The Impact of Self-Control Indices on Peer Smoking and Adolescent Smoking Progression

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Objective  To determine the direct impact of self-control variables on baseline smoking and smoking progression and determine whether self-control had indirect effects on smoking practices through effects on peer smoking.  Methods  Study participants were 918 adolescents who were followed from 9th through the 12th grade and completed self-report measures of peer smoking, self-control, and cigarette smoking. An exploratory factor analysis (EFA) was conducted to assess the factor structure of a 41-item self-control measure. The EFA indicated a six-factor structure comprising of impulsive control, planning, hostile blaming, attentional disregulation, conscientiousness, and physical aggression.  Results  The results of a latent growth model indicated that conscientiousness (OR = 0.81, CI = 0.73–0.90), hostile blaming (OR = 0.89, CI = 0.81–0.99), and physical aggression (OR = 1.16, CI = 1.06–1.27) had direct effects on baseline smoking, whereas planning (OR = 0.90, CI = 0.82–0.99) and impulse control (OR = 1.15, CI = 1.02–1.28) had indirect effects on adolescent smoking at baseline through baseline peer smoking. There were no significant direct or indirect effects of the self-control indices on smoking progression. There was a direct effect of peer smoking progression (number of peers who smoked) on adolescent smoking progression, such that increases in the number of peers who smoked across time increased the odds that an adolescent would progress to a higher level of smoking.  Conclusions  Youth smoking prevention and intervention program outcomes may potentially improve by addressing self-control behaviors as they appear to have direct effects on smoking and indirect effects through peers who smoke.

Key words  adolescents; self-control; smoking.

Cigarette smoking is the leading preventable cause of morbidity and mortality in the United States (McGinnis & Foege, 1993). Adolescents are among the most susceptible of developing a lifelong smoking habit. Each day, thousands of youth will try their first cigarette and over 2,000 youth will become daily smokers (Substance Abuse and Mental Health Services Administration, 2000). The etiology of adolescent smoking is complex and likely results from the interplay of environmental and individual characteristics. For example, peer smoking has been shown to highly influence adolescent smoking practices, including initiation of smoking experimentation and progression to greater levels of smoking (Chassin, Presson, Rose, & Sherman, 1996; Choi, Pierce, Gilpin, Farkas, & Berry, 1997; Conrad, Flay, & Hill, 1992; Flay et al., 1994; Wang, Fitzhugh, Westerfield, & Eddy, 1995). However, our understanding of how peer smoking contributes to adolescent smoking is limited (Kobus, 2003). It is possible that individual characteristics directly influence adolescent smoking and indirectly influence adolescent smoking through peer smoking.

Self-control is an individual characteristic that may directly impact an adolescent’s decision to smoke. Also,
it may indirectly impact adolescent smoking through the selection of peers who smoke or by increasing an adolescent's susceptibility to the influences of peers who smoke. Self-control can be conceptualized as a behavioral repertoire of skills for regulating one's choices or behavior. Indices of self-control have been linked to substance use including tobacco (Jackson, Henriksen, Dickinson, Messer, & Robertson, 1998; Simons-Morton et al., 1999; Sussman, McCuller, & Dent, 2003; Wills & Cleary, 1999; Wills, DuHamel, & Vaccaro, 1995). Good self-control reflects a tendency to approach situations through thoughtfully planning, implementing, and monitoring a course of action (e.g., dependability, focused attention, goal-oriented behavior, and problem-solving skills), whereas poor self-control reflects a tendency to respond to situations without considering the approach or goals (e.g., impatience, impulsiveness, distractibility, and coping through anger) (Wills, Sandy, & Yaeger, 2000).

Poor self-control has been shown to be positively associated with adolescent and peer substance use (Wills & Cleary, 1999; Wills, Vaccaro, & McNamara, 1994). Also, poor self-control has been shown to be inversely related to substance-use resistance efficacy. This may indicate that adolescents who are high in poor control have less confidence in their ability or less intentions to refuse substance offers (Wills, Gibbons, Gerrard, & Brody, 2000). Thus, poor self-control skills may both directly promote adolescent smoking and indirectly promote smoking through the effects of peer smoking.

By contrast, good self-control has been shown to be directly related to less substance use in adolescents (Wills et al., 2001). In addition, good self-control has been shown to be positively associated with factors considered protective of substance use, such as fewer negative life events, greater school involvement, and positive mood (Wills, Gibbons et al., 2000), and inversely associated with factors that promote substance use, such as deviant peer relationships (Wills, Sandy, & Shinar, 1999). Thus, good self-control skills may directly protect against smoking and indirectly protect against smoking by adolescents choosing peers who do not smoke or by making an adolescent less amenable to peer smoking influences (e.g., modeling, cigarette offer refusals).

To date, studies have not evaluated whether specific aspects of good or poor self-control influence adolescent smoking behavior, how these variables may impact smoking progression, and the role that these variables play in the effects of peer smoking on adolescent smoking. Such findings would have implications for addressing important regulatory skills in youth smoking prevention and intervention programs. In addition, these findings may help clarify how these skills relate to peer smoking influences.

