RESEARCH REPORT

Why children start smoking cigarettes: predictors of onset

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Abstract
We review findings from 27 prospective studies of the onset of cigarette smoking conducted since 1980. Almost 300 measures of predictors of smoking onset were examined, and 74% of them provided multivariate support for predictors of onset derived from theory and previous empirical findings. Expected relationships were strongly supported for (a) socioeconomic status, with students with compromised status being more likely to try smoking; (b) social bonding variables, particularly peer and school bonding, with less support for family bonding; (c) social learning variables, especially peer smoking and approval, prevalence estimates, and offers/availability, with less consistent support for parent smoking and approval; (d) refusal skills self efficacy; (e) knowledge, attitudes and intentions, with the expected stronger predictions from intentions than from attitudes than from knowledge; and (f) broad indicators of self-esteem. The few investigators who analyzed their data separately by age, gender, or ethnicity found many differences by these factors, though there were too few of them to detect any pattern with confidence. Though the 27 studies are far from perfect, we believe that they confirm the importance of many well-accepted predictors and raise some questions about others. In particular, family smoking, bonding and approval each received unexpectedly low support. It is not clear whether this lack of support reflects reality as it has always been, is due to a changing reality, reflects developmental changes, either in the age of subjects or the stage of onset, or is due to poor measurement and too few tests. Future prospective studies need to be theory-driven, use measures of known reliability and validity, report analyses of scale properties, and use statistical methods appropriate to the hypotheses or theories under study. Finally, we encourage more investigations of the potentially different predictors of transitions to experimental or regular cigarette smoking. This will require multi-wave studies and careful measurement of changes in smoking behavior.

Introduction
Cigarette smoking is a major preventable cause of premature death and disability throughout the world (Ball, 1990). While the prevalence of smoking among adults has declined during recent years, the prevalence among adolescents remains high, with the age of onset actually declining over time (Flay, 1992). The goal of developing effective adolescent smoking prevention programs depends on the identification of reliable predictors of smoking onset (Collins et al., 1987).

Researchers have used both cross-sectional and longitudinal research designs to investigate the causes of smoking in children. The limitations of cross-sectional designs for studying developmental processes, including the process of becoming a smoker, are well known (Chassin et al., 1986;
Collins et al., 1987; Flay et al., 1983). In cross-sectional research, relationships are explored between variables, say peer group affiliations and smoking, which are measured at the same time. Cross-sectional studies are useful in suggesting hypotheses and can rule out possible causes when relationships between variables are not found. But they do not determine with certainty which came first, smoking or the variables correlated with it.

In contrast, the longitudinal design, or prospective study, can determine the order of events—an important criterion of causation. It can show, for instance that non-smoking children with certain peer group affiliations at Time 1 are more likely to have become smokers one year later than are non-smoking children who had different peer group affiliations at Time 1. In order to study onset effectively, we need to take only wave 1 nonsmokers and predict their transition (or lack of it) to first trying smoking. Unfortunately, statistical analyses of most earlier longitudinal studies and some later ones did not take full advantage of the longitudinal nature of the data.

In an earlier review (Flay et al., 1983), we found few longitudinal studies of the predictors of the onset of smoking. Fortunately, many such studies have appeared since then and we limit this review to longitudinal, prospective studies that have appeared since 1980. (Many other studies report trends and patterns of tobacco and other substance use. These are not reviewed here). Because even the longitudinal method does not provide proof of causation, we refer to variables measured at one time that relate to smoking behavior at a subsequent time as predictors, rather than causes.

The onset of smoking involves several stages (Flay et al., 1983; Leventhal & Cleary, 1980; Stern et al., 1987). This paper focuses on action or initiation, the third stage of cigarette smoking onset among adolescents. That is, our interest is in initiation, the third stage of cigarette smoking onset of most earlier longitudinal studies and some later ones did not take full advantage of the longitudinal nature of the data.

In an earlier review (Flay et al., 1983), we found few longitudinal studies of the predictors of the onset of smoking. Fortunately, many such studies have appeared since then and we limit this review to longitudinal, prospective studies that have appeared since 1980. (Many other studies report trends and patterns of tobacco and other substance use. These are not reviewed here). Because even the longitudinal method does not provide proof of causation, we refer to variables measured at one time that relate to smoking behavior at a subsequent time as predictors, rather than causes.

