smokers show a robust increase in self-reported craving, as well as a modest increase in heart rate and skin conductance (Carter & Tiffany, 1999). It was proposed that these cue-specific reactions may reflect the motivational processes that are responsible for why smokers continue to smoke or fail to remain abstinent (Carter & Tiffany, 2001). Smoking parents and friends may thus act as cues to trigger craving for cigarettes in adolescents. The present study additionally showed that smoking of significant others is negatively related to prolonged smoking cessation through levels of nicotine dependence, whereby higher levels of dependence were associated with smoking in the social environment. Studies on smoking cessation processes among adults reported that smoking lapse and relapse are highly dynamic processes that are subject to both background conditions and momentary situational influences (Shiffman, 2005). Based on earlier studies and on our results, it is expected that, when adolescent smokers undertake a quit attempt, those who experience little craving and withdrawal symptoms and who are modestly or not at all exposed to smokers in their social environment, are most likely to avoid lapses and relapses. Figure 1 is a graphical representation of this model. In contrast to the TTM, the proposed model attempts to incorporate the importance of time variance and situational phenomena in explaining smoking cessation.

Figure 1 A dynamic model of adolescent smoking cessation, based on earlier studies and results of the studies presented in this thesis.



Limitations of the thesis

The previous chapters have addressed most of the limitations related to the individual studies. The following section discusses some additional (more general) shortcomings of the studies as well as some methodological issues.

Self-reports

The limitations of self-reported data are well documented (Johnston et al., 2004; Schwarz and Oyserman, 2001; Stone et al., 1999). The validity of self-reports on smoking behaviour in particular has often been questioned because of the assumption that smokers are likely to underestimate the amount of cigarettes smoked or even to deny their smoking behaviour all together, either due to the tendency to give socially-desirable responses or to a recall bias (Patrick et al., 1994). Several authors have attempted to validate adolescent self-reports by biochemical assessments such as cotinine (a metabolite of nicotine found in plasma, urine, or saliva), expired air carbon monoxide levels, and thiocyanate (a derivative of cyanogens in tobacco smoke found in plasma or saliva). These methods are

considered more objective and less susceptible to bias. In a meta-analysis on the validity of self-reports, Patrick and colleagues (1994) reported generally high levels of sensitivity and specificity with regard to self-reported smoking behaviour. Furthermore, Stanton and colleagues (1996b) found that information obtained from adolescents on smoking and quitting was reliable and had high internal consistency and validity. Finally, a recent intervention study reported a very high concurrence of self-reported smoking data with salivary cotinine measures (Campbell et al., 2008). One particular shortcoming of the use of biochemical indicators among adolescent smokers is the fact that intermittent and irregular smoking among adolescents cannot be reliably validated with biochemical measures (Klesges et al., 1992). Finally, assuring strict confidentiality of the responses was also suggested as a condition to optimize measurement validity (e.g. Docini et al., 1996; Hansen et al., 1985b). In the studies reported in this thesis, confidentiality procedures were carefully applied and clearly communicated to the respondents.

Design

The goal of the present thesis was to identify factors associated with smoking cessation in adolescent smokers. When little is known about a phenomenon, surveys form a particularly suitable study design because they allow to investigate the relationship between variables and, when longitudinal, to establish links between past behaviours and present behaviours or outcomes among large samples. However, theory-driven survey studies do not allow researchers to determine causation. To enable judgement of causality, studies employing an experimental design are necessary.

Interval between measurements.

Because the interval between measurements of the long-term longitudinal study was relatively long, certain transitions in the process towards smoking cessation may not have been adequately detected. Although at every measurement we assessed information on various intermediate outcomes of smoking cessation (such as the frequency of smoking and the number and duration of quit attempts during the past year), our design does not allow to adequately evaluate changes in behaviour that emerge due to external influences or that may be strongly context dependent. Although longitudinal surveys are suitable to detect changes in cognitions and behaviour that ultimately lead to smoking cessation, observational studies in real-life situations may provide more insight into short-term context-dependent changes in behaviour.

Attrition and Generalizability.

Chapters 3, 5, 7, 8, and 9 report data from the large longitudinal study that started in January 2003. At the start of this study, following random selection from the telephone book, 33 schools in four regions of the Netherlands agreed to take part in what was initially going to be a longitudinal study consisting of three measurements. At the time of the third measurement (November 2004) all 33 school were asked to prolong their participation in the study by an additional two years; 25 schools agreed with this prolongation. Although all demographic areas (four regions) remained sufficiently represented, longitudinal analyses that include the fourth measurement comprised data

collected only at those 25 schools that agreed to prolong their participation in our study. On the respondent level, the attrition between the different longitudinal measurements can to a large extent be explained by the fact that, from the fourth measurement onwards, respondents who were in their fourth year of preparatory vocational training and junior general secondary training, or their fifth year of senior general secondary education, had already graduated at the follow-up measurement. When possible, these respondents were contacted at home and asked to fill out the questionnaire. Graduating and leaving school is also the main reason why in Chapter 7 (in which we report on the fourth and fifth measurements), a total of 17 schools are included instead of 25. At the time of the last measurement, eight schools had only students who were receiving preparatory vocational training or junior general secondary training. In addition, two schools failed to meet the deadline for returning the questionnaires because of management issues.

Attrition analyses of our longitudinal samples showed an under-representation of lower educated adolescents, males and smokers, meaning that our results may not be generalisable to the general adolescent smoking population, especially not to lower educated male smokers. However, because smoking is generally more prevalent among students attending preparatory vocational training and junior general secondary training (Stivoro, 2007), the selection effects on the respondent level can for a large part be attributed to the selection effects on the school level. Nevertheless, the limitations considering the generalizability should be kept in mind when interpreting the results of our longitudinal findings.

Implications for practice and intervention development

Because adolescent smoking cessation is a complex process, no single intervention approach can be expected to fully tackle the problem of adolescent smoking cessation. Multilevel approaches are likely to be needed to adequately address the problem of adolescent smoking (Mermelstein, 2003). For instance, broad approaches aiming at increasing adolescents' general motivation to stop smoking are needed, as well as approaches that are more specific and may be more appropriate for adolescents who are already motivated to quit. Also, specialized interventions are likely to be needed for adolescents who have a more severe dependence profile. In the following sections, the results of the present thesis will be discussed in light of the opportunities for practice and intervention development on different levels.