In light of these gaps in our understanding of the relationship between adolescent smoking, aspects of self-control, and peer smoking, this study sought to determine the direct impact of self-control variables on baseline smoking and smoking progression and determine whether self-control had indirect effects on smoking practices through effects on peer smoking. We hypothesized that indices of self-control would have direct effects on adolescent smoking practices at baseline and smoking progression. We further hypothesized that these indices of self-control would indirectly affect adolescent smoking at baseline and smoking progression through their effects on peer smoking.

**Methods**

**Participants and Procedures**

Participants included 918 high-school students who were enrolled in one of five public high schools in northern Virginia. Over half of the sample (52%) was female, and the approximate racial distribution of the sample was 65% Caucasian, 11% Hispanic, 10% Asian, 8% African American, and 6% other. These adolescents comprise a cohort followed for 4 years (9th to 12th grade) to evaluate the biobehavioral predictors of adolescent smoking adoption. Adolescents were ineligible to participate in the study if they had a special classroom placement (i.e., severe learning disability and/or English as a second language) that might preclude valid survey administration.

Eligible participants were identified through class rosters at the beginning of ninth grade. On the basis of the above exclusionary criteria, 89% (2,120 of 2,393) of students were eligible to participate in Grade 9. After determining eligibility, we initiated recruitment efforts by mail. Seventy-two percent (1,533 of 2,120) of the parents or guardians approached provided a response regarding permission for their adolescent to participate. Of those parents who responded, 75% (1,151 of 1,533) provided written consent for their adolescent to participate. Thus, 54% (1,151 of 2,120) of parents of eligible students provided written consent and 18% (382 of 2,120) declined. Caucasian parents with greater than a high-school education were significantly more likely to provide consent when compared with parents with a high-school or less education (Audrain, Tercyak, Goldman, & Bush, 2002). Although these differences in parental consent were small (89% vs. 77%), some caution is warranted in generalizing the results of this study.
Study enrollment required both active parental consent and adolescent assent (administrative approval of the study protocol was granted by the university’s Institutional Review Board). Of the 1,151 students with parental permission to participate, 15 declined (1%) and 13 (1%) were unavailable during baseline survey administration days because of school absence, although later provided assent.

Because this was a longitudinal study, participants were resurveyed in the fall and spring of the 10th grade and in the spring of 11th and 12th grades, for a total of five data collection waves. The rates of participation at the three spring follow-ups in the 10th, 11th, and 12th grades were approximately 96% (1,081), 93% (1,043), and 89% (1,005), respectively. As the primary variables of interest were self-control, peer smoking, and smoking progression from 9th to 12th grade, the data presented below are based on 918 participants with complete data for these variables as well as the covariates (i.e., gender, race, household smoking, alcohol use, and marijuana use).

**Measures**

**Demographics**

Gender and race were assessed by self-report. Race was dichotomized as Caucasian vs. non-Caucasian (0 vs. 1). These demographic variables were examined to characterize the sample and to utilize as controlling variables.

**Substance Use**

Thirty-day alcohol use was assessed at baseline with an item that asked “During the past 30 days, on how many days have you had at least one drink (not just a sip) of alcohol?” (Grunbaum et al., 2004; Kann et al., 1998). The response options ranged from “0 days” (1) to “all 30 days” (7). Marijuana use was assessed at baseline with an item that asked “During your life, how many times have you used marijuana?” (Grunbaum et al., 2004; Kann et al., 1998). The response options ranged from “0 times” (1) to “100 or more times” (7).

**Household Smoking**

Participants were asked whether anyone living in their household currently smoked cigarettes, including parents and siblings (Choi et al., 1997).

**Self-Control**

Self-control reflects aspects of good self-control and poor self-control. Seventeen items that measured aspects of good self-control were derived from an inventory of general control in daily situations (Kendall & Williams, 1982; Wills et al., 1995, 1999; Wills, Vaccaro, McNamara, & Hirky, 1996). Good self-control ($\alpha = .89$) was measured in the 10th grade. Items were scored from 1 to 5 to indicate how true each state was for the individual (“not at all” to “very true”) or how much the individual engaged in particular behaviors when he or she had a problem (“never” to “usually”).

Twenty-four items that measured aspects of poor self-control were derived from inventories of general poor control, impulsive behavior, and anger coping (Eysenck & Eysenck, 1977; Kendall & Wilcox, 1979; Wills et al., 1996). Poor self-control ($\alpha = .92$) was measured in the 10th grade. The response options were the same as above (1, “not at all true,” to 5, “very true”) or (1, “never,” to 5, “usually”).