The onset of smoking involves several stages (Flay et al., 1983; Leventhal & Cleary, 1980; Stern et al., 1987). This paper focuses on action or initiation, the third stage of cigarette smoking onset among adolescents. That is, our interest is in prospective predictors of initial smoking. However, limitations of most of the studies we review requires us to limit our interest to prospective predictors of movement from never having tried smoking to any level of smoking (trying, experimenting, or becoming a regular smoker). Unfortunately, few studies have been of long enough duration to investigate separately the predictors of each of these steps.

Studies reviewed
We located 27 reports of prospective prediction of onset published during or since 1980 and that were not available to us for our previous review (Table 1). Two of these studies were quite different from the others. Kellam, Ensminger & Simon (1980) and Pulkkinen (1982) followed samples of Chicago and Finnish youth, respectively, from very young ages (ages 6 and 8 respectively) for many years. Their published analyses examined predictors of any level of smoking at the final wave of measurement. Strictly speaking then, these studies mix predictors of onset and distal predictors of young adult smoking. By the end of these studies 77% of the Chicago sample and 93% of the Finnish sample had tried smoking. All of the following descriptive summaries concern only the remaining 25 studies.

For the remaining 25 studies, the age of students at the beginning of the studies ranged from 10-17 years. The modal (and median) ages was 12-13 years. The length of these studies ranged from 4 months to 2 years (most for one year). The number of students who had never tried smoking at the beginning of these studies with complete data at two or more waves ranged from 268 to 5065 (mean = 1127).

Attrition ranged from 8% to 55% (mean = 28%). High levels of attrition may or may not have compromised predictive relationships. We know that students dropping out of studies such as these (or school) are much more likely to be smokers than those students who remain in the studies (and school) (Biglan & Ary, 1985; Flay et al., 1989; Hansen et al., 1985; Pirie, Murray & Luepker, 1988). At minimum, then, the distribution of behavior is altered when attrition is high—correlational relationships between behavior and predictor variables are likely to be affected significantly at the most extreme levels of attrition.

All but eight of these 25 studies were conducted in the United States. Four studies were conducted in Britain, two in Germany, and one each in Australia and the Netherlands. Most of these studies involved urban populations. Generalization of findings is, thus, limited.