First of all, we reported straightforward findings regarding the negative effect of nicotine dependence on adolescent smoking cessation. Our studies revealed several risk factors for developing more severe dependence symptom profiles, for instance being exposed to environmental smoking and having an extravert or neurotic personality. Especially among these latter high-risk groups, decreasing dependence symptoms appear pivotal in establishing successful smoking cessation. One option to lower nicotine dependence levels may be the use of pharmacotherapy. Among adults in smoking cessation treatment, the use of pharmacologic methods was found effective in reducing smoking rates (Bolliger et

al., 2000; Etter et al., 2002; Windsor et al., 1999) and also showed potential for deferred quitting (Wennike et al., 2003). Among adolescents, on the other hand, studies on the effectiveness of either nicotine replacement therapy or bupropion in aiding adolescent smoking cessation are limited and inconclusive (Grimshaw & Stanton, 2006; Hurt et al., 2000; Killen et al., 2004; Smith, 1996). However, with regard to individual variation in nicotine dependence among adolescents, we postulate that pharmacotherapy might prove useful for adolescent smokers who are in the highest dependence profiles. Adolescents with less severe dependence profiles may be better helped by cognitive-based approaches since reasons for smoking continuation in these particular groups were found to be more embedded in smoking-related cognitions.

Second, our results indicate that being motivated to quit is important to improve the chances of undertaking a quit attempt. However, because adolescents' plans for quitting are often vague and far in the future, motivating adolescents to stop smoking presents substantial challenges. As noted earlier, engagement in active cognitive and behavioural strategies as postulated by the TTM, does not seem to be significantly associated with adolescents' readiness to quit. Therefore, other means should be considered. Our results indicated that challenging adolescents' disengagement beliefs may be a means to increase their readiness to engage in a quit attempt. In Chapter 7 we reasoned that to debunk disengagement beliefs, it may be useful to stress the less well-known short-term health consequences. Health concerns are the most cited reasons to quit among adolescent smokers (Stanton, 1995; Stone & Kristeller, 1992). Apart from future and current health concerns, other frequently cited reasons for wanting to quit may also form important motivational points with regard to intervention planning, such as saving money, preventing addiction, as well as concerns about physical appearance and about athletic performance (Mermelstein, 2003; Riedel et al., 2002). Interventions could emphasize topics that are perceived as relevant by adolescents, rather than focusing on increasing readiness by addressing additional reasons to quit. Also, in their communication with adolescents, health professionals could emphasize the health issues that are particularly relevant to adolescent smokers.

Additionally, it should be kept in mind that, for adolescents, smoking is to a large extent embedded in the social context. Our results indicated that smoking of parents and friends was associated with adolescents' readiness to quit smoking. In Chapter 8 it was mentioned that children of non-smoking parents may perceive more resistance to their smoking behaviour, which may increase their readiness to quit smoking. Therefore, discouraging parental smoking might have an effect on adolescent smoking behaviour as well. In addition, even if parents are active smokers, the use of smoking-specific parenting practices appears to be useful in increasing their children's readiness to quit smoking (Van Zundert et al., 2007). Furthermore, friends' smoking habits are regarded as an important barrier to quitting smoking (O'Loughlin et al., 2002b). Peer pressure is one mechanism by which to explain this finding. Adolescents have noted that by quitting smoking they might risk exclusion from friendship groups where smoking was the norm (Nichter et al., 1997). However, peer influence on smoking does not necessarily have to

be negative and may even be employed to discourage adolescents from smoking and motivate them to quit. Campbell et al., (2008) found preliminary evidence that a peer-led education intervention in which influential students were selected as peer-educators might be effective in achieving a sustained reduction in uptake of regular smoking among adolescents (Campbell et al., 2008). Another study reported that one of the strongest predictors of being engaged in smoking cessation activities was whether students were actively influencing other students not to smoke (Stanton et al., 2006). Participation of peers in school-based smoking cessation programs, and more actively involving these adolescents in prompting and encouraging their peers to try and quit, may be a useful method to enhance adolescents' readiness to quit.

Third, although we studied individual cognitive characteristics, dependence, and the influence of parents and peers, influences on a more macro-environmental level have also been distinguished. For example, saving money is a frequently mentioned reason for wanting to quit smoking and higher cigarette prices are associated with a decrease in smoking, particularly among youthful smokers who do not smoke on a daily basis (Chaloupka, 2003; Chaloupka et al., 2002; Harris & Chan, 1999). Also, since our findings indicate that exposure to smoking in the environment enhances nicotine dependence symptoms, the recent smoking ban in public places (now including restaurants and bars) may also be effective in decreasing smoking among Dutch adolescents.

Finally, the present thesis indicates that adolescents may not be fully aware of their bio-psychological dependence until they actually engage in an attempt to abstain from smoking for a longer period of time. Because of their limited experience with undertaking quit attempts, adolescents may underestimate the difficulties of persevering with smoking cessation and may be overly optimistic about their chances to succeed. Enabling a more realistic assessment of barriers with regard to smoking cessation in combination with the development of effective coping skills to deal with nicotine withdrawal symptoms and craving may help to increase the success of quit attempts. Also, information could be provided about the possibility of pharmacotherapy for heavily-dependent adolescent smokers.

Directions for future research

Validating and testing the proposed dynamic model of adolescent smoking cessation

A dynamic model of adolescent smoking cessation, proposed in the present thesis, incorporates the results of our studies as well as recent insights from the smoking cessation research field. However, the model should not be viewed as exhaustive and it will undoubtedly need modification as future studies increase our understanding about adolescent smoking cessation processes. With the proposed model we intend to offer a view on the process of adolescent smoking cessation that might form an alternative to the more general TTM. In agreement with the TTM, our model distinguishes between a motivational phase and an action phase. Undergoing motivational changes and subsequent action changes are the two key aspects of the TTM. However, although a

stronger motivation or readiness to quit is an important condition for behaviour change, it is not sufficient (Brug et al., 2005). Contrary to the TTM, our model also includes: (1) the moment-to-moment evaluation of motives to stop smoking, (2) the dynamic nature of readiness to quit in relation to the current situation and external influences, and (3) the role of nicotine dependence. Further research is needed to investigate and validate the assumptions made in the model with regard to the underlying mechanisms and predictors of readiness to quit smoking, making quit attempts and successful smoking cessation.

