



Published in final edited form as:

Nicotine Tob Res. 2008 August ; 10(8): 1283–1291. doi:10.1080/14622200802238993.

Developmental Trajectories of Cigarette Smoking from Adolescence to the Early Thirties: Personality and Behavioral Risk Factors

David W. Brook, M. D.,
New York University School of Medicine

Judith S. Brook, Ed.D.,
New York University School of Medicine

Chenshu Zhang, Ph.D.,
New York University School of Medicine

Martin Whiteman, Ph.D.,
New York University School of Medicine

Patricia Cohen, Ph.D., and
New York Psychiatric Institute

Stephen J. Finch, Ph.D.
State University of New York at Stony Brook

Abstract

The purpose of this study was to identify distinct trajectories of cigarette smoking from ages 14 to 32, and to examine adolescent personality factors that distinguish trajectories of smoking behavior. Participants (N=975) were randomly selected and followed prospectively since 1975. Follow-up data on cigarette use and personality and behavioral attributes were collected at five points in time, using structured interviews given in private by trained interviewers. Of these subjects, 746 comprised the cohort used in this study. Growth mixture modeling identified five smoking trajectory groups: nonsmokers, occasional smokers, late starters, quitters, and heavy/continuous smokers. Adolescent personality and behavioral risk factors such as lower ego integration, more externalizing behavior, and lower educational aspirations distinguished the trajectory groups. No gender differences were noted. The findings supported the hypotheses indicating multiple distinct trajectory groups of smoking behavior. Smoking behavior appeared in early adolescence and most often continued into adulthood. Emotional difficulties (i.e., lower ego integration), externalizing behavior, and lower educational aspirations in early adolescence were associated both with smoking at an early age and with continuing to smoke into the thirties. To be more effective, smoking prevention programs should target personality and behavioral variations, before smoking becomes habitual, particularly focused on characteristics reflecting behavioral problems as manifested in emotional difficulties, externalizing behavior, and low educational aspirations in early adolescence. The implications for research, prevention, and treatment are discussed.

Correspondence can be sent to Dr. Judith Brook, Department of Psychiatry, New York University School of Medicine, 215 Lexington Avenue, 15th Floor, New York, NY 10016, judith.brook@med.nyu.edu; phone (212) 263-4663; fax (212) 263-4660..

The work for this study was performed at New York University School of Medicine, Department of Psychiatry, 215 Lexington Avenue, 15th Floor, New York, NY 10016.

The long-term consequences of cigarette smoking include such potentially fatal diseases as lung cancer, coronary artery disease, chronic obstructive pulmonary disease (COPD), and stroke (Centers for Disease Control and Prevention, 2002). Such severe consequences of smoking have prompted researchers to identify the psychosocial antecedents of smoking behavior in order to advance prevention, intervention, and cessation programs. One theory that explains the development of adolescent tobacco use is Jessor and Jessor's problem behavior theory (Jessor & Jessor, 1977). According to problem behavior theory and empirical research, higher levels of externalizing problem behaviors such as aggression and delinquency are related to smoking behavior (Burt, Dinh, Peterson, & Sarason, 2000; Masse & Tremblay, 1997; McMahon, 1999). Higher levels of internalizing problem behaviors, such as depression, have also been found in some studies to predict smoking behavior (Lerman, et al., 1996; Patton, Lewinsohn, Seeley, & Wagner, 1996). Many of these studies are somewhat limited in that they do not consider changes over time in subgroups of smokers in relation to personality/behavioral attributes. The present study was designed to examine adolescent personality/behavioral attributes (e.g., internalizing and externalizing behaviors) that differentiate among various smoking trajectories in sub-groups of smokers from adolescence to adulthood.

Over the past several years, major advances have been made using semi-parametric, group-based approaches (Muthen & Shedden, 1999; Roeder, Lynch, & Nagin, 1999) to analyze developmental trajectories of problem behavior in the areas of delinquency and criminal behavior (Laub, Nagin, & Sampson, 1998; Nagin & Tremblay, 1999; Nagin & Tremblay, 2001), in the field of alcohol use (Colder, Richardson, Campbell, Ruel, & Flay, 2002; Chassin, Pitts, & Prost, 2002), and in the study of cigarette use (Chassin, Presson, Pitts, & Sherman, 2000; White, Johnson, & Buyske, 2000; White, Pandina, & Chen, 2002). This analytic approach distinguishes among smoking trajectories and explores the predictors of the different etiological pathways underlying the trajectories of different subgroups of smokers.

Several investigators have found distinct trajectories of smoking from early adolescence into young adulthood (Orlando, Tucker, Ellickson, & Klein, 2004). Using a large community sample, Chassin et al. (2000) identified four trajectory groups. They found that some psychosocial variables such as peer smoking, parental smoking, tolerance of deviance, and smoking-related beliefs distinguished among the smoking groups. Using a primarily white sample (N=432), White et al. (2002) identified three smoking trajectories; namely, nonsmokers/experimental smokers, occasional/maturing out smokers, and heavy/regular smokers. They found that some risk factors, such as being more uninhibited and receiving lower grades, differentiated smokers (i.e., occasional/maturing out smokers and heavy/regular smokers) from nonsmokers, and also distinguished heavy/regular smokers from the rest of the sample.