The prevalence of smoking at wave 1 among the studied student populations ranged from a low of 8% to a high of 60% (mean = 33%). This is a wide range, and we must wonder whether predictive relationships might be different for different levels of the 'adoption curve' or in communities or schools where prevalence remains low. The percentage of wave 1 nonsmokers who tried smoking by the final wave ranged from 2% to 48% (mean = 22%). This too is a wide range. We must be careful to remember the pretest prevalence and the incidence rates...
<table>
<thead>
<tr>
<th>Studies</th>
<th>Year of publication</th>
<th>Place</th>
<th>Age at start of study</th>
<th>Time (months)</th>
<th>% Attr</th>
<th>N non-smoker</th>
<th>% Wave 1 prevalence</th>
<th>% Onset</th>
<th>Analytic method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Abilgren et al.</td>
<td>1982</td>
<td>Minnesota</td>
<td>10-11, 11-12</td>
<td>6</td>
<td>na</td>
<td>562</td>
<td>na</td>
<td>2</td>
<td>MAN, MR</td>
</tr>
<tr>
<td>2. Alexander et al.</td>
<td>1983</td>
<td>NSW Australia</td>
<td>10,11,12</td>
<td>12</td>
<td>na</td>
<td>5065</td>
<td>10</td>
<td>15</td>
<td>LR</td>
</tr>
<tr>
<td>7. Charlton &amp; Blair</td>
<td>1989</td>
<td>Manchester, UK</td>
<td>12-13</td>
<td>4</td>
<td>8</td>
<td>1513</td>
<td>35</td>
<td>16</td>
<td>LR</td>
</tr>
<tr>
<td>8. Chassin et al.</td>
<td>1984</td>
<td>Indiana</td>
<td>11-16</td>
<td>12</td>
<td>38</td>
<td>1207</td>
<td>46</td>
<td>21</td>
<td>DIS, MR</td>
</tr>
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<td>9. Chassin et al.</td>
<td>1986</td>
<td>Indiana</td>
<td>11-16</td>
<td>12</td>
<td>30</td>
<td>1459</td>
<td>31</td>
<td>na</td>
<td>LR</td>
</tr>
<tr>
<td>10. Collins et al.</td>
<td>1987</td>
<td>Los Angeles</td>
<td>12-13</td>
<td>16</td>
<td>39</td>
<td>1354</td>
<td>60</td>
<td>44</td>
<td>DIS</td>
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<tr>
<td>11. de Vries et al.</td>
<td>1990</td>
<td>Netherlands</td>
<td>Secondary</td>
<td>12</td>
<td>na</td>
<td>555</td>
<td>15</td>
<td>8</td>
<td>R</td>
</tr>
<tr>
<td>13. Kellam et al.</td>
<td>1980</td>
<td>Chicago</td>
<td>6-7</td>
<td>120</td>
<td>43</td>
<td>705</td>
<td>0</td>
<td>77</td>
<td>MAN</td>
</tr>
<tr>
<td>15. Lawrence &amp; Robinson</td>
<td>1986</td>
<td>Illinois</td>
<td>12-14</td>
<td>8</td>
<td>26</td>
<td>346</td>
<td>38</td>
<td>25</td>
<td>DIS</td>
</tr>
<tr>
<td>17. McNeill et al.</td>
<td>1989</td>
<td>Bristol, UK</td>
<td>11-13</td>
<td>30</td>
<td>23</td>
<td>1261</td>
<td>42</td>
<td>48</td>
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</tr>
<tr>
<td>18. Mittlemark et al.</td>
<td>1987</td>
<td>Minnesota</td>
<td>12-14, 14-16</td>
<td>18</td>
<td>50</td>
<td>887</td>
<td>19</td>
<td>27</td>
<td>DIS</td>
</tr>
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<td>21. Pulkinen</td>
<td>1982</td>
<td>Finland</td>
<td>8-9</td>
<td>144</td>
<td>63</td>
<td>135</td>
<td>0</td>
<td>93</td>
<td>ANOVA</td>
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<td>22. Semmer et al. (a)</td>
<td>1987</td>
<td>Berlin-Bremen</td>
<td>12-14</td>
<td>16</td>
<td>17</td>
<td>763</td>
<td>33</td>
<td>12</td>
<td>LR</td>
</tr>
<tr>
<td>23. Semmer et al. (b)</td>
<td>1987</td>
<td>Berlin-Bremen</td>
<td>12-13</td>
<td>24</td>
<td>18</td>
<td>761</td>
<td>31</td>
<td>23</td>
<td>MR</td>
</tr>
<tr>
<td>25. Stacy et al.</td>
<td>1988</td>
<td>Los Angeles</td>
<td>12-13</td>
<td>16</td>
<td>39</td>
<td>1116</td>
<td>60</td>
<td>43</td>
<td>LISREL</td>
</tr>
<tr>
<td>26. Sussman et al.</td>
<td>1987</td>
<td>Los Angeles</td>
<td>12-13</td>
<td>16</td>
<td>39</td>
<td>338</td>
<td>60</td>
<td>43</td>
<td>DIS</td>
</tr>
<tr>
<td>27. Ureberg et al.</td>
<td>1990</td>
<td>Detroit suburb</td>
<td>13-14, 16-17</td>
<td>12</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>MR</td>
</tr>
</tbody>
</table>

Mode & Median: Mn = 21, Mn = 28, Mn = 1127, Mn = 33, Mn = 22
SD = 23, SD = 13, SD = 571, SD = 17, SD = 15

Notes:
- Time = Number of months from beginning of study to final follow-up wave.
- N non-smokers = Number of non-smokers at beginning of study.
- % Attr = Percent attrition during study.
- % Onset = Percent of pretest non-smokers trying smoking by follow-up.
- ~ = Approximate estimate based on provided information.
- na = Not available.
- * = Analysis conducted and prediction tested on split half samples.
- ** = 40% White, 56% Hispanic, 5% Black, 26% Asian.
- † = Partly due to selection of smaller subsample because of limited funding.
- Mn = Mean.
- SD = Standard deviation.
- All Mn and SD exclude the Kellam and Pulkinen studies.
- Analytical method:
  - R = Correlation.
  - MAN = MANOVA.
  - MR = Multiple Regression.
  - LR = Logistic Regression.
  - DIS = Discriminant Analysis.
  - LISREL = Covariance Structural Models.
- * = A continuous dependent variable (amount smoked) was used.
- In all other analyses the dependent variable was dichotomous.
when interpreting different findings from different studies.