Experimental research

Clinical studies on NRT. The use and efficacy of nicotine replacement therapy (NRT) in adolescent smokers is still somewhat controversial (e.g. Adelman, 2004; Ginzler et al., 2007; Slotkin, 2008). Because the maturation of the brain continues into adolescence, this is a vulnerable period in which nicotine can change the trajectory of neurodevelopment. Also, given addictiveness of nicotine, there are concerns about the persistent use of or dependence on NRT products (Shiffman & Sweeney, 2008). However, it has been shown that about 6% who use nicotine gum for quitting used it for longer than 6 months, and less than 2% used nicotine patches for more than 6 months (Shiffman et al., 2003a,b). Furthermore, it was estimated that only 0.7-1.4% of all nicotine gum users would transfer their nicotine dependence to the nicotine in the gum (Hughes et al., 2004). Two additional studies showed that smoking (which rapidly delivers nicotine to the brain) demonstrates abuse and addiction potential, while NRT products did not (Henningfield & Keenan, 1993; Houtsmuller et al., 2002). Therefore, it seems that the abuse liability of NRT products is very low. In their review on smoking cessation interventions for young people, Grimshaw and Stanton (2006) concluded that the existing evidence on pharmacological interventions gives no reason to believe that the neuropharmacological efficacy, effectiveness and safety would be different for adolescents than for any other group of smokers. Taking into account the above, we stress that the use of pharmacological interventions for highly dependent adolescents is to be preferred to the harmful health effects of smoking. However, it should be taken into account that the context and meaning of smoking in adolescence is very different from that for adult smokers (Amos et al., 2006). Although some adolescents were found to favour the use of NRT because of anticipated difficulties with withdrawal symptoms (Molyneux et al., 2006), a substantial proportion of adolescents have a rather negative attitude towards NRT and smoking cessation services, partly because they consider these to belong to the world of adults who had been smoking longer and were more likely to be addicted (Amos et al., 2006). Clinical studies should determine whether pharmacological aids are effective in bringing about smoking cessation in adolescents with high dependence profiles if they are motivated and willing to use these products.

Intervention Studies. It was shown in this thesis that different nicotine dependence profiles can be identified and that the emergence of these profiles are predicted by different sets of individual and environmental factors. These findings provide an indication that

interventions aimed at smoking treatment should be tailored to specific individuals. Future experimental studies are needed to establish whether tailoring the intensity and type of smoking treatment based on nicotine dependence profiles may be more effective in bringing about smoking cessation compared to more widely implemented general approaches.

Genetic factors

Fisher (1958) is considered to be the first to note genetic factors in smoking behaviour (Hutchison et al., 2002). Since then, several studies have provided evidence for the heritability of both smoking behaviour in general, as well as for the occurrence of nicotine dependence symptoms (e.g. Audrain McGovern et al., 2007; Boomsma et al., 1994; Koopmans et al., 1999; McGue et al., 2000; Vink et al., 2005; White et al., 2003). Among adolescents, molecular genetic research on smoking initiation and progression described a number of candidate genes that are associated with susceptibility for developing nicotine dependence. Several genes implicated in the dopaminergic system were reported to be associated with smoking behaviour among adolescents. Allelic variation in dopamine receptor gene DRD4 was related to smoking initiation, whereas smoking continuation and nicotine dependence showed associations with the DRD2 risk allele. Variation in DRD3 genes were associated with the likelihood to initiate smoking and the age of onset of daily smoking (Laucht et al., 2008). Lastly, the dopamine transporter gene, SLC6A3, was found to be associated with smoking uptake and continuation (Timberlake et al., 2006). Also, nicotine-metabolizing enzymes (e.g. CYP2A6 gene) were associated with differences in smoking frequency and nicotine dependence (Huang et al., 2005; O'Loughin et al., 2004; Audrain-McGovern et al., 2007). In addition, variation in polymorphisms in the promoter region of the serotonin transporter gene (5HTT, 5HTTLPR) was found to be associated with smoking initiation and heaviness of smoking (Gerra et al., 2005). Another class of genes involved in nicotine-related behaviour is the family of nicotinic acetylcholine receptors (nAChRs). However, the role of nAChRs in nicotine reinforcement has only been investigated among adult smokers (Mineur & Picciotto, 2008; Schnoll et al., 2007).

It is, however, becoming increasingly clear that to understand individual differences in dependence phenotypes, it is not sufficient to know to what extent genes affect the behavior; the focus should rather be on interactions between genes and environment (Haberstick et al., 2007; Morley et al., 2007; Rutter, 2002; Vink et al., 2003b). In Chapter 9, we reported that the interaction between exposure to smoking in the environment by significant others and the personality trait of extraversion was linked to experiencing more severe dependence symptoms. Since personality traits have a strong genetic basis (e.g. Bouchard, 2004), it is plausible that an interaction between genes and environment also underlies the development of dependence symptom profiles in adolescents. Identification of specific genetic and environmental mechanisms that underlie the emergence of dependence among adolescent novice smokers will probably lead to a more refined understanding of the aetiology of nicotine dependence.

Also, some (although not all) candidate gene studies have associated variants in genes related to dopamine and opioid neurotransmission with success in smoking cessation

(Lerman et al., 2004; 2006; Swan et al., 2005). Investigating whether adolescent smoking cessation has genetic components may help to match the type and/or intensity of treatments with the smokers most likely to benefit from them (Uhl et al., 2008).