In the present study, we hypothesized multiple subgroups of trajectories of cigarette smoking extending from age 14 to age 32. Based on previous research, we expected to identify personality and behavioral factors in adolescence that predict and distinguish among different trajectories of smoking behavior into adulthood. With a few important exceptions (e.g., Chassin et al., 2000; Colder et al., 2002; White et al., 2002), we are the only investigators who have studied an array of personality and behavioral factors as they relate to the development of smoking behavior beginning in early adolescence and extending into the thirties. Furthermore, our study is unique in that we examined a composite measure of externalizing behavior problems and a separate composite measure of internalizing behavior problems. Under the term externalizing behavior problems, we included the more active forms of externalization (e.g., rebellion, aggression and delinquency), as well as those that are less active (e.g., tolerance of deviance and low responsibility). Similarly, under the term

internalizing behavior problems, we included both intrapersonal (e.g., depression and anxiety) and interpersonal dimensions (e.g., interpersonal difficulty).

Method

Participants and Procedure

Participant data were based on a randomly selected cohort (N=975) at T1 studied prospectively since 1975. The families in this study were generally representative of the population of families in Albany and Saratoga, two upstate New York counties^a in 1975 with respect to ethnicity, gender, family intactness, family income, and education. There was a close match of the participants on family income, maternal education, and family structure with the 1980 survey conducted by the U.S. Bureau of Census. For example, 75% of our children lived with married parents, and 19% lived with a mother who was not currently married; the census figures were 79% and 17%, respectively. Follow-up data were collected in their homes in 1983 (T2), 1985-1986 (T3), 1992 (T4), 1997 (T5), and 2002 (T6). The mean ages (SDs) of the participants at the follow-up interviews were 14.05 (2.80), 16.26 (2.81), 22.28 (2.82), 26.99 (2.80), and 32.00 (2.84), respectively. The analyses for the current paper were based on those subjects who participated in the study at T2 and at least once from T3 through T6. Extensively trained and supervised lay interviewers administered the interviews in private. Written informed consent was obtained from the participants and their mothers in 1983, 1986, and 1992, and from the participants only in 1997 and 2002. Approval for the use of human subjects was authorized by the Institutional Review Board of New York University School of Medicine. The sample (N=746) on which the analysis is based was 95% white and 51% female. There were no significant differences on the demographic variables (e.g., family income at T1, $t=1.57$; $p>0.05$) between those who remained in the study and those who dropped out. Of the 746 participants, 553 (74.1%) were present at all of the assessments from T2 through T6; 137 (18.4%) were present at four time waves; 38 (5.1%) were present at three time waves; and 18 (2.4%) were present at two time waves. For more details about the sampling procedures and the original sample, see Cohen and Cohen (1996) and Brook, Whiteman, Gordon, and Cohen (1986).

Measures

Cigarette Use—The data were obtained from interviewer-administered questionnaires. At each time wave (T2–T6), questions about tobacco use were included. These questions asked about the frequency of smoking cigarettes in early adolescence (1983; prior to T2), smoking cigarettes during the last two years in adolescence (1985; T2–T3), smoking cigarettes during the last five years in the early twenties (1992; T3–T4), smoking cigarettes during the past five years in the late twenties (1997; T4–T5), and smoking cigarettes during the last five years in the early thirties (2002; T5–T6). The tobacco measure at each point in time had a scale coded as none (0), less than daily (1), 1–5 cigarettes a day (2), about half a pack a day (3), about a pack a day (4), and about 1.5 packs a day or more (5).

^aAlbany County was identified as one of the poorest counties in the New York State, and adjacent Saratoga County as one of the wealthiest. These were chosen for study by means of a sample survey. Primary sampling units were created from enumeration districts and block groups, which, when taken together, comprised the entire area and population of the target counties. The primary sampling units in each county were stratified by urban/rural status, the proportion of Whites, and median income. A systematic sample of primary sampling units in each county was then drawn with probability proportional to the number of households, and probabilities equal for members of all strata. Segments of blocks were then selected with probability proportional to size (number of households), and each was surveyed in the field with a proportion of the households being selected according to the predetermined sampling ratio. Address lists were compiled in this process, and interviewers were sent to the selected addresses. Those households with at least one child between the ages of 1–10 years were qualified for the study. In each qualified household, the interviewer, by use of a set of Kish Tables, randomly selected one child from those in the appropriate age range (Cohen & Cohen, 1996).