In most cases the dependent variable was dichotomous, although Ary et al. (1983) used a continuous transformed variable of amount smoked at wave 2. Twelve of the studies used discriminant analysis or logistic regression methods, discriminating between those wave 1 nonsmokers who tried smoking by wave 2 and those who did not. Most of the investigators not using discriminant analysis, used multiple regression and three recent studies used LISREL.

**Findings**

Findings of the 27 studies are summarized in Table 2. We consider the variables in much the same groupings as suggested by our previous model of the onset process (Flay, 1992). In the sections below, we summarize the findings by noting the proportion of results that were consistent with theoretical expectations and then describing briefly the non-confirming findings.

**Sociodemographic factors**

Sociodemographic factors were investigated as predictors of smoking onset with 21 indicators in 11 studies. Measures of sociodemographic status included socioeconomic status (SES), age, gender, parental education and occupation, single-parent status, home density (operationalized as the number of people per bedroom), school type and location, availability of spending money, and recent migration from the south of the United States.

Findings were consistent with theoretical expectations 76% of the time (16 of 21 indicators). Lower SES (de Vries et al., 1990; Semmer et al., 1987a) and older age (Alexander et al., 1983; Brunswick & Messeri, 1984, [females only]; McNeil et al., 1989) predicted onset consistently in multiple studies. Female gender (Goddard, 1990), occupation (Murray et al., 1983), being a single-parent (Goddard, 1990), availability of spending money (Alexander et al., 1983) and recent migration from the south for black urban females (Brunswick & Messeri, 1984) also predicted onset in one study each.

Often the same variable was predictive in one analysis or study but not in another. In one study, Ary & Biglan (1983) found that the number of people per bedroom was predictive of onset, but in another study by the same group (Ary et al., 1988) it was not. Type of school was predictive in the de Vries et al. (1990) and Semmer et al. (1987a,b) studies but not in the Alexander et al. (1983) work. Ary & Biglan (1988), and Semmer et al. (1987b) found that less parent education was predictive of smoking onset, but Mittelmark et al., 1987) found it only for high school females, and Ary et al. (1988) did not find it at all.

![Figure 1. Six domains of determinants of tobacco use.](image-url)
Table 2. Observed predictors of smoking onset in 27 studies: Number of supportive (+ +) and unsupportive (− −) findings

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Subtots</th>
<th>Totals</th>
<th>%Support</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>++</td>
<td>− −</td>
<td>++</td>
</tr>
<tr>
<td>SES</td>
<td></td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>Social bonding</td>
<td></td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Family</td>
<td></td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>Peer</td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>School</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Religiosity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>Social learning</td>
<td></td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Family smoking</td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Family approval</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Other adult influences</td>
<td>27</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Peer use and approval</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Prevalence estimates</td>
<td>7</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>67</td>
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<tr>
<td>Intrapersonal variables</td>
<td></td>
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<td>23</td>
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<tr>
<td>Refusal skills</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>193</td>
</tr>
</tbody>
</table>

Social bonding
Social bonding factors were investigated as predictors of smoking onset with 56 indicators in 20 studies. Social bonding included family bonding, peer bonding, school influences, and religiosity. Findings were consistent with theoretical expectations in 40 cases (71%) and inconsistent in 16 cases.

Family bonding. Family bonding factors were investigated as predictors of smoking onset with 15 indicators in 9 studies. Measures of family bonding included attachment to mother and father, having father present, spending spare time with family, parents’ academic expectations of their child, and supervision/strictness.

Only 60% of the findings were consistent with theoretical expectations (nine of 15 indicators). Often the same variable was predictive in some analyses or studies but not in others. In two studies (Ahlgren et al., 1982; Krohn et al., 1983) lower level or quality of attachment to parents was predictive of onset, but in one study (Brunswick & Messeri, 1984) it was predictive only for females, and in another study (Mittlemark et. al., 1987) it was not predictive. Skinner et al. (1985) found attachment to parents to predict onset only for older students, and found the opposite relationship for younger students. Lower levels of supervision/strictness was predictive in two studies (Mittlemark et al., 1987; Murray et al., 1983) but not in three others (Krohn et al., 1983; McNeill et al., 1989; Skinner et al., 1985). Chassin et al. (1986) found an interaction between levels of parental strictness and age, with higher levels of strictness predicting onset for younger subjects (ages 11–12), lower levels predicting onset for older subjects (ages 15–16) and no relationship for subjects in between (ages 13–14).

Having a father present (Brunswick & Messeri, 1984) and parents’ academic expectations (Chassin et al., 1984) were examined but were non-predictive.