Neuropsychological processes

In recent years, due to advancements in the developmental neuroscience of adolescence, a new perspective on the subject of adolescent risk-taking behaviour has emerged (Steinberg, 2004). Risk taking is thought to be due to a combination of logical reasoning and psychosocial factors. However, whereas logical-reasoning abilities seem relatively fully developed around age 15 years, psychosocial abilities that improve decision making and moderate risk taking (for instance impulse control, delay of gratification, and resistance to peer influence) are thought to continue to develop into young adulthood (Steinberg, 2004). This relatively late development of brain circuits may explain part of the receptivity for substance use during the period of adolescence (Volkow, 2005). Compared to adults, adolescents are cognitively immature in the neurological processes related to decision making (Lopez et al., 2008).

With regard to neurological development in relation to behaviour in adolescence it is thought that neurological development influences risk-taking behaviour by creating an imbalance in the reward and harm avoidance systems (Ernst et al., 2006). Adolescents are highly sensitive to rewards (Chambers et al. 2003) and rewards play a large role in associative learning and the development of 'hard to break' habits (Baumeister et al., 1994). A better understanding of the neurological developments that influence adolescents' reward systems may provide additional insights into how smoking patterns become entrenched in adolescent behaviour, and may subsequently provide more insight into the development of habits and dependence and the difficulties of smoking cessation. Also, a better understanding with respect to the effects of the cognitive immaturity on adolescent decision making about tobacco use may be helpful for the construction of more developmentally appropriate interventions targeting adolescent substance use.

Biological and physiological indicators of nicotine dependence

As in this thesis, nicotine dependence is usually assessed by forms of self-report. However, self-reports of nicotine dependence may be subject to recall bias, subjective interpretations of the questions, and the possibility of under- or over-reporting of symptoms. Besides self-reports, several biological indices can also be used as an indirect measure of nicotine dependence, for example cotinine, expired air carbon monoxide levels, and thiocyanate (e.g. Noland et al., 1988; Pechacek et al., 1984; Rojas et al., 1998; Prokhorov et al., 2000). However, the use of biological measures as markers of nicotine dependence is not yet fully elucidated. Although generally high levels of sensitivity and specificity are found when comparing biological measures with self-reported smoking behaviour (i.e., smoking frequency), several studies found only moderate or even no associations between cotinine levels and self-report measures of dependence symptoms (Dozois et al., 1995; Rojas et al., 1998; Stanton, 1995). Besides self-reports and biological indices, specific physiological responses have been linked to the absence or presence of

cigarettes, providing an indication of experienced nicotine dependence symptoms such as craving and withdrawal. For instance, there is preliminary evidence that skin conductance levels are associated with the presentation of smoking cues (Drobes & Tiffany, 1997), the perceived availability of cigarettes (Carter & Tiffany, 2001), and to frustration brought about by removing a reinforcer (Otis & Ley, 1993). In addition, salivation was demonstrated to be sensitive to the perceived availability of smoking (Field and Duka, 2001), and decreased heart rate has been mentioned as a symptom of withdrawal (Hughes et al., 1990). However, the sole use of physiological responses as markers of nicotine dependence would provide a rather limited concept of dependence. For future research purposes, the use of a variety of self-report, biological and physiological measures may ensure a more optimal and valid measurement of nicotine dependence symptoms among adolescent smokers.

Data collection in real time

In the present thesis, two approaches have been used to tap adolescent smokers' nicotine dependence symptoms. One method comprised a retrospective assessment of symptoms among current smokers. Most studies on nicotine withdrawal use retrospective ratings or single ratings for large periods of time. However, this method is susceptible to biases, including recall bias and bias concerning availability of data (Engels & Bot, 2003; McCarthy et al., 2006; Merinkangas, 2004). The other method that we applied aimed to measure craving and withdrawal symptoms among adolescent regular smokers in a more naturalistic setting by instructing them to remain abstinent for a period of 24 hours. However, to increase our understanding about the impact of nicotine dependence symptoms on the success of smoking cessation, studies on data that are collected through Ecological Momentary Assessment (EMA) might also prove useful. EMA can be viewed as an alternative approach to assess behaviour in real time. The use of EMA as a method to regularly assess experienced craving and withdrawal before and during a quit attempt (for example, by providing electronic diaries), may allow valuable information to be collected on the effects of craving and withdrawal during the various phases of smoking cessation.

Concluding remark

This thesis provides insight into potential determinants and mechanisms of adolescent smoking cessation. Results showed that, compared to nicotine dependence symptoms, smoking-specific cognitions and the engagement in active cognitive and behavioural strategies appear to be less relevant with regard to adolescent smoking cessation. Among adolescent smokers, nicotine dependence is prevalent and forms an important barrier in the process of successful quitting. Intervention programs are advised to take into account individual differences in nicotine dependence and special attention should be paid to adolescents who are at risk of developing more severe nicotine dependence profiles.

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Summary of results

Summary of results

Despite the well-known damaging health effects of smoking, a substantial proportion of adolescents continue to take up a smoking habit. Tobacco contains the highly addictive substance nicotine and adolescent smokers are known to experience symptoms of nicotine dependence, even if their exposure to cigarette smoking has been relatively short and/or intermittent. Because of the addictive and damaging properties of smoking, it is important to encourage adolescent smokers to quit. However, the main focus of adolescent smoking research has been on identifying and influencing the factors that are thought to contribute to experimentation and initiation. Far less research has focused on the predictors of smoking cessation among adolescents. This initial lack of interest may partly be explained by the prevailing thought that adolescent smokers were unlikely to be already dependent on nicotine and would, therefore, be able to stop smoking easily if they wanted to. Meanwhile, however, it is known that even though many adolescent smokers want to quit smoking, relapse rates are high and maintenance of smoking cessation is poor. Because the literature addressing adolescent smoking cessation is still limited and the adolescent smoking cessation treatment field is still considered to be in its infancy, this thesis presents a number of studies that aimed to identify and explore the determinants of smoking cessation, as well as the determinants of important parameters of cessation - such as readiness to quit smoking and undertaking quit attempts.

As mentioned, one of the major risks of adolescent smoking is that youngsters develop dependency symptoms and continue to smoke into adulthood. Because research on the occurrence of nicotine dependence symptoms among adolescents is scarce, Part 1 of this thesis focuses on providing a better understanding of the measurement and development of nicotine dependence among adolescents.