Personality and Behavioral Attributes—at T2. At T2, we assessed the personality and behavioral attributes of the participants. The Cronbach's alphas, measures of internal consistency, are listed as follows (Cronbach & Meehl, 1955). For personality and behavioral attributes, we included a measure of ego-integration which assesses emotional control [7 items, $\alpha=0.62$; e.g., "I generally rely on careful reasoning in making up my mind." (Brook, Brook, Gordon, Whiteman, & Cohen, 1990)], a measure of sensation seeking [5 items, $\alpha=0.52$; e.g., "I like 'wild' uninhibited parties." (Zuckerman, Eysenck, & Eysenck, 1978)], and a measure of educational aspiration [2 items, $\alpha=0.91$; e.g., "How far do you expect you will go in school?" (Original)]. In addition, we included a measure of externalizing behavior problems ($\alpha=0.79$), which consisted of 8 items assessing tolerance of deviance [e.g., "How wrong do you think it is to fake an excuse note from home?" (Jessor, Graves, Hanson, & Jessor, 1968)], 8 items assessing rebelliousness [e.g., "When rules and regulations get in the way, you sometimes ignore them." (Smith & Fogg, 1979)], 6 items assessing low responsibility [e.g., "If you get too much change in a store, you never give it back." (Gough, 1957)], 3 items assessing aggression [e.g., "You often make people angry by teasing them." (Original)], and 5 items assessing delinquency [e.g., "How often have you gotten into a serious fight at school or work?" (Gold, 1966)]. We also included a measure of internalizing behavior problems ($\alpha=0.85$), which consisted of 5 items assessing depression [e.g., "Over the last few years, how much were you bothered by feeling low in energy or slowed down?" (Derogatis, Lipman, Richels, Uhlenhuth, & Covi, 1974)], 4 items assessing anxiety [e.g., "Over the last few years, how much were you bothered by feeling fearful?" (Derogatis et al., 1974)], and 6 items assessing interpersonal difficulties [e.g., "Over the last few years, how much were you bothered by feeling easily annoyed or irritated with other people?" (Derogatis et al., 1974)].

Demographic characteristics included gender and socioeconomic status (i.e., family income and highest level of parental education). Less than 2% of the independent variables at T2 were missing. When a participant had a missing value, we used the full information maximum likelihood (FIML) approach, which was automatically applied by the software Mplus.

Analysis

A developmental trajectory, such as that used in this study, describes the course of smoking behavior across ages. The goal of the present data analysis was: (1) to identify distinctive developmental trajectories of smoking behavior over an 18-year time span, using data collected when the participants were at ages 14, 16, 22, 27, and 32 years; (2) to determine the personality and behavioral risk factors that predicted the participants' membership in each smoking trajectory group. We used the growth mixture model (GMM) approach (Muthén & Shedden, 1999) to identify the developmental trajectories of cigarette use. Our group-based, semi-parametric approach assumed that the population is composed of a mixture of distinct groups defined by their developmental trajectories (Nagin, 1999; White et al., 2002). In a structural equation modeling (SEM) framework, GMM estimates the mean growth curves, described by growth factors such as the intercept and slope, for each group. GMM captures individual variation around these growth curves by estimation of variances of growth factors for each group. This modeling approach is available through the software program known as Mplus (Muthén & Muthén, 2007).

We conducted the GMM analyses using the Bayesian Information Criterion (BIC) to empirically determine the number of trajectory groups. We treated the dependent variable (smoking at each time point) as an ordinal variable. The within group variations were captured by: 1) gender and other demographic characteristics (i.e., parental educational level and parental income) and 2) the variances of the growth factors. The GMM analyses used a

multinomial logistic regression model for unordered polytomous responses (Muthén & Shedden, 1999) to predict group membership. The independent variables in this part of the analyses were the personality/behavioral factors in adolescence and age at T2. We used age at T2 as an independent variable because T2 age ranged from 9 to 19. The personality/behavior factors were standardized (based on the entire sample), so that the estimated odds ratios from the multinomial logistic model (see Table 1) were estimates of the change in odds for a one standard deviation change in the personality/behavior factor. In addition, due to the unequal time intervals between the interviews, we used one time varying covariate to adjust the dependent variable at each time point: namely, the participant's age at that interview. Finally, to calculate the average cigarette use at each time point displayed in Figure 1, we assigned each participant to the trajectory group with the largest Bayesian posterior probability.

Results

Trajectories of Cigarette Use

We tested two-group (BIC=7813.99), three-group (BIC=7598.94), four-group (BIC=7523.32), and five-group (BIC=7474.05) cubic models (The computations for a six-group model did not converge). The five-group model had the smallest BIC score and was selected as the best fitting model. The trajectory groups were named: nonsmokers (NS, 44.0%), occasional smokers (OS, 9.9%), late starters (LS, 20.2%), quitters (Q, 9.4%), and heavy/continuous smokers (HC, 16.5%). Detailed information about the classification is available from the authors upon request. Figure 1 presents the five trajectories of average cigarette use from T2 through T6.

As noted in Figure 1, among the smoking groups, the occasional smokers started smoking late and never smoked on a daily basis. The late starters were characterized by starting smoking late but increasing smoking from late adolescence to the late twenties, and then staying stable at the level of smoking of more than a half pack a day. The quitters started smoking early then tapered off from late adolescence into adulthood. The heavy/continuous smoking group started smoking early, achieved its maximum level of smoking at about one pack a day on average in the late twenties, and then stayed stable at that level.