Peer bonding. Peer bonding factors were investigated as predictors of smoking onset with 15 indicators in nine studies. Measures of peer bonding included number of friends, attachment to or agreement with peers, social involvement pertaining to social life, anti-social activities, sports and job...
involvement, number of clubs an adolescent belonged to and having a boyfriend or girlfriend.

Findings were consistent with theoretical expectations 73% of the time (11 of 15 measures). Attachment to or agreement with peers predicted onset consistently in four studies (Ahlgren et al., 1982; Krohn et al., 1983; Semmer et al., 1987b; Skinner et al., 1985), but only for high school students in one study (Chassin et al., 1984). Number of friends (Brunswick & Messeri, 1984, [males only]; Murray et al., 1983), level of social life (Kellam et al., 1980), participation in anti-social activities (Kellam et al., 1980), and having a boyfriend or girlfriend (McNeill et al., 1989) also predicted onset.

In one study (Murray et al., 1983) having a job was predictive of onset, but in two other studies (Krohn et al., 1983; Skinner et al., 1985) it was not. Sports involvement (Murray et al., 1983) and number of clubs belonged to (Brunswick & Messeri, 1984) were examined but they were non-predictive.

School influences. School Influences factors were investigated as predictors of smoking onset with 25 indicators in 17 studies. Measures of school influences included: school-level variance in prevalence of student smoking, academic values/expectations, academic achievement, reading test scores, aspirations and grade point average (GPA), commitment/satisfaction, favoring school discipline, problem behavior/truancy, extracurricular and prevention program.

Findings were consistent with theoretical expectations 80% of the time (in 20 cases). Academic values/expectations (Ahlgren et al., 1982; Bauman et al., 1984; Chassin et al., 1984; Goddard, 1990); commitment/satisfaction (Ahlgren et al., 1982; Krohn et al., 1983; Murray et al., 1983; Skinner et al., 1985), and school-level variance (Bauman et al., 1984; Semmer et al., 1987a,b) were each consistent predictors of onset in multiple studies.

Exhibiting little problem behavior/truancy was predictive of onset in one study (Murray et al., 1983) but only for Whites and Asians (not Blacks or Hispanics) in Los Angeles (Sussman et al., 1987). Also predictive were having high aspirations and a good GPA (Newcomb, McCarthy & Bentler, 1989), favoring school discipline (Murray et al., 1983), and being involved in extracurricular activities (McCaul et al., 1982).

Other mixed findings were also present. In several studies, academic achievement was predictive of onset (Ahlgren et al., 1982; McCaul et al., 1982; Pulkinen, 1982), and Sussman et al. (1987) found it to be predictive for Whites and Asians (and not for Blacks and Hispanics), but in studies by Brunswick & Messeri (1984) and Kellam et al. (1980) it was not predictive. Reading test scores (Brunswick & Messeri, 1984) and exposure to prevention programs (Alexander et al., 1983; Charlton & Blair, 1989) were examined but were non-predictive.

Religiosity. Religiosity was examined in one study (Krohn et al., 1983). It was non-predictive.

Social learning. Social learning factors were investigated as predictors of smoking onset with 93 indicators in 22 studies. Social learning factors included family smoking, family approval, other adult influences, peer influences, prevalence estimates, and offers and availability of cigarettes. Findings were consistent with theoretical expectations in 67 cases (72%) and inconsistent in 26 cases.

Family smoking. Family smoking factors were investigated as predictors of smoking onset with 26 indicators in 16 studies. Measures of family smoking included parent smoking, sibling smoking, and smoking in general.

Findings were consistent with theoretical expectations 69% of the time (in 18 cases). Older sibling smoking (Bauman et al., 1984; Chassin et al., 1984; McCaul et al., 1982) predicted onset consistently across multiple studies. Mother's smoking status was also predictive in two studies (Ahlgren et al., 1982; Skinner et al., 1985, [males only]).