Besides the possible role of nicotine dependence in smoking cessation, it is known that smoking-specific cognitions and environmental factors are also associated with adolescents' quitting. However, because these variables have rarely been tested in an integrated model to explain smoking cessation, little is known about the mechanisms by which these factors influence the process of smoking cessation. Therefore, Part 2 of this thesis examines in greater depth the process of adolescent smoking cessation by simultaneously analyzing the impact of potential influential determinants. In addition, the possible mechanisms by which these factors may explain adolescent smoking cessation practices are also investigated.

In order to achieve the above-mentioned objectives, longitudinal survey data have been collected from more than 10,000 Dutch adolescents (both smokers and non-smokers). The questionnaires that were used contained questions on psychological, habitual and environmental processes in relation to tobacco use. All chapters (except Chapters 6 and 10) are based on the data collected within this longitudinal study. The study presented in Chapter 6 was conducted among 367 adult smokers and is included to enable comparison with a similar study focusing on excuses to continue smoking among adolescent smokers. Chapter 10 reports on a longitudinal study investigating 98 adolescents who are daily smokers.

Part 1: On the measurement and development of nicotine dependence in adolescence

How can nicotine dependence be adequately conceptualized and measured among adolescent smokers? (Chapter 2)

Because no gold standard is available against which to measure adolescent nicotine dependence, Chapter 2 focuses on developing a scale that captures multiple features of nicotine dependence among adolescent smokers. In a cross-sectional sample, distinct features of nicotine dependence were identified and then validated in a second sample. In addition, convergent validity for the dimensions of nicotine dependence was established. From this study it was concluded that nicotine dependence among adolescents consists of multiple features, namely behavioural aspects of physical tolerance, craving, and withdrawal symptoms. Using this multidimensional measure offers an important advantage over the use of a one-dimensional measure, since multiple components can better capture the overall construct of nicotine dependence.

Is there individual variation in the development and intensity of nicotine dependence symptoms among adolescent smokers? (Chapter 3)

The results of Chapter 3 show that four distinctive subtypes of nicotine dependence can be distinguished; namely 1) low craving only, 2) high craving and withdrawal, 3) high craving and physical tolerance, and 4) high craving, physical tolerance and withdrawal. These symptom profiles appear to be stable over time and, moreover, are differentially associated with previously identified correlates of nicotine dependence, namely parental and peer smoking, depressive mood, and self-efficacy to refrain from smoking. Also, differences are found between the four subtypes with regard to smoking uptake and cessation, with adolescents in the 'low craving only' having the highest chance of being a non-smoker one year later, followed by the 'high craving and withdrawal', 'high craving and physical tolerance' and the 'high craving, physical tolerance and withdrawal' profiles.

Part 2: Identifying determinants and mechanisms of adolescent smoking cessation

What are the most important factors and mechanisms underlying smoking cessation practices among adolescents? (Chapters 4, 5, 7, 8, 9 and 10)

Chapters 4 and 5 examine the usefulness of ten active cognitive and behavioural strategies, also known as the processes of change (Transtheoretical Model; Prochaska et al., 1992), in explaining readiness to quit smoking and actual smoking cessation. Examples of the processes of change are: asking others for help to quit smoking, removing ashtrays from one's immediate surroundings, or realising that others may be bothered by one's smoking. The results in Chapter 4 show that, contrary to the assumptions of the Transtheoretical Model, processes of change are only marginally associated with adolescents' readiness to quit smoking as measured by the stages of change construct. Controlling for the impact of the processes of change, nicotine dependence remained significantly associated with readiness to quit. Adolescents with higher levels of nicotine dependence are less ready to quit smoking. In agreement with the cross-sectional results in Chapter 4, the longitudinal study in Chapter 5 shows that the processes of change do

not seem important in explaining adolescents' transitions through the stages of readiness to change, whereas nicotine dependence contributes significantly to the explanation of adolescents' transition towards smoking cessation, after adjustment for the processes of change. Adolescents with a low level of nicotine dependence quit smoking more often than adolescents with high levels of nicotine dependence. In both Chapter 4 and Chapter 5 it is noted that, among Dutch adolescents, the readiness to quit smoking is generally low. Furthermore, processes of change are of limited importance in explaining adolescents' readiness to quit smoking and transitions towards smoking cessation.

Chapter 6 presents a longitudinal study on the role of excuses to continue smoking (i.e. disengagement beliefs) within the process of smoking cessation among adults. Results show that adherence to smoking-specific disengagement beliefs is negatively related to adult smokers' readiness to quit, changes in readiness to quit, and smoking cessation. Chapter 7 elaborates on this study by testing whether adolescents also adhere to disengagement beliefs. We found that adolescent smokers' adherence to disengagement beliefs is stronger than that of adults. Among adolescent smokers we found that, compared to the level of nicotine dependence, disengagement beliefs are more strongly associated with the readiness to quit. However, in comparison to disengagement beliefs, at follow-up nicotine dependence was the strongest predictor of smoking cessation. Thus, although adolescents adhere more strongly to disengagement beliefs than adults, these beliefs do not seem to play an important role in explaining actual smoking cessation.

In Chapter 8, a longitudinal approach is used to test two models specifying multiple levels of influence on adolescent smoking cessation. In these models we examined the influences of the readiness to quit, nicotine dependence, and smoking behaviour of parents and peers on undertaking quit attempts and actual smoking cessation, respectively. It is shown that both readiness to quit and nicotine dependence are associated with undertaking quit attempts, while only nicotine dependence is inversely associated with successful cessation. Instead of a direct relation, parental and peers' smoking mainly affect adolescent smoking cessation practices by enhancing experienced nicotine dependence symptoms and decreasing readiness to quit. In other words, having smoking parents and friends is associated with a lower readiness to quit and a higher level of nicotine dependence. A lower readiness to quit is subsequently associated with a lower probability of undertaking a quit attempt, whereas a higher level of nicotine dependence is associated with a higher probability of undertaking a quit attempt but also with a lower chance of successful smoking cessation. Thus, among adolescent smokers, readiness to quit seems to be most important in determining whether one will try to quit smoking, whereas the degree of nicotine dependence seems to determine whether or not a quit attempt will be successful.