**Smoking Progression**

Adolescent smoking practices were assessed with an ordered-categorical variable generated from responses to a series of standard epidemiological questions regarding smoking such as “Have you ever tried or experimented with cigarette smoking, even a few puffs?” and “Have you smoked a cigarette in the past 30 days?” (Choi et al., 1997; Grunbaum et al., 2004; Kann et al., 1998). The five ordered categories are never smoker (0), puffer (not ever having smoked a whole cigarette) (1), experimenter (smoked at least one cigarette, but ≤100 cigarettes in total, in a lifetime) (2), current smoker (smoked in the last 30 days and >100 cigarettes in a lifetime) (3), and frequent smoker (≥20 days smoked in the last 30 days and >100 cigarettes in a lifetime) (4). Smoking practices were assessed at all four waves. Adolescents who smoked greater than 100 cigarettes in a lifetime, but not in the past 30 days ($n = 4$), were classified as experimenters.

**Peer Smoking**

Exposure to peer smoking has been shown to influence smoking practices in adolescents (Choi et al., 1997; Conrad et al., 1992). For peer smoking, adolescents were asked whether their best friend smokes and how many of their other four best males and how many of their other four best female friends currently smoke. Responses to these three items were summed to provide an estimate of smoking among their nine best friends. The item was given three cut points, creating a three-category ordered polytomous variable, approximating tertiles, with 0 indicating “no best friends smoke,” 1 “3 or fewer best friends smoke,” and 2 “greater than three best friends smoke.” We chose to use an ordered polytomous variable because the original summation was highly skewed and a log-transformed variable would be difficult to interpret. Peer smoking practices were assessed...
Statistical Analysis

Univariate statistics were generated to describe the study population for demographics, smoking practices, peer smoking, and self-control. An exploratory factor analysis (EFA) was conducted to assess the factor structure of self-control. Latent curve growth modeling (LGM) was conducted to assess the effects of self-control on adolescent smoking and peer smoking, in addition to the measurement models for adolescent smoking and peer smoking. LGM was conducted using Mplus version 3.01 software (Muthén & Muthén, 1998–2004). LGM is a structural equation modeling (SEM) method that models repeated observed measures on factors (latent variables) representing random effects ($\eta$). In this analysis, we conducted associated processes LGM. Associated processes LGM is a multivariate method that allows testing paths among random effects (i.e., levels $[\eta_0]$ and trends $[\eta_1]$) from two or more LGMs (Duncan, Duncan, Strycker, Li, & Alpert, 1999). Two associated processes were modeled in this study, one each for the ordered categorical variables adolescent smoking and peer smoking. LGM with repeated measures of an ordered categorical variable (e.g., smoking) in Mplus is conducted with a proportional odds logistic regression model (Muthén & Muthén, 1998–2004). A logit transformation is used to estimate the log odds of progression with the proportional odds model (see Agresti, 2002; Hosmer & Lemeshow, 2000 for an explanation of the proportional odds model). Exponentiation of the log odds results in an odds ratio, facilitating interpretation.

In this study, model fit was evaluated with reference to the model chi-square, root means square error of approximation (RMSEA), and weighted root mean residual (WRMR). Suggested criteria for model fit are non-significant or small model chi-square, RMSEA below .50–.80, and a WRMR value below .9 (Loehlin, 2004; Muthén & Muthén, 2001). Although there are a variety of methods for estimating model parameters, this analysis employed a weighted least squares estimation technique (WLSMV) in which the diagonal weight matrix uses robust standard errors, and the chi-square test statistic is mean and variance adjusted (Muthén & Muthén, 1998–2004). WLSMV is the default weight matrix in Mplus 3.01 when modeling with categorical outcome variables (e.g., adolescent smoking and peer smoking in this analysis). Moreover, multivariate modeling was conducted for participants with complete data on the dependent variables smoking and peer smoking (listwise deletion), as data analysis suggested that missing data on the dependent variables are missing completely at random (MCAR). Nevertheless, the model with all available data did not differ from the model with complete data.

Results

Descriptive Statistics

The distributions for smoking and peer smoking at each wave are summarized in Table I. The data indicate an overall increase in smoking and the number of peers who smoke over time.

Exploratory Factor Analysis

EFA was conducted to identify a reliable factor structure for 41 observed self-control items, because the factor structure of a measure may vary by population (Loehlin, 2004; Pedhazur & Schmelkin, 1991; Stevens, 2002). Principle component analysis yielded a mean communality greater than .60, supporting the use of the Kaisers criterion of eigenvalues greater than 1 for selecting the number of components to retain (Stevens, 2002). The results identified nine components meeting this criterion. To enhance the interpretability of the components, the