Sometimes the same variable was predictive in some analyses or studies but not in others. Parent smoking in general was predictive in five studies (Chassin et al., 1984; Goddard, 1990; Murray et al., 1983; Semmer et al., 1987a,b), predictive for females only in two others (Charlton & Blair, 1989; Chassin et al., 1986) and not in six others (Alexander et al., 1983; Ary et al., 1983; Ary & Biglan, 1988; McCaul et al., 1982; McNeill et al., 1989; Mittelmärk et al., 1987). Ahlgren et al. (1982), found that father smoking was predictive of onset, but Skinner et al. (1985) did not. Ahlgren et al. (1982) also found that mother smoking was predictive. Skinner et al. (1985) found that mother smoking was predictive of onset for males only. Sibling smoking in general was predictive in three studies (Alexander et al., 1983; Goddard, 1990; Murray et al., 1983), only for younger females in
one study (Mittelmark et al., 1987) and not at all in another one study (Ary & Biglan, 1988).

**Family approval.** Family approval factors were investigated as predictors of smoking onset with 14 indicators in 10 studies. Measures of family approval included approval/disapproval, supportiveness, attitudes toward smoking, agreement with smoking, and sibling pressures.

Findings were consistent with theoretical expectations in 43% of the time (six cases) and inconsistent in eight cases. De Vries et al. (1990) were the only investigators to examine sibling pressure, and found it to be predictive of onset. Chassin et al. (1984) found that perceived agreement between parents regarding expectations of the adolescent was predictive.

Most of the remaining family approval measures were predictive in one situation but not in another. In three studies (Bauman et al., 1984; Chassin et al., 1986; Collins, 1987), parental attitudes toward smoking was predictive of onset, but in four others (Ary et al., 1983; Ary & Biglan, 1988; McNeill et al., 1989; Murray et al., 1983) it was not. Chassin and colleagues found general parental supportiveness to be predictive of smoking onset on one study (1986) but not in another (1984).

Family approval/disapproval of smoking (Ary et al., 1983; Ary & Biglan, 1988; Sussman et al., 1987) was examined in three studies but it was non-predictive.

**Other adult influences.** Other adult influences were investigated as predictors with eight indicators in six studies. Measures of other adult influences included other adult smoking, other adult approval, other adult pressure, exposure to advertising, watching tobacco sponsored sports, and church approval.

Findings were consistent with theoretical expectations in five cases (63%) and inconsistent in three cases. Other adult approval (McNeill et al., 1989; Sussman et al., 1987, [for Hispanics and Asians only]); other adult pressure (de Vries et al., 1990); and church approval (Bauman et al., 1984) were predictive of onset.

One study (Sussman et al., 1987) found other adult smoking was predictive of onset for Whites and Asians, but Alexander et al. (1983) reported a non-significant finding. Exposure to tobacco advertising (Goddard, 1990) and watching tobacco sponsored sports (Charlton & Blair, 1989) were examined in one study each, but they were non-predictive.

**Peer influences.** Peer influences were investigated with 32 indicators in 19 studies. Measures of peer influences included friends' smoking, friends use of other substances, friends expectations regarding smoking, friends approval, social normative beliefs, and motivation to comply.

Eighty-four percent of the reported findings (27 of 32 cases) were consistent with theoretical expectations. Friends' smoking was predictive in 15 studies (Alexander et al., 1983; Ary et al., 1983; Ary & Biglan, 1988; Bauman et al., 1984; Charlton & Blair, 1989, [females only]; Chassin et al., 1984, 1986; de Vries et al., 1990; McCaul et al., 1982; Mittelmark et al., 1987; Murray et al., 1983; Semmer et al., 1987a,b; Stacy et al., 1988; Sussman et al., 1987, [Asians only]; Urberg, Cheng & Shyu, 1990) but not in one (Newcomb et al., 1989). In a LISREL analysis of the role of different social influences, Stacy et al. (1988) found that friends' smoking did not add to the prediction of onset in a model that included prevalence estimates, susceptibility to offers, and peer bonding (subjective norms). Friends' approval of smoking was predictive of onset in six studies (Ary & Biglan, 1988, [older students only]; Bauman et al., 1984; Collins et al., 1987; McNeill et al., 1989; Murray et al., 1983; Sussman et al., 1987, [Whites and Hispanics only]) but not on two others (Ary et al., 1983; Chassin et al., 1986). Friends' use of other substances (Ary & Biglan, 1988) and friends' expectations regarding smoking (Chassin et al., 1986; Murray et al., 1983) were predictive of onset. Stacy et al. (1988) found social normative beliefs to be predictive but Chassin et al. (1984) did not. Motivation to comply was predictive in the Collins et al. (1987) study but not in the Chassin et al. (1984) study.