After having explored and established the role of nicotine dependence as an important predictor of adolescent smoking cessation, Chapter 9 further elaborates on the occurrence of nicotine dependence symptoms. Results show that the exposure to smoking behaviour of significant others constitutes a risk for the onset of nicotine dependence symptoms, whereas further progression of dependence symptoms is related to having a neurotic or

extravert personality. The development of severe dependence symptom profiles appears to be the result of an interaction between individual disposition and the exposure to smoking in the social environment.

Chapter 10 presents a study conducted among 98 adolescent daily smokers who were instructed to remain abstinent (refrain from smoking) for 24 hours. The findings show that the level of craving among adolescent smokers is higher when measured during abstinence than when measured during ad libitum smoking. Therefore, it appears that adolescent smokers experience an increase in craving (and to some extent an increase in withdrawal symptoms) when they are periodically abstinent, for example when they try to quit smoking. Furthermore, craving, but not withdrawal, predicts prolonged cessation four months later. This means that the urge or desire to smoke a cigarette is a stronger predictor of smoking cessation than, for example, experiencing problems with concentrating, or feeling angry, anxious or nervous during abstinence. Craving measured during abstinence, however, was a stronger predictor compared to craving measured during ad libitum smoking. Adolescent smokers are likely to suffer increasing craving when they try to quit smoking, and the measurement of craving in vivo seems preferable to the measurement of craving during ad libitum smoking.

Finally, in Chapter 11 the results of the work presented in this thesis are summarized and discussed. It is concluded that, among adolescent smokers, nicotine dependence is prevalent and forms an important barrier in the process of successful quitting. Compared to nicotine dependence symptoms, smoking-specific cognitions and the engagement in active cognitive and behavioural strategies appear less relevant for adolescent smoking cessation. Smoking cessation programs targeting adolescent smokers are advised to take into account individual differences in nicotine dependence. Furthermore, it is recommended that special attention be paid to adolescents who are at risk of developing more severe nicotine dependence profiles, such as adolescents scoring high on the personality traits extraversion or neuroticism and who have many smokers in their social environment. Lastly, the shortcomings and implications of these studies are discussed, and recommendations are made for future research.

Samenvatting

Summary in Dutch

Samenvatting

Ondanks hun bekendheid met de mogelijke schadelijke gevolgen, begint een groot aantal jongeren toch met roken. Tabak bevat de zeer verslavende stof nicotine en jongeren kunnen, zelfs na een periode van kort en/of onregelmatig roken, symptomen van nicotineafhankelijkheid ontwikkelen. Vanwege de verslavende werking en de schadelijke gezondheidsgevolgen van roken en vanwege het feit dat stoppen met roken steeds moeilijker wordt naarmate men langer rookt, is het van belang om het stoppen met roken onder jongeren aan te moedigen. Onderzoek naar het rookgedrag van adolescenten was tot nu toe echter vooral gericht op het onderscheiden en beïnvloeden van factoren die een rol spelen bij het experimenteren en beginnen met roken. Er is nog weinig onderzoek gedaan naar factoren die stoppen met roken onder adolescenten kunnen beïnvloeden. Het gebrek aan onderzoek naar stoppen met roken onder adolescenten kan voor een deel worden toegeschreven aan het feit dat lang werd verondersteld dat adolescente rokers nog niet afhankelijk konden worden van nicotine. Aangenomen werd dat adolescenten zonder al te veel moeite met roken zouden kunnen stoppen wanneer ze dat zelf maar wilden. Inmiddels is echter bekend dat de terugval na het ondernemen van stoppogingen ook onder adolescenten erg hoog is. In dit proefschrift worden een aantal studies naar determinanten van stoppen met roken bij jongeren beschreven, waaronder ook studies naar determinanten van eerdere stadia in het proces van stoppen met roken, zoals de motivatie om met roken te stoppen en het ondernemen van een stoppoging. Dit met als eerste doel meer inzicht te geven in het proces van stoppen met roken bij jongeren en met als uiteindelijke doel bij te dragen aan de ontwikkeling van stoppen-met-roken behandelingen voor jongeren.

Zoals eerder beschreven, is de ontwikkeling van afhankelijkheid een belangrijke factor in het continueren van roken in de volwassenheid. Vanwege het gebrek aan onderzoek naar nicotineafhankelijkheid bij jonge rokers, heeft Deel 1 van dit proefschrift tot doel bij te dragen aan een beter begrip van de ontwikkeling van symptomen van nicotineafhankelijkheid onder adolescente rokers. Hiertoe is allereerst een instrument ontwikkeld en gevalideerd om nicotineafhankelijkheid bij jongeren te meten. Met behulp van dit instrument is vervolgens de rol van nicotine afhankelijkheid binnen het stopproces van adolescente rokers onderzocht.

Aangezien eerder onderzoek uit heeft gewezen dat naast nicotineafhankelijkheid ook rookspecifieke cognities en omgevingsfactoren samenhangen met stoppen met roken onder adolescenten, is Deel 2 van dit proefschrift gericht op het beter doorgronden van het proces van stoppen met roken bij jongeren, waarbij het effect van verschillende potentiële invloedrijke factoren op het proces van stoppen met roken gelijktijdig is getest. Dit is bijzonder omdat rookspecifieke cognities, omgevingsfactoren en nicotineafhankelijkheid tot nu toe nauwelijks gezamenlijk zijn getoetst in een geïntegreerd model om stoppen met roken te verklaren. Daarnaast zijn mechanismen die mogelijk verantwoordelijk zijn voor het feit dat deze factoren stoppen met roken verklaren, nader onderzocht.

Om bovengenoemde doelen te bewerkstelligen is een longitudinaal vragenlijstonderzoek onder ruim 10.000 Nederlandse adolescenten (zowel rokers als niet-rokers) uitgevoerd.

De vragenlijsten bevatten vragen over psychologische, omgevings- en verslavingsfactoren die van belang kunnen zijn voor het verklaren van rookgedrag onder adolescenten. Met uitzondering van hoofdstuk 6 en 10, zijn alle hoofdstukken gebaseerd op de data van deze longitudinale studie. Hoofdstuk 6 is een studie uitgevoerd onder een groep van 367 volwassen rokers met als doel een vergelijking te maken tussen adolescentie en volwassen rokers. Hoofdstuk 10 presenteert de bevindingen van een korte longitudinale studie onder 98 dagelijks rokende jongeren.