<table>
<thead>
<tr>
<th>Category</th>
<th>10th grade fall</th>
<th>10th grade spring</th>
<th>11th grade spring</th>
<th>12th grade spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never smoker</td>
<td>59.10</td>
<td>56.00</td>
<td>51.50</td>
<td>46.50</td>
</tr>
<tr>
<td>Puffer</td>
<td>12.60</td>
<td>12.70</td>
<td>12.60</td>
<td>12.40</td>
</tr>
<tr>
<td>Experimenter</td>
<td>22.20</td>
<td>24.10</td>
<td>25.50</td>
<td>27.50</td>
</tr>
<tr>
<td>Current</td>
<td>3.00</td>
<td>2.50</td>
<td>3.60</td>
<td>4.80</td>
</tr>
<tr>
<td>Frequent smoker</td>
<td>3.10</td>
<td>4.70</td>
<td>6.80</td>
<td>8.90</td>
</tr>
<tr>
<td>Peer smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No peers smoking</td>
<td>45.70</td>
<td>41.60</td>
<td>38.70</td>
<td>38.50</td>
</tr>
<tr>
<td>1–3 peers smoking</td>
<td>35.20</td>
<td>38.40</td>
<td>35.00</td>
<td>36.40</td>
</tr>
<tr>
<td>4–9 peers smoking</td>
<td>19.00</td>
<td>20.00</td>
<td>26.30</td>
<td>25.20</td>
</tr>
</tbody>
</table>
factors were rotated with an oblique Promax rotation. Analysis of the absolute interfactor correlations supported the use of an oblique factor rotation. Interfactor correlations ranged from .10 to .51.

To increase the reliability of the factor structure, only factors with four or more loadings greater than .60, or at least 10 loadings greater than .40, were retained (see Stevens, 2002 for a discussion of criteria for component selection and factor reliability). Only six factors met the stricter criteria. A second EFA with a cap of six components was performed, first with principle component analysis, followed by an oblique rotation. The first six components accounted for 54% of the variation. The Promax rotated factor analysis resulted in at least four loadings per factor, with values meeting the .60 or 10 loadings meeting the .40 reliability criteria. The six factors were labeled impulsive control, planning, hostile blaming, attentional disregulation, conscientiousness, and physical aggression, for their indicators. The six factors along with their eigenvalues, and associated factor loadings (correlations between each indicator and its factor) and communalities, are summarized in Table II. The selected indicators of each factor were linearly summated to provide a raw index of each facet of self-control. The average level of each facet, along with its standard deviation, was: Impulsive Control (M = 20.25, SD = 7.62, Range = 10–50); Planning (M = 27.91, SD = 6.67, Range = 8–40); Hostile Blaming (M = 10.93, SD = 4.07, Range = 5–25); Attentional Disregulation (M = 12.94, SD = 4.45, Range = 5–25); Conscientiousness (M = 29.10, SD = 6.08, Range = 9–45); Physical Aggression (M = 6.30, SD = 2.98, Range = 4–20). Cronbach’s coefficient \( \alpha \) reliability estimates for the six constructs ranged from .78 to .90 and are summarized in Table II.

**Latent Curve Growth Modeling**

**Smoking Measurement Model**

A two-factor LGM (one factor each for the level \( [\eta_0] \) and linear trend \( [\eta_1] \) in the model) was fit to the data. The four factor loadings (\( \lambda_w \), where \( w \) is wave, and \( w = 1 . . 4 \) were \( \lambda_1 = 0, \lambda_2 = 1, \lambda_3 = 3, \) and \( \lambda_4 = 5 \)). The first two factor loadings were separated by a single unit (6 months), whereas the latter three loadings were separated by two units, as the first two waves were separated by 6 months, the latter were spaced 1 year apart. Baseline was centered at 10th grade fall because the self-control items were measured at that time. The smoking measurement model fit the data well with the linear trend, \( \chi^2 (8, N = 960) = 9.77, p = .28, \) RMSEA = .01, CFI = 1.00, WRMR = .37. The trend factor was significant, \( \eta_1 = .06, z = 9.18, p < .0001 \), indicating a 7% increase (OR = 1.07, CI = 1.05–1.08) in the odds of smoking progression for each 6-month unit of change, or a 14% increase (OR = 1.14, CI = 1.12–1.15) in the odds of progression for a 1-year time change. The mean level (\( \eta_0 \)) is standardized to zero when modeling with categorical variables in LGM, because the intercept is represented in the thresholds (\( \tau \)). Both the level and trend variances were significant (\( p < .0001 \)), indicating heterogeneity in developmental trajectories.

This modeling approach accounts for the degree of change in smoking progression by using thresholds in a proportional odds logistic regression model. The proportional odds logistic regression model compares the probability of attaining a level against higher levels (Agresti, 2002; Hosmer & Lemeshow, 2000). Unlike other models for categorical data analysis, the proportional odds model uses a single parameter to measure the likelihood of movement between categories (here, ordered categories of smoking reflect greater smoking behavior). However, the proportional odds model uses thresholds as a proxy for distance, so information about the “distance” between two categories is not lost. Briefly, thresholds represent the likelihood of progression from a lower to a higher category, determined by the distribution of participants in each ordered category. The number of thresholds equals the number of categories less one. In the present case, with five categories of smoking, there are (5–1) = 4 thresholds. A threshold value of zero represents equal probability of being in the lower vs. higher category. Lower threshold values indicate easier movement from one category to the next, whereas higher thresholds reflect a more difficult transition between categories. For instance, the threshold between the two categories never smoker and puffer (\( \tau = 0.29 \)) is lower than the threshold between experimenter and current smoker (\( \tau = 1.66 \)). These increasingly higher thresholds reflect that progression from being a never smoker to being a puffer is easier than progression from experimentation to current smoking.