**Prevalence estimates.** Despite the widespread knowledge that students tend to overestimate the proportion of their own peers or adults who smoke, and the likely influence of these misperceptions on behavior, very few investigators have studied the phenomenon longitudinally. Smoking prevalence estimates were investigated with five indicators in four studies. Measures of prevalence estimates included prevalence estimates in general, as well as estimates of smoking among peers, adults, and teachers.

Findings were consistent with theoretical expectations 80% of the time (in four cases). Prevalence
estimates of use by peers was consistently predictive in three studies (Chassin et al., 1984; Collins et al., 1987; Stacy et al., 1988). Chassin et al. (1984) found the relationship to be stronger for younger than older students. Chassin et al. (1984) also found that estimates of adult use were predictive of onset, more strongly for older than younger students, just the opposite of their findings for estimates of peer smoking. Stacy et al. (1988) conducted a 3-wave analysis of the relationship between prevalence estimates and friends' use, and of their relative predictive power. They found that: (a) prevalence estimates of T1 were correlated with number of friends smoking at T1 (even prior to any personal smoking); (b) friends' smoking at T1 influenced smoking onset at T2; (c) friends' smoking at T1 also influenced prevalence estimates at T2; and (d) prevalence estimates at T1 influenced smoking onset at T3. Estimates of smoking among teachers was examined in one study (McNeill et al., 1989) but was non-predictive.

**Offers/availability.** One needs no theory to suspect that those students more often offered cigarettes by parents, other adults or peers are more likely to start smoking. The general availability of cigarettes ought also to predict smoking onset. Offers/availability factors were examined with eight indicators in seven studies. Measures of offers/availability included general offers, offers from parents, offers from siblings, and general availability.

Findings were consistent with theoretical expectations in seven cases (88%) and inconsistent in one case. General availability predicted onset in three studies (Bauman et al., 1984; Semmer et al., 1987b; Sussman et al., 1987, [but not for Asians]). Offers from parents and offers from siblings (Murray et al., 1983) were also predictive.

In two studies (Ary et al., 1983; Ary & Biglan, 1988) general offers was predictive of onset for junior high school students, but in another study (Stacy et al., 1988) it was not. No studies examined offers from friends.

**Intrapersonal/personality/self-image**

Intrapersonal/personality/self-image factors were investigated with 30 indicators in 14 studies. Measures of intrapersonal/personality/self-image included locus of control, tolerance of deviance, independence, alienation, curiosity, rebelliousness/risk-taking, intelligence, constructiveness, shy/submissiveness, aggressiveness, social helplessness, self esteem, personal efficacy, social impact efficacy, social expectancy, distress/stress, emotional well-being, and short time orientation.

Findings were consistent with theoretical expectations in 23 cases (77%) and inconsistent in seven cases. Rebelliousness/risk-taking predicted smoking onset in multiple studies (Bauman et al., 1984; Collins et al., 1987; Mittelmark et al., 1987; Sussman et al., 1987, [but only for Blacks]). Being shy/submissive and aggressive also predicted onset (Kellam et al., 1980; Pulkkinen, 1982). Locus of control (Chassin et al., 1984), tolerance of deviance (Chassin et al., 1984), alienation (Brunswick & Messeri, 1984, [males only]), curiosity (Bauman et al., 1984), intelligence (Kellam et al., 1980), constructiveness (Pulkkinen, 1982), personal efficacy (de Vries et al., 1990), and short time orientation (Brunswick & Messeri, 1984, [females only]) also predicted onset in one study each.

In several studies (Ahlgren et al., 1982; Semmer et al., 1987a, [Hauptschule only], 1987b, Sussman et al., 1987, [Asians only]) self esteem was predictive of onset, but in another study (Goddard, 1990) it was not. Independence was predictive for older males in the Mittelmark et al. (1987) study but not at all in the Chassin et al. (1984) study. Distress/stress was predictive in the Semmer et al. (1987b) study but not in the Brunswick & Messeri (1984) study.

Social helpfulness (Pulkkinen, 1982), social impact efficacy (Newcomb, McCarthy & Bentley, 1989), social expectancy (Brunswick & Messeri, 1984) and emotional well-being were examined but they were non-predictive.

**Refusal skills.** With the recent focus on resistance skills, it is surprising that only three prospective studies (Lawrence & Robinson, 1986; Stacy et al., 1988; Sussman et al., 1987) have included measures of ability or self-efficacy to refuse offers (or susceptibility to offers). Findings were consistent with theoretical expectations in all studies.