Risk and Protective Personality Factors as Predictors of Smoking Group Membership

Table 1 presents the results from the multinomial logistic regression model for trajectory group memberships. The regression analyses were aimed at identifying the risk and protective personality factors that differentiated the participants' membership in the ten comparisons of trajectory groups: the heavy/continuous group versus each of the other four groups; the quitters versus the late starters, the occasional smokers and nonsmokers; the late starters versus the occasional smokers and the nonsmokers; the occasional smokers versus the nonsmokers. We hypothesized that the heavy/continuous group as compared with other groups would be higher on sensation-seeking, externalizing behavior, and internalizing behavior and lower on ego-integration and educational expectations and aspirations. A Bonferroni correction was then applied to these comparisons. The results indicated that there were more significant results than expected by chance, and these results were consistent with the hypotheses. We did not hypothesize how the remaining groups, noted above, would differ from one another. A Bonferroni correction was also applied to this second set of comparisons. The number of significant results was somewhat greater than the number expected by chance.

As shown in Table 1, the risk and protective factors predicted smoking trajectory group membership on three personality/behavioral measures; namely, lower ego integration, more

externalizing behavior problems, and lower educational aspirations. There was an association between a lower level of ego-integration and the likelihood of becoming a heavy/continuous smoker as compared with a nonsmoker, an occasional smoker, and a quitter. There was also an association between a high level of externalizing behavior problems and the likelihood of becoming: 1) a heavy/continuous smoker as compared with a nonsmoker and an occasional smoker; and 2) a quitter as compared with a nonsmoker, an occasional smoker, and a late starter. Lower educational aspirations predicted the likelihood of becoming: 1) a heavy/continuous smoker as opposed to a nonsmoker and an occasional smoker; 2) a quitter as opposed to an occasional smoker; and 3) a late starter as opposed to an occasional smoker. No factors were found to be associated with the likelihood of becoming an occasional smoker as compared with a nonsmoker. Also, no factors were found associated with the likelihood of becoming a heavy continuous smoker as compared with a later smoker; and no factors were associated with the likelihood of becoming a late starter compared with a non-smoker.

Discussion

Most research in the field has examined one underlying trajectory of change in smoking behavior related to age, with some important exceptions (Chassin et al., 2000; Colder et al., 2001; White et al., 2002). This tends to prevent identification of the heterogeneity that exists among subgroups of smokers. In our study, we identified five groups: nonsmokers, occasional smokers, late starters, quitters, and heavy/continuous smokers. In general, our findings regarding the number of groups are quite similar to that of Chassin et al. (2000). However, the percentage of participants in the trajectory groups differed in the two studies. For example, in the heavy use group, we found 17%, Chassin and colleagues (2000) found 5%. The differences may be due to the fact that their sample was a relatively well-educated sample. In contrast, the sample for the present study was more diverse. In contrast to the findings of White et al. (2002), we identified more groups than they did. One possibility is that our sample is larger than White's sample (White et al., 2002).

In the heavy/continuous group there was a steady rise in the trajectory of smoking from age 14 until 27, when it leveled off slightly. In the quitters, there was a gradual decline in the level of smoking from adolescence into adulthood. In the late starters there was a steep and significant rise in the smoking trajectory to age 27, and then it leveled off slightly. In contrast, in the occasional smokers there was a slight rise in the trajectory of smoking from 14 until 22, when it leveled off. Consequently, it is critical to determine whether there are diverse etiologic pathways that underlie different trajectories of tobacco use. The present study adds to the literature in that it is the first study to link a composite measure of externalizing behaviors as well as a composite measure of internalizing behaviors to multiple trajectories of smoking behavior, beginning in early adolescence and extending into the thirties, partialing out demographic factors. By partialing out the demographic factors, we have greater confidence that the relationship between the independent variables and the trajectories of smoking behavior are not due to the relationship between the demographic factors and (a) the independent variables and (b) the trajectories of tobacco use.

As noted above, smoking appeared to level off in the occasional smokers, the late starters and the heavy/continuous smokers in the twenties. This may be related to the fact that a number of adults in our study took on adult roles beginning at about that age, such as entering into a committed relationship, establishing themselves in their careers, and raising a family (Newcomb, 1994). The fact that there is no decline in smoking during adolescence in the late starters and heavy/continuous smokers suggests that once adolescents began to smoke, it was very difficult for them to give up smoking, perhaps due to the psychopharmacological effects of tobacco/nicotine on the central nervous system (Balfour,

2003). Furthermore, individuals in early adolescence are less likely to be concerned with the consequences of their behavior (e.g., smoking), and therefore may be more likely to continue to smoke into adulthood. As noted by Masse and Tremblay (1997), if smoking is perceived as less harmful, there is an increase in the probability of smoking. Nevertheless, there was a small group of smokers (i.e., quitters) who gave up smoking gradually from adolescence into adulthood.