To assess whether time affects threshold values, an indication of the effects of time on the facility of progression, thresholds are constrained equal across time. Therefore, a significant trend (\( \eta_1 \)) value is an indication that the equality of thresholds across time is not a tenable hypothesis, and time affects the likelihood of progression. The significant (\( \eta_1 \)) represents the log odds of progression for each unit change in time, for a linear trend. Exponentiation results in the odds of progression for a unit change in time. Thus, growth is well reflected in longitudinal data analysis employing an ordered categorical measure of smoking, while not ignoring the fact of inequality of distance between categories.
A two-factor LGM with a linear trend was also fit to the repeated measures of peer smoking. This model fit the data well, $\chi^2(5, N = 982) = 18.74, p = .0021$, RMSEA = .05, CFI = .99, WRMR = .83. The trend factor was significant ($\eta_1 = .039, z = 4.96, p < .0001$). Level and trend variances were significant ($p < .0001$), indicating heterogeneity in initial status and development of peer smoking across time.

**Associative LGM**

An associative LGM with the two parallel processes, smoking progression and peer smoking, was fit to the
data. An associative LGM is a SEM method used to assess a priori relationships between at least two LGMs (Duncan et al., 1999). We assessed the direct effects of the self-control facets on smoking, and the indirect effects of the self-control indices on smoking through peer smoking. We controlled for the following covariates: gender, race, household smoking at baseline, past 30-day alcohol use, and lifetime marijuana use. The associative LGM model fit the data well, $\chi^2(31, N = 918) = 30.48$, $p = .49$, RMSEA = .01, CFI = 1.00, WRMR = .41. A graphic representation of the associative LGM with standardized path coefficients from the significant effects ($\gamma$s) is presented in Figure 1. Nonstandardized path coefficients from the six self-control facets and covariates, along with standard errors and test statistics, are presented in Table III.

Effects of Self-Control on Smoking

Four self-control facets had significant effects on baseline smoking. Physical aggression increased the likelihood of being at a higher smoking level at baseline. More specifically, for each standard deviation increase ($SD = 2.98$) in physical aggression, there was a 16% increase (OR = 1.15, CI = 1.02–1.28) in the odds of smoking at a higher level at baseline. Standard deviations were used to increase the interpretability of the effects, as a change of a standard deviation is more meaningful than a single-unit change in any one of these self-control variables (Hosmer & Lemeshow, 2000). However, hostile blaming decreased the likelihood of smoking by 11% ($SD = 4.07$; OR = 0.89, CI = 0.80–1.00), meaning that the odds of progression were not significant at $\alpha = .05$. There were no significant effects from the self-control facets on smoking trend ($p > .05$).

Effects of Self-Control on Peer Smoking

Two self-control facets had significant effects on baseline level of peer smoking. For each standard deviation increase in impulse control ($SD = 7.62$), the odds of having peers who smoke increased by 15% (OR = 1.15, CI = 1.02–1.28).

### Table III. Unstandardized Path Coefficients ($\gamma$) with Standard Errors ($SE$) and Test Statistics

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Peer level $\gamma$</th>
<th>Peer trend $\gamma$</th>
<th>Smoking level $\gamma$</th>
<th>Smoking trend $\gamma$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\gamma$ $SE$ $\gamma/SE$</td>
<td>$\gamma$ $SE$ $\gamma/SE$</td>
<td>$\gamma$ $SE$ $\gamma/SE$</td>
<td>$\gamma$ $SE$ $\gamma/SE$</td>
</tr>
<tr>
<td>Female</td>
<td>0.289 0.078 3.705**</td>
<td>-0.049 0.027 -1.804</td>
<td>-0.034 0.087 -0.395</td>
<td>-0.012 0.020 -0.621</td>
</tr>
<tr>
<td>Non-Caucasian</td>
<td>0.176 0.077 2.282*</td>
<td>0.020 0.026 0.761</td>
<td>0.049 0.082 0.599</td>
<td>-0.069 0.020 -3.479**</td>
</tr>
<tr>
<td>Impulsive control</td>
<td>0.018 0.007 2.412*</td>
<td>-0.001 0.003 -0.342</td>
<td>0.007 0.008 0.848</td>
<td>0.000 0.002 0.072</td>
</tr>
<tr>
<td>Planning</td>
<td>-0.015 0.007 -2.115*</td>
<td>0.003 0.002 1.295</td>
<td>0.013 0.007 1.806</td>
<td>-0.002 0.002 -1.197</td>
</tr>
<tr>
<td>Hostile blaming</td>
<td>-0.011 0.012 -0.980</td>
<td>0.002 0.004 0.476</td>
<td>-0.027 0.012 -2.180*</td>
<td>0.002 0.003 0.583</td>
</tr>
<tr>
<td>Attentional disregulation</td>
<td>-0.020 0.012 -1.761</td>
<td>0.003 0.004 0.856</td>
<td>-0.026 0.013 -1.989*</td>
<td>0.001 0.003 0.223</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>-0.011 0.008 -1.296</td>
<td>-0.005 0.003 -1.890</td>
<td>-0.033 0.009 -3.743**</td>
<td>0.002 0.002 0.920</td>
</tr>
<tr>
<td>Physical aggression</td>
<td>0.024 0.016 1.563</td>
<td>-0.004 0.005 -0.826</td>
<td>0.048 0.016 3.081*</td>
<td>-0.003 0.004 -0.660</td>
</tr>
<tr>
<td>30-day alcohol use</td>
<td>0.152 0.034 4.539**</td>
<td>0.030 0.013 2.243*</td>
<td>0.189 0.032 5.878**</td>
<td>-0.013 0.008 -1.521</td>
</tr>
<tr>
<td>Life time marijuana use</td>
<td>0.252 0.043 5.842**</td>
<td>0.018 0.018 1.028</td>
<td>0.223 0.041 5.369**</td>
<td>-0.003 0.012 -0.235</td>
</tr>
<tr>
<td>Household smoking</td>
<td>0.308 0.080 3.853**</td>
<td>0.019 0.029 0.656</td>
<td>0.386 0.089 4.338**</td>
<td>0.000 0.020 -0.012</td>
</tr>
</tbody>
</table>