Deel 1: Het meten en de ontwikkeling van nicotineafhankelijkheid in de adolescentiefase

Hoe kan nicotineafhankelijkheid adequaat geconceptualiseerd en gemeten worden onder adolescentie rokers? (Hoofdstuk 2)

Omdat een gouden standaard voor het meten van nicotineafhankelijkheid nog altijd ontbreekt, hebben we ons allereerst gericht op het ontwikkelen van een meetinstrument dat in staat is om meerdere aspecten van nicotineafhankelijkheid onder adolescentie rokers te identificeren. In een cross-sectionele steekproef zijn verschillende aspecten van nicotineafhankelijkheid onderscheiden, en deze zijn vervolgens gevalideerd in een tweede steekproef. Daarnaast is de convergente validiteit voor deze dimensies van nicotineafhankelijkheid bepaald. Geconcludeerd kan worden dat nicotineafhankelijkheid onder adolescenten uit drie aspecten bestaat, namelijk gedragsmatige aspecten van fysieke tolerantie, craving en onthoudingsverschijnselen. Het gebruik van dit multidimensionale meetinstrument heeft als belangrijk voordeel dat het meerdere componenten onderscheidt en daardoor een beter beeld geeft van het totale construct van nicotineafhankelijkheid.

Is er individuele variatie in de ontwikkeling en intensiteit van nicotineafhankelijkheids-symptomen onder adolescentie rokers? (Hoofdstuk 3)

De resultaten in hoofdstuk 3 laten zien dat vier afzonderlijke symptoomprofielen van nicotineafhankelijkheid geïdentificeerd kunnen worden bij adolescentie rokers, namelijk (1) alleen lage craving, (2) hoge craving en onthoudingsverschijnselen, (3) hoge craving en fysieke tolerantie en (4) hoge craving, fysieke tolerantie en onthoudingsverschijnselen. Deze symptoomprofielen zijn stabiel door de tijd en verschillend geassocieerd met eerder vastgestelde correlaten van nicotineafhankelijkheid, namelijk roken van ouders en vrienden, depressieve stemming en zelfeffectiviteit om niet te roken. Ook zijn er verschillen gevonden tussen de vier subtypes en respectievelijk het beginnen en stoppen met roken, waarbij jongeren met het profiel 'alleen lage craving' een jaar later het vaakst niet-rokers waren, gevolgd door respectievelijk de profielen 'hoge craving en onthoudingsverschijnselen', 'hoge craving en fysieke tolerantie' en 'hoge craving, fysieke tolerantie en onthoudingsverschijnselen'.

Deel 2: Het identificeren van determinanten en mechanismen van stoppen met roken onder adolescenten

Wat zijn de belangrijkste factoren en onderliggende mechanismen in het proces van stoppen met roken bij jongeren? (Hoofdstuk 4, 5, 7, 8, 9 en 10)

In hoofdstuk 4 en 5 wordt onder adolescentie rokers onderzocht in hoeverre het gebruik van actieve cognitieve- en gedragsstrategieën, beter bekend als de processen van verandering (Transtheoretisch Model; Prochaska e.a., 1992), samenhangt met de motivatie om te stoppen en het daadwerkelijk stoppen. Voorbeelden van processen van verandering zijn het vragen van hulp aan anderen bij het stoppen met roken, het verwijderen van asbakken uit de omgeving, of je realiseren dat je omgeving last heeft van roken. De resultaten in hoofdstuk 4 laten zien dat, in tegenstelling tot de aannames van het Transtheoretisch Model, de processen van verandering slechts marginaal samenhangen met de motivatie om te stoppen. Nicotineafhankelijkheid blijkt echter wel significant samen te hangen met de motivatie om te stoppen, zelfs wanneer er gecontroleerd wordt voor het effect van de processen van verandering. Naarmate jongeren meer symptomen van nicotineafhankelijkheid vertonen, zijn ze minder gemotiveerd om te stoppen. In overeenstemming met de resultaten uit hoofdstuk 4, laat de longitudinale studie in hoofdstuk 5 zien dat de processen van verandering ook de transitie door de verschillende fasen van motivatie niet kunnen voorspellen. Ook hier blijkt nicotineafhankelijkheid wel significant bij te dragen aan de transitie naar stoppen met roken, ook na het controleren voor de effecten van de processen van verandering. Jongeren met een lage nicotineafhankelijkheid stoppen vaker met roken dan jongeren met een hoge nicotineafhankelijkheid. Zowel in hoofdstuk 4 als 5 wordt opgemerkt dat de motivatie om met roken te stoppen onder Nederlandse adolescenten in het algemeen laag is. Verder lijkt het gebruik van allerlei cognitieve- en gedragsstrategieën die voorbereidend kunnen zijn op stoppen met roken niet samen te hangen met de motivatie om te stoppen en het maken van de daadwerkelijke beslissing om te stoppen.

Hoofdstuk 6 beschrijft een longitudinale studie naar de rol van excuses of smoesjes om te roken in het proces van stoppen met roken onder volwassenen. De resultaten laten een negatieve relatie zien tussen het onderschrijven van excuses om te roken en de motivatie om te stoppen, motivatieverandering en stoppen met roken. Hoofdstuk 7 bouwt voort op deze studie door te toetsen in hoeverre adolescentie rokers excuses om te blijven roken onderschrijven. Gevonden is dat adolescentie rokers de verschillende excuses sterker onderschrijven dan volwassen rokers. Onder adolescentie rokers hangen de excuses om te roken sterker dan nicotineafhankelijkheid samen met de motivatie om te stoppen. Vergeleken met excuses om te roken is nicotineafhankelijkheid echter wel de sterkste voorspeller van daadwerkelijk stoppen een jaar later. Dus ondanks dat adolescenten de excuses om te roken sterker onderschrijven, lijken deze excuses geen belangrijke rol te spelen in het proces van daadwerkelijk stoppen met roken.