Our findings indicate that differences in the trajectories of smoking may be related in part to manifestations of personality and behavioral attributes. Numerous investigators have indicated that attributes that reflect a behavioral lack of control during adolescence, including impulsivity (Lynskey, Fergusson, & Horwood, 1998) and conduct disorder and rebelliousness (Burt et al., 2000), also predict smoking behavior in adulthood. Our findings add to the literature by demonstrating that such characteristics are not only related to smoking assessed at one point in time, but are also predictive of trajectories of smoking behavior assessed over time. They further demonstrate that the characteristics of externalizing behavior (e.g., aggression) at age 14 are related to whether one will become a heavy/continuous smoker versus a nonsmoker or an occasional smoker. Moreover, the quitters displayed externalizing behavior more often than nonsmokers. In a related vein, Chassin et al. (2000) reported that early stable smokers were more unconventional. Similarly, White et al. (2002) found that uninhibited behavior predicted heavy smoking for males. The multivariate results also indicate that the heavy/continuous smokers, in comparison to the nonsmokers, the occasional smokers, or the quitters, were more likely to exhibit emotional difficulties including poor impulse control as manifested in low ego integration (e.g., "I sometimes feel that I am about to go to pieces or fall apart"). The emotional difficulties may also have been expressed as feelings of hopelessness, which contributed to lower educational aspirations in the heavy/continuous smokers. Indeed, the heavy/continuous smokers had lower educational aspirations than the nonsmokers and the occasional smokers.

Thus, it appears that, as compared with the nonsmokers and the occasional smokers, three types of variables predict a heavy/continuous smoking trajectory: (a) the area of emotional behavior, such as low ego integration, which requires emotional control, (b) the area of externalizing problem behavior, and (c) the area of educational aspirations. The quitters did experience difficulties in the behavioral area of externalizing behaviors, but this group did not show evidence of increased emotional difficulties such as low ego integration as compared with the nonsmokers or the occasional smokers. The nonsmokers and the occasional smokers had the most favorable patterns of behavioral and emotional characteristics.

Consistent with the findings of White et al. (2002), internalizing behavior in early adolescence did not distinguish among the five groups in our study. In contrast, Chassin and colleagues (2000) reported that depression did differentiate among some of the trajectory groups (e.g., early stable smokers versus abstainers). It may be that depression in our study was mediated by other factors such as ego-integration.

Aside from the personality and behavioral attributes studied, little is known about the other psychosocial interactions over time by which these personality and behavioral characteristics could lead to the different trajectories of smoking behavior that extend from adolescence to the thirties. One possibility is that adolescents who are less well-integrated and engage in externalizing behaviors (e.g., rebellion and aggression) are more likely to associate with peers who exhibit similar behaviors and who smoke, and who, therefore, serve as role models. This, in turn, is associated with engaging in and encouraging smoking behavior (Brook, Brook, Richter, & Whiteman, 2003). Another possibility is that individuals

in the heavy/continuous smoking group derive different psychopharmacological effects from smoking than other people, and these effects then influence their smoking trajectories. A third possibility is that the personality/behavioral risk factors that predict smoking trajectories over time may persist into adulthood and continue to influence smoking behavior. In line with this supposition, there is evidence that many of the personality and behavioral factors examined in this study have stability over time (Brook et al., 1990). Future research should study the interaction of the biological and psychological factors that may mediate the association between ego integration and externalizing problems and the development of smoking behavior from adolescence to adulthood. Such knowledge may facilitate the implementation of effective treatment programs.

Low academic aspirations at age 14 did differentiate between the heavy/continuous group of smokers and the nonsmokers or the occasional smokers. These findings are in accord with those of White et al. (2002). Youngsters with low academic aspirations are less likely to achieve academically than others and are likely to have school conduct problems. The stress of performing in a difficult educational environment may also contribute to this finding (Lynskey & Hall, 2000). These factors may then account in part for the developmental pathways adolescents are likely to take into adulthood with respect to smoking behavior.

There are some limitations to the study. For the questions on smoking, we asked the participants at each time point, how often they smoked “on average,” although there may have been some variability during each of the time intervals for some of the participants. Nevertheless, this measure has predicted later nicotine dependence, drug use, delinquency, alcohol use and abuse in our other studies (e.g., Brook, Brook, Zhang, & Cohen, 2002). Although our data suggest that personality and behavioral factors may be associated with distinct trajectories of different smoking groups, we have not identified childhood personality and behavioral factors that precede smoking trajectories, which would enable us to make stronger inferences regarding possible causality. Thus, we can only identify some of the adolescent personality and behavior factors that may serve as the targets of prevention programs. Another limitation is that data was obtained from the participants in this study using self-report measures without external verification. Furthermore, we have not examined personality/behavioral factors in interaction with genetic and environmental risk factors, which might be related to different trajectories of smoking behavior. Future research should be directed toward identifying such interactions that may further clarify the risks for the different trajectories of smoking behavior over time. Additionally, there are two statistical caveats. First, the BIC may not perfectly estimate the number of categories in the sample (McLachlan & Peel, 2000). Second, because of the multiple testing issues, the adolescence personality and behavior factors that differentiate among the groups must be further replicated in independent studies.