*Female: 0, male: 2. Female: Non-Caucasian: 0, Caucasian: 1, non-Caucasian. Household smoking: 1, household member smokes; 0, no household members smoke. Test statistic, $z = \gamma/SE$.

*p < .05, **p < .001
However, planning had the opposite effect on the likelihood of having peers who smoke. For each standard deviation increase in planning ($SD = 0.67$), there was a 10% decrease ($OR = 0.90, CI = 0.82–0.99$) in the odds of having at least one peer who smokes. There were no significant effects from the self-control facets on peer smoking trend ($p > .05$).

### Effects of Peer Smoking on Smoking Level and Trend

The path from baseline peer smoking to smoking trend was not significant ($p > .05$). However, there was a significant effect for baseline peer smoking on adolescent smoking at baseline ($\gamma_{peer level - smoking level} = .57, z = 9.71, p < .0001$). Having a peer who smokes at baseline increased the odds, by 78% ($OR = 1.78, CI = 1.58–2.00$), of smoking at a higher level at baseline. Thus, impulsive control had an indirect effect on smoking at baseline, by increasing the odds of having at least one peer who smokes. However, planning had the opposite indirect effect, decreasing the odds of having a peer who smokes, thereby decreasing the odds of smoking at baseline. There was also an effect for peer trend on smoking trend ($\gamma_{peer trend - smoking trend} = .43, z = 4.15, p < .0001$). Having a peer who smoked increased the odds of smoking at a higher level over time, by 53% ($OR = 1.41, CI = 1.25–1.88$). There were no indirect effects through peer trend, as none of the paths from self-control facets to peer trend was significant.

### Discussion

This study sought to determine whether indices of self-control affected adolescent smoking status at 10th grade and smoking progression from the 10th to the 12th grade. In addition, the study sought to determine whether self-control had indirect effects on adolescent smoking practices through effects on peer smoking. Conscientiousness, hostile blaming, and physical aggression had direct effects on baseline smoking. Planning and impulsive control had indirect effects on adolescent smoking at baseline through baseline peer smoking. There were no significant direct or indirect effects of the self-control indices on smoking progression. Increases in the number of peers who smoked across time had a direct effect on adolescent smoking progression, increasing the odds an adolescent progressing to a higher level of smoking.

Our hypothesis that indices of self-control would have direct effects on adolescent smoking practices at baseline and smoking progression was partially supported. Conscientiousness and hostile blaming decreased the odds of smoking at baseline by about 20 and 10%, respectively, whereas physical aggression increased the odds of smoking at baseline by 16%. Conscientiousness encompasses the essence of good self-control (e.g., dependable, responsible, organized), and it is not surprising that adolescents with these types of qualities were less likely to smoke at baseline. Previous research has noted that good self-control is related to less substance use and that as good self-control increases, adolescent substance use decreases (Wills & Stoolmiller, 2002). These findings clarify what aspects of good self-control may be directly related to the decision not to smoke and pinpoint skills to target to prevent youth smoking.