In hoofdstuk 8 is de invloed van enkele potentieel invloedrijke factoren op het rookgedrag van adolescenten getoetst aan de hand van twee longitudinale modellen. In deze

modellen werd gekeken naar de invloed van de motivatie om te stoppen, nicotine afhankelijkheid en het roken van ouders en vrienden op respectievelijk het ondernemen van stoppogingen en daadwerkelijk stoppen. De resultaten laten zien dat zowel motivatie om te stoppen als nicotineafhankelijkheid samenhangen met het ondernemen van een stoppoging. Succesvol stoppen met roken hangt echter enkel samen met nicotineafhankelijkheid. Het roken van ouders en vrienden blijkt ook samen te hangen met het ondernemen van stoppogingen en daadwerkelijk stoppen, maar dit proces verloopt voornamelijk via nicotineafhankelijkheid en motivatie om te stoppen. Met andere woorden, het hebben

van rokende ouders en vrienden hangt samen met een hogere nicotine afhankelijkheid en met een lagere motivatie om te stoppen. Een lagere motivatie om te stoppen hangt vervolgens weer samen met het minder vaak ondernemen van een stoppoging en een hogere nicotine afhankelijkheid hangt samen met vaker ondernemen van een stoppoging, maar tevens minder met daadwerkelijk succesvol stoppen. Onder adolescente rokers lijkt de motivatie om te stoppen voornamelijk belangrijk voor het al dan niet ondernemen van een stoppoging, terwijl nicotineafhankelijkheid voornamelijk bepaald of een stoppoging succesvol zal zijn.

Na te hebben vastgesteld dat nicotineafhankelijkheid een belangrijke barrière vormt voor stoppen met roken onder adolescenten, richt hoofdstuk 9 zich op het verkrijgen van meer inzicht in het ontstaan van symptomen van nicotineafhankelijkheid. De resultaten laten zien dat blootstelling aan het rookgedrag van anderen in de nabije omgeving een risico vormt voor het ontstaan van symptomen van afhankelijkheid bij rokende adolescenten. Dit resultaat is vergelijkbaar met de bevinding in hoofdstuk 8 dat het hebben van rokende ouders en vrienden samen hangt met een hogere nicotine afhankelijkheid. Een toename van afhankelijkheidssymptomen lijkt verder gerelateerd te zijn aan het hebben van een neurotische of extraverte persoonlijkheid. De ontwikkeling van meer ernstige profielen van afhankelijkheid lijkt dus het resultaat van een interactie tussen persoonlijkheidskenmerken enerzijds en de blootstelling aan een rokende omgeving anderzijds.

In hoofdstuk 10 worden de resultaten van het onderzoek onder 98 dagelijks rokende adolescenten die 24 uur niet mochten roken beschreven. De uitkomsten laten zien dat het niveau van craving bij jongeren hoger is wanneer het gemeten wordt gedurende een periode van abstinentie (niet roken) dan wanneer het gemeten wordt gedurende een periode van vrij roken. Adolescente rokers ervaren dus een toename in craving (en in verminderde mate een toename in onthoudingsverschijnselen) wanneer ze een periode abtinent zijn, bijvoorbeeld omdat ze een stoppoging ondernemen. Verder blijkt de mate van craving het daadwerkelijk stoppen met roken te belemmeren, terwijl onthoudingsverschijnselen niet significant samenhangen met stoppen met roken vier maanden later. Dit betekent dat een sterke drang of verlangen naar een sigaret meer dan bijvoorbeeld het ervaren van een verminderde concentratie of gevoelens van boosheid, angst of nervositeit gedurende abstinentie een belemmering zijn voor het slagen van een stoppoging. Craving gemeten gedurende abstinentie blijkt echter een sterkere voorspeller

van stoppen met roken dan craving gemeten gedurende een periode van vrij roken. Om stoppen met roken bij jongeren te voorspellen, verdient het meten van craving gedurende abstinentie dus de voorkeur boven het meten van craving gedurende vrij roken.

Tot slot worden bevindingen van het huidige proefschrift in het laatste hoofdstuk samengevat en besproken. Er wordt geconcludeerd dat nicotineafhankelijkheid al duidelijk voorkomt onder adolescente rokers en tevens dat het een belangrijke barrière vormt voor het proces van stoppen met roken bij jongeren. Rookspecifieke cognities en het gebruik van actieve cognitieve- en gedragstrategieën lijken, vergeleken met symptomen van nicotineafhankelijkheid, minder relevant met betrekking tot stoppen met roken door jongeren. Geadviseerd wordt om bij het ontwikkelen van stoppen-met-roken interventies voor adolescenten rekening te houden met individuele verschillen in nicotineafhankelijkheid. Verder wordt aangeraden om extra aandacht te besteden aan adolescenten die een verhoogt risico lopen op het ontwikkelen van de ernstigere profielen van nicotineafhankelijkheid, zoals adolescenten die hoog scoren op extraverte of neurotische persoonlijkheidstrekken en die tevens veel rokers in de sociale omgeving hebben. Tot slot worden in het laatste hoofdstuk de beperkingen en implicaties van de beschreven studies besproken en worden aanbevelingen voor toekomstig onderzoek gedaan.

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Curriculum Vitae

Marloes Kleinjan was born on 18th March 1981, in Ommen (the Netherlands). After completing her secondary school (VWO) at the Agnieten College in Zwolle in 1999, she continued her studies at the University of Groningen. There she obtained a Master's degree in Social Psychology in 2004 with additional minors in Health Psychology and Clinical Psychology, followed by a Master's degree in Epidemiology at the Netherlands Institute for Health Sciences in 2007. In 2004 she started her PhD studies at IVO (Scientific Bureau for Research on Lifestyle, Addiction and related Social Developments) whilst employed by the Erasmus University Medical Center. To pursue a research visit (2.5 months) at the Research Unit on Children's Psychosocial Maladjustment (G.R.I.P), University of Montréal (Canada), she received grants from the Erasmus University Trust Fund and IVO. In November 2008 Marloes Kleinjan started working as a senior researcher at IVO head office in Rotterdam. As of February 2009, she will start as a Postdoc at the Behavioural Science Institute of the Radboud University Nijmegen.