Despite these limitations, the present study has several important methodological strengths. The study uses a large representative sample, a longitudinal design extending from adolescence (age 14) to adulthood (age 32), the assessment of cigarette use at multiple time periods, and the assessment of composite measures of behavioral and emotional problems. In addition, it uses statistical techniques that enable one to assess the behavioral and emotional problems related to trajectories of tobacco use, while partialing out demographic variables.

The current investigation has identified multiple trajectories of cigarette smoking from adolescence (age 14) to adulthood (age 32) and distinguished among them in terms of personality/behavioral risk and protective factors assessed at age 14. Etiological theories of smoking must take into consideration the fact that there are specific psychosocial developmental factors that predict different trajectories of smoking behavior. This step is

necessary to develop: 1) translational research that is better adapted to target specific subgroups in the population, and 2) effective prevention and treatment programs. Furthermore, our findings indicate that those adolescents with greater externalizing behaviors and more emotional difficulties such as low ego integration, as well as and lower educational aspirations were more likely to become heavy/continuous smokers. Consequently, it is important to focus on these factors in treating adolescents. More specifically, treatment programs for 14 year old adolescents should focus not only on the adolescents' smoking but also the following: (1) improving emotional control; (2) increasing educational aspirations in a realistic manner; and (3) decreasing rebellious, delinquent, and aggressive behavior. The findings suggest that it is important to implement educational and public health interventions that help adolescent smokers and their parents learn about the long-term consequences of the risk behaviors, noted above, for smoking.

Acknowledgments

This research was supported by grant awards to Dr. Judith S. Brook from the National Institutes of Health: Research Scientist Award DA00244 and research grant DA03188 from the National Institute on Drug Abuse, and research grant CA94845 from the National Cancer Institute. We thank the reviewers for their thoughtful suggestions, which have greatly improved the manuscript.

References

- Balfour DJK. The psychopharmacology of tobacco dependence. *Journal of Clinical Psychiatry Mongographs*. 2003; 18(1):12–21.
- Brook DW, Brook JS, Zhang C, Cohen P, Whiteman M. Drug use and risk of major depressive disorder, alcohol dependence, and substance use disorders. *Archives of General Psychiatry*. 2002; 59:1039–1044. [PubMed: 12418937]
- Brook JS, Brook DW, Gordon AS, Whiteman M, Cohen P. The psychosocial etiology of adolescent drug use: A family interactional approach. *Genetic, Social, and General Psychology Monographs*. 1990; 116(2):111–267.
- Brook, JS.; Brook, DW.; Richter, L.; Whiteman, M. Risk and protective factors of adolescent drug use: Implications for prevention programs. In: Sloboda, Z.; Bukoski, WJ., editors. *Handbook of drug abuse prevention: Theory, science and practice*. Plenum; New York: 2003. p. 265-287.
- Brook JS, Whiteman M, Gordon AS, Cohen P. Dynamics of childhood and adolescent personality traits and adolescent drug use. *Developmental Psychology*. 1986; 22:403–414.
- Burt R, Dinh K, Peterson A, Sarason I. Predicting adolescent smoking: A prospective study of personality variables. *Preventive Medicine*. 2000; 30:115–125. [PubMed: 10656839]
- Centers For Disease Control and Prevention. Trends in cigarette smoking among high school students. United States 1991-2001. *MMWR Morbidity and Mortality Weekly Report*. 2002; 51:409–412. [PubMed: 12033476]
- Chassin L, Pitts SC, Prost J. Binge drinking trajectories from adolescence to emerging adulthood in a high-risk sample: Predictors and substance abuse outcomes. *Journal of Consulting and Clinical Psychology*. 2002; 70(1):67–78. [PubMed: 11860058]
- Chassin L, Presson CC, Pitts SC, Sherman SJ. The natural history of cigarette smoking from adolescence to adulthood in a Midwestern community sample: Multiple trajectories and their psychosocial correlates. *Health Psychology*. 2000; 19(3):223–231. [PubMed: 10868766]
- Cohen, P.; Cohen, J. *Life values and adolescent mental health*. Lawrence Erlbaum Associates; Mahwah, NJ: 1996.
- Colder CR, Mehta P, Balanda K, Campbell RT, Mayhew KP, Stanton WR, et al. Identifying trajectories of adolescent smoking: an application of latent growth mixture modeling. *Health Psychology*. 2001; 20(2):127–135. [PubMed: 11315730]
- Colder CR, Richardson JL, Campbell RT, Ruel E, Flay BR. A finite mixture model of growth trajectories of adolescent alcohol use: Predictors and consequences. *Journal of Consulting and Clinical Psychology*. 2002; 70(4):976–985. [PubMed: 12182281]