In contrast, adolescents who were more physically aggressive were more likely to smoke at baseline. It is possible that adolescents who have difficulty coping with anger and frustration use cigarettes as a coping method. Nicotine has been shown to have palliative effects on anger and to reduce the frequency of anger reports in smokers with high levels of hostility (Delfino, Jamner, & Whalen, 2001; Jamner, Shapiro, & Jarvik, 1999). In fact, recent research that evaluated the metabolic effects of nicotine on the brain found that nicotine triggered dramatic changes in regions of the brain important in behavioral control in individuals rated as more aggressive or easier to anger (Fallon, Keator, Mbogori, Turner, & Potkin, 2004). This may be especially relevant for understanding adolescent smoking, as adolescents attempt to manage extremes in emotion before behavioral control centers in the brain have finished maturation (Spear, 2000). This finding seems somewhat at odds with the finding that adolescents higher in hostile blaming were less likely to smoke at baseline. It appears that how an adolescent copes with anger may play a role in smoking behavior. Verbalizing anger and pinpointing others as responsible for difficulties may be helpful with respect to not initiating smoking or progressing to a regular habit, although it may not be constructive in other domains.

We found partial support for the hypothesis that the indices of self-control would indirectly affect adolescent smoking at baseline and across time through their effect on peer smoking. Planning and impulse control had indirect effects on adolescent smoking at baseline through baseline peer smoking. Adolescents who were higher in planning were 10% less likely to have a peer who smoked and, in turn, were less likely to smoke at baseline. However, adolescents with more problems with impulse control were 15% more likely to have peers who smoked at baseline, which was associated with adolescent smoking at baseline. Smokers have been
found to score higher on measures of impulsivity (Mitchell, 1999). It is possible that adolescents with problematic impulse control may begin smoking at an earlier age (at or before age 15) because (a) they affiliate with peers with similar impulse control characteristics and similar smoking experiences and (b) they are more influenced by the behaviors of their peer group including smoking. Adolescents with self-control problems, such as impulsivity, are more likely to affiliate with peers who use substances (Lynskey, Fergusson, & Horwood, 1998). These findings may shed some light on why individuals with impulse control difficulties are more likely to smoke. These findings suggest that the types of behaviors involved in planning (e.g., a problem-solving approach) are key in reducing the impact of peer smoking effects.

Adolescent smoking prevention programs may benefit from including or providing more emphasis on components to build self-control skills. Although cigarette refusal skills and building confidence in one’s ability to refuse cigarette offers are common components in adolescent prevention programs (Langlois, Petosa, & Hallam, 1999), they may not fully encompass all of the self-control skills that may be protective against smoking. For example, Elder, Sallis, Woodruff, and Wildey (1993) reported on the results of a longitudinal youth smoking prevention program that incorporated refusal skill training. Refusal skill training produced significant differences in overall refusal skill quality at one time point only, and refusal skill quality was not related to overall cigarette smoking at any grade. Self-control or regulatory skills, such as problem-solving, conscientiousness, coping with anger, thinking, and weighing the consequences of one’s actions before acting, may need to be promoted in prevention programs alongside refusal skill training to prevent adolescent smoking and to counteract the effects of peer smoking influences. Botvin’s Life Skills Training program is one example of a program for youth that has been shown to be an effective primary prevention program for substance use that attends to these factors (Botvin & Griffin, 2002). Indices of self-control account for unique predictive variance beyond dispositional variables in explaining substance use among adolescents, which suggests that self-control is not simply part of a problematic temperament (Sussman et al., 2003).

Contrary to our expectations, the self-control variables did not directly or indirectly affect adolescent smoking progression. It is possible that these variables discriminate who initiates experimentation and regular smoking earlier (before 10th grade) and plays a less significant role in later onset or subsequent progression (Jackson et al., 1998; Wills & Stoolmiller, 2002). Thus, by mid adolescence, the effects of self-control on substance use may only be observed at the earliest measurement point (Wills & Cleary, 1999) or the effects of self-control variables on substance use may be indirect through variables that are more closely linked to substance use, such as coping behavior (Wills et al., 1995). In support of this notion, we found that delay discounting (likelihood of choosing reward immediacy over reward magnitude) had a direct effect on baseline smoking, but only an indirect effect on smoking progression through the types of activities an adolescent found rewarding (Audrain-McGovern et al., 2004). Another reason why an effect of the self-control variables on smoking progression was not found may be because we measured the self-control variables at just one point in time. Baseline levels of self-control, a potential time-varying covariate, may not have provided the strongest test of the relationship between these variables and smoking across time (Collins & Graham, 2002). Moreover, although we subjected the items to EFA and found strong support for six factors, with good reliability coefficients, and evidence of convergent and discriminant validity (data not shown), it is possible that our measure of self-control was not optimal.