- Cronbach LJ, Meehl PE. Construct validity in psychological tests. *Psychological Bulletin*. 1955; 52:281–302. [PubMed: 13245896]
- Derogatis LR, Lipman RS, Richels K, Uhlenhuth EH, Covi L. The Hopkins Symptom Checklist (HSCL): A self-report symptom inventory. *Behavioral Science*. 1974; 19:1–15. [PubMed: 4808738]
- Gold M. Undetected delinquent behavior. *Journal of Research in Crime and Delinquency*. 1966; 3:27–46.
- Gough, HG. *The California Psychological Inventory*. Consulting Psychological Press; Palo Alto, CA: 1957.
- Jessor, R.; Graves, TD.; Hanson, RC.; Jessor, SL. *Society, personality, and deviant behavior: A study of a tri-ethnic community*. Holt, Rinehart, & Winson; New York: 1968.
- Jessor, R.; Jessor, SL. *Problem behavior and psychosocial development*. Academic Press; New York: 1977.
- Laub JH, Nagin DS, Sampson RJ. Trajectories of change in criminal offending: Good marriages and the desistance process. *American Sociological Review*. 1998; 63:225–238.
- Lerman C, Audrain J, Orleans CT, Boyd R, Gold K, Main D, et al. Investigation of mechanisms linking depressed mood to nicotine dependence. *Addictive Behaviors*. 1996; 21:9–19. [PubMed: 8729703]
- Lynskey M, Fergusson D, Horwood L. The origins of the correlation between tobacco, alcohol, and cannabis use during adolescence. *Journal of Child Psychology and Psychiatry*. 1998; 39:995–1005. [PubMed: 9804032]
- Lynskey M, Hall W. The effects of adolescent cannabis use on educational attainment: A review. *Addiction*. 2000; 95(11):1621–1630. [PubMed: 11219366]
- Masse LC, Tremblay RE. Behavior of boys in kindergarten and the onset of substance use during adolescence. *Archives of General Psychiatry*. 1997; 54(1):62–68. [PubMed: 9006402]
- MaLachlan, G.; Peel, D. *Finite mixture models*. John Wiley & Sons; New York: 2000.
- McMahon TJ. Child and adolescent psychopathology as risk factors for smoking initiation: An overview. *Nicotine and Tobacco Research*. 1999; 1(Suppl.):S45–S50. [PubMed: 11768186]
- Muthén B, Shedden K. Finite mixture modeling with mixture outcomes using the EM algorithm. *Biometrics*. 1999; 55:463–469. [PubMed: 11318201]
- Muthén, LK.; n. *Mplus User's Guide*. Fourth Edition. Muthén & Muthén; Los Angeles, CA: 1998-2007.
- Nagin DS. Analyzing developmental trajectories: A semiparametric, group-based approach. *Psychological Methods*. 1999; 4(2):139–157.
- Nagin DS, Tremblay RE. Trajectories of boys' physical aggression, opposition, and hyperactivity on the path to physically violent and nonviolent juvenile delinquency. *Child Development*. 1999; 70(5):1181–1196. [PubMed: 10546339]
- Nagin DS, Tremblay RE. Analyzing developmental trajectories of distinct but related behaviors: A group-based method. *Psychological Methods*. 2001; 6(1):18–34. [PubMed: 11285809]
- Newcomb MD. Drug use and intimate relationships among women and men: Separating specific from general effects in prospective data using structural equation models. *Journal of Consulting and Clinical Psychology*. 1994; 62(3):463–476. [PubMed: 8063973]
- Orlando M, Tucker JS, Ellickson PL, Klein DJ. Developmental trajectories of cigarette smoking and their correlates from early adolescence to young adulthood. *Journal of Consulting and Clinical Psychology*. 2004; 72(3):400–410. [PubMed: 15279524]
- Patton RA, Lewinsohn PM, Seeley JR, Wagner EF. Is smoking associated with depression and anxiety in teenagers? *American Journal of Public Health*. 1996; 86:225–230. [PubMed: 8633740]
- Roeder K, Lynch KG, Nagin DS. Modeling uncertainty in latent class membership: A case study in criminology. *Journal of the American Statistical Association*. 1999; 94:766–776.
- Smith, GE.; Fogg, CP. Psychological antecedents of teen-age drug use. In: Simmons, R., editor. *Research in community and mental health: An annual compilation of research*. JAI; Greenwich, CT: 1979. p. 87-102.

- White HR, Johnson V, Buyske S. The moderating effects of family environment on adolescent alcohol and cigarette use. *Journal of Substance Abuse*. 2000; 12:287–310. [PubMed: 11367605]
- White HR, Pandina RJ, Chen PH. Developmental trajectories of cigarette use from early adolescence into young adulthood. *Drug and Alcohol Dependence*. 2002; 65:167–178. [PubMed: 11772478]
- Zuckerman M, Eysenck S, Eysenck HJ. Sensation seeking in England and America: Crosscultural, age, and sex comparisons. *Journal of Consulting and Clinical Psychology*. 1978; 46:139–149. [PubMed: 627648]

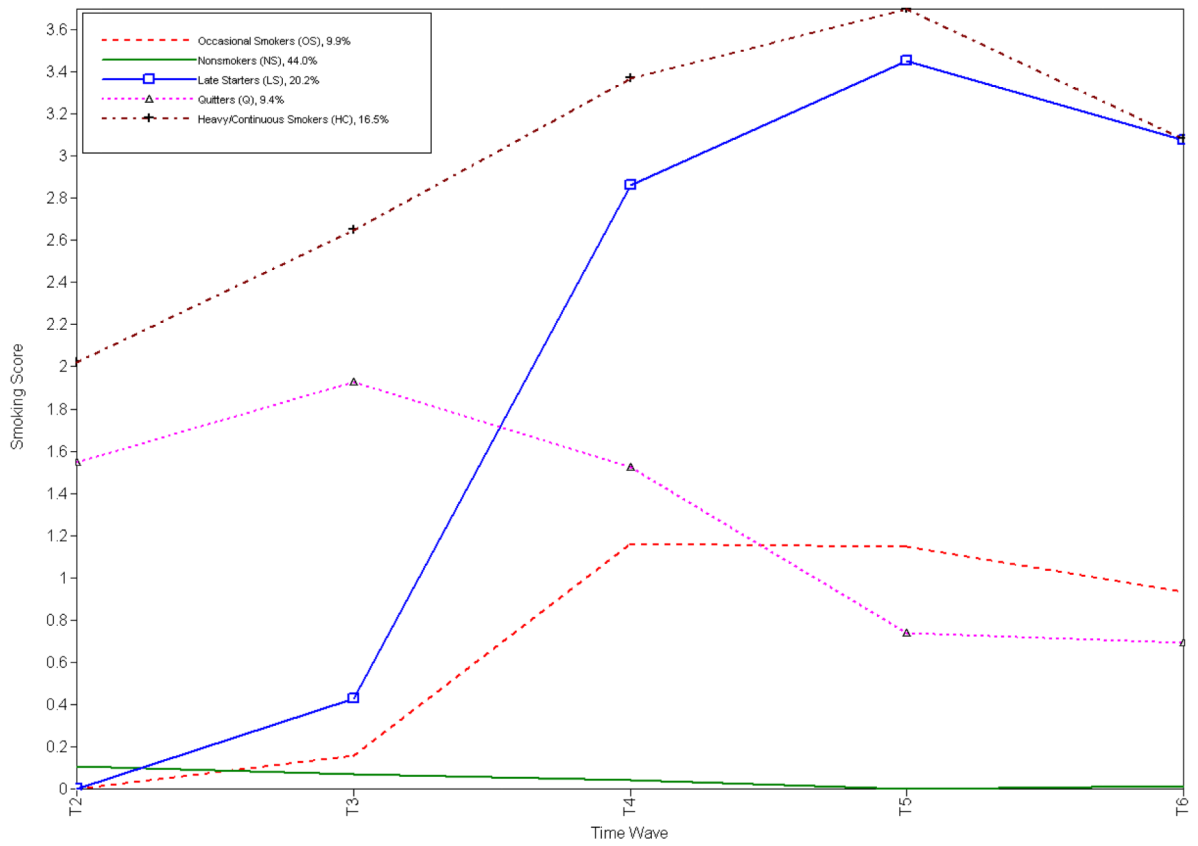


Figure 1.
 Trajectories of Average Cigarette Use: Age 14 to Age 32.
 Note: The smoking score refers to the following: 5.00=1.5 packs a day or more; 4.00=one pack per day; 3.00=1/2 pack per day; 2.00=1-5 cigarettes a day; 1.00=less than daily smoking; 0.00=none.

Risk and Protective Factors at Age 14 Associated with the Trajectories of Cigarette Smoking Over Time: Odds Ratios Adjusted for Demographic Factors

Table 1

Independent Variables at Age 14	HC vs NS A.O.R. 95% CI	HC vs OS A.O.R. 95% CI	HC vs LS A.O.R. 95% CI	HC vs Q A.O.R. 95% CI	Q vs OS A.O.R. 95% CI	Q vs LS A.O.R. 95% CI	LS vs NS A.O.R. 95% CI	LS vs OS A.O.R. 95% CI	OS vs NS A.O.R. 95% CI
Ego Integration	0.65 (0.46-0.92)**	0.61 (0.37-1.02)*	N.S.	0.47 (0.23-0.97)*	N.S.	N.S.	N.S.	N.S.	N.S.
Sensation Seeking	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Externalizing Behavior	1.99 (1.30-3.04)**	2.52 (1.47-4.33)***	N.S.	N.S.	4.45 (1.79-11.07)*	2.92 (1.17-7.24)*	N.S.	N.S.	N.S.
Internalizing Symptoms	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Educational Aspirations	0.57 (0.43-0.77)**	0.48 (0.33-0.70)***	N.S.	N.S.	0.64 (0.41-0.99)*	N.S.	N.S.	0.64 (0.41-0.98)*	N.S.

1.

2. NS = Nonsmokers; OS = Occasional Smokers; LS = Late Starters; Q = Quitters; HC = Heavy/Continuous Smokers

3. A.O.R. (adjusted odds ratio) is adjusted for age at T2 and all the other independent variables.

4. Each of the independent variables was continuous and standardized.

* $P < .05$

** $P < .01$

*** $P < .001$