This study adds to the findings of previous longitudinal investigations that have shown that peer smoking influences adolescent smoking progression (Chassin, Presson, Pitts, & Sherman, 2000; Choi et al., 1997) and extends previous findings by showing that increases in the number of peers who smoke contribute to progression along the adolescent smoking uptake continuum. Peer smoking has been shown to influence adolescent smoking cessation. In fact, time spent with peers who smoke is inversely related to the number of prior quit attempts among teenage smokers (Jones, Schroeder, & Moolchan, 2004). More research is needed to understand how peer smoking influences adolescent smoking across time and what adolescent characteristics affect peer relationships and smoking behaviors. Self-regulatory variables may be important as found in this study. In addition, psychological factors, such as depression, may make an adolescent more vulnerable to peer smoking practices (Patton et al., 1998). A better understanding of peer smoking influences may be meaningful for smoking prevention in adolescents as well as smoking cessation in adolescents and adults. Similar relationship between peers, smoking, and smoking cessation has been noted for adult smokers (Chassin et al., 1996; Chen, White, & Pandina, 2001; Rose, Chassin, Presson, & Sherman, 1996).
With respect to the rate of smoking progression in this study, about 33% of the sample progressed in their smoking behavior across the 4 years of the study. About 34% of the progression was to a regular smoking habit (i.e., to current or frequent smoking). 44% of the progression was to experimentation, and 22% of the progression was from never smoking to puffing. Several longitudinal studies indicate comparable levels of progression for similarly aged adolescents. One longitudinal study noted that 31% of adolescent experimenters progressed to regular smoking across 4 years (Choi et al., 1997). A 3-year cohort study of Australian youth found that just under 14% of adolescents progressed in their smoking for each study year of risk and that 8% of adolescents who had experimented transitioned to regular smoking across 4 years (Choi et al., 1997). About 33% of the sample progressed in their smoking for each study year of risk (Patton et al., 1998).

It is important to note the limitations of the present study. First, we measured the indices of self-control at one point in time and they were treated as time-invariant covariates in the model. It is possible that these variables changed over time. Second, the indices of self-control accounted for a modest amount of variance in smoking. Thus, skills associated with self-control would only comprise one component of a multicomponent youth smoking prevention effort. Third, this study does not distinguish between types of peer smoking influence, such as best friend, other friends, or friend’s gender. A closer evaluation of these parameters of peer smoking may offer further insight into the adolescent–peer smoking relationship (Kobus, 2003). It is also important to note that the peer smoking variable provides an estimate of peer smoking status, which addresses the number of peer smokers associated with an adolescent, but does not provide information about the type of current smoker a peer may be (e.g., experimenter, current, or frequent smoker). Further, these data do not indicate whether peer selection or peer influence processes were more important for adolescent smoking. These data can only suggest that adolescents have differences in self-regulation capabilities, which impacts their decision to smoke and whether they have peers who smoke. However, the data do suggest through the significant path from peer smoking trend to adolescent smoking trend that increases in the number of peers who smoke across time significantly increase the odds that adolescents will progress in their smoking.

Although 75% of those parents who responded provided consent and the differences between those who provided consent and those who declined were relatively small and few (Audrain et al., 2002), caution is warranted in generalizing the results of this study, especially in light of the study’s consent rate (54%). However, it is important to point out that our sample was nationally and locally representative on basic demographic characteristics (Developmental Research and Programs, 2001; U.S. Bureau of Census, 2003a, 2003b). In addition, the smoking rates in our sample are fairly comparable to those found in national surveys. For example, 2003 data from Monitoring the Future (MTF) and from the Youth Risk Behavior Surveillance (YRBS) survey for the geographical area of our sample are comparable to our figures (Developmental Research and Programs, 2001; Grunbaum et al., 2002; Johnston, O’Malley, Bachman, & Schulenberg, 2003, 2004). Data from our 2003 survey indicated that 10% are daily smokers compared with about 9% in the 2003 YRBS survey and about 15% in the 2003 MTF survey. In addition, 15% of the adolescents in our sample were current smokers compared with 13% in the 2003 YRBS survey and 24% in the 2003 MTF survey. Although the smoking rates of our sample may not be completely representative of those of all adolescents nationwide, they are representative of the region and the population of high-school students in the county from which the sample was drawn. In addition, our low attrition rate contributes to a sample less biased by loss than several large nationwide surveys of high-school students. However, although our good and poor self-control scores are comparable to the scores found in previous studies (Wills, Sandy, & Yaeger, 2002), we cannot eliminate the possibility that our sample is less “problem prone” than a nationally representative group of high-school students.

In summary, this study found that self-control variables have direct effects on adolescent smoking and indirect effects through peer smoking. This is the first study to examine the direct and indirect effects of a variety of variables important in self-regulation on smoking in adolescents and to relate these to peer smoking influences. Future research should prospectively investigate the indices of self-control as time-varying covariates and their relationship to smoking experimentation and the progression to a regular habit. Future research aimed at understanding the contribution of peers to adolescent smoking may want to evaluate the peer point of reference (e.g., best friend, other friends) (Kobus, 2003). Further, it would be clinically informative to test whether modifying self-control skills prevents smoking experimentation and progression to greater use or whether improvements in self-control affect smoking cessation outcomes for youth.
Acknowledgment

This study was supported by National Cancer Institute/National Institute on Drug Abuse grant P50 CA/DA 84718. The authors thank and extend appreciation to the high-school faculty members, administrative personnel, and students involved in the research.

Received June 15, 2004; revisions received September 10, 2004 and November 4, 2004; accepted November 12, 2004

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