All of Lawrence & Robinson’s measures concerned student self-efficacy to refuse offers of cigarettes under various conditions. Sussman et al. (1987) found student ratings of their difficulty in refusing offers to predict subsequent smoking onset. As with availability, we observed this relationship for White, Hispanic and Black students, but not for Asians. Stacy et al. (1988) found that susceptibility to offers was a strong predictor of onset, second only to prevalence estimates.
Knowledge, attitudes, and behaviors

In developmental theories of onset, development of supportive knowledge, beliefs, attitudes and intentions are part of the process of becoming a smoker, as well as being predictors. However, most studies have considered them only as predictors. Knowledge, attitudes, intentions and related behaviors were investigated as predictors of smoking onset with 59 indicators in 21 studies. Findings were consistent with theoretical expectations 75% of the time (in 44 cases).

Knowledge/beliefs. Knowledge/beliefs factors were investigated with 24 indicators in 14 studies. Measures included knowledge/beliefs regarding physical consequences and addiction, subjective expected utility, positive expectancies, negative expectancies, affective expectancies, look/smell good/bad, health knowledge, effect on self-image, beliefs about tobacco and alcohol, and perceived weight.

Findings were consistent with theoretical expectations for 67% of the cases (16 cases) and inconsistent in eight cases. Affective beliefs (Semmer et al., 1987a, [Hauptschule only]; 1987b), and tobacco and alcohol beliefs (Krohn et al., 1983; Skinner et al., 1985) each predicted onset consistently in multiple studies. Beliefs about the effects of smoking on self-image predicted onset in two studies (Semmer et al., 1987b; Sussman et al., 1987), though only for Whites and Hispanics in Los Angeles (Sussman et al., 1987). Beliefs about addiction (Mittelmark et al., 1987, [older students only]) and positive expectancies (Charlton & Blair, 1989, [females only]) also predicted onset in one study each, though only for subgroups in each case.

In several studies, knowledge of physical consequences (McCaul et al., 1982; Middelmark et al., 1987, [younger students only]; Murray et al., 1983; Semmer et al., 1987b) was predictive but not in other studies (Collins et al., 1987; McNeill et al., 1989; Sussman et al., 1987). Subjective expected utility was predictive in the Bauman et al. (1984) study but not in the Stacy et al. (1988) study. Look/smell good/bad was predictive for older females in the Mittelmark et al. (1987) study but not at all in the McCaul et al. (1982) study.

Negative expectancies (Charlton & Blair, 1989), perceived weight (Brunswick & Messeri, 1984), health knowledge (Charlton & Blair, 1989) were examined but were non-predictive.

Attitudes. Attitude factors were investigated with 11 indicators in ten studies. Measures included attitudes toward smoking and toward a smoking ban in public, approval of cigarette ads, viewing the health professional as an exemplar, and thinking about health.

Findings were consistent with theoretical expectations in eight cases (73%) and inconsistent in three cases. Attitudes toward banning smoking in public places (McCaul et al., 1982), viewing the health professional as an exemplar (Mittelmark et al., 1987) and thinking about health (Brunswick & Messeri, 1984) were predictive of onset among females only in one study each.

Attitudes toward smoking were predictive of onset in four studies (Chassin et al., 1984; Goddard, 1990; de Vries et al., 1990; Murray et al., 1983) but not in two others (McNeill et al., 1989; Mittelmark et al., 1987). Approval of cigarette ads was predictive in the Alexander et al. (1983) study but not in the Charlton & Blair (1989) study.

Intentions. Smoking intentions were investigated in nine studies. Findings were consistent with theoretical expectations 89% of the time. In eight studies, intentions to smoke predicted onset (Ary et al., 1983, [younger students only], Ary & Biglan, 1988; Bauman et al., 1984; Chassin et al., 1984; Goddard, 1990; McCaul et al., 1982; Newcomb et al., 1989; Sussman et al., 1987, [but only for Asians]). Chassin et al. (1984) found intentions to be a stronger predictor of onset for high school than middle school students. (They also found intentions to be a stronger predictor of transition from trying to further experimentation than of initial onset). In the McNeill et al. (1989) study, intentions were not predictive of smoking onset behavior.

Other behaviors. In general, one of the strongest predictors of any behavior is prior behavior. In the absence of actual smoking behavior, other exposures to smoking and related behaviors should be predictive. Other behaviors were investigated with 14 indicators in 11 studies. Measures of other behaviors included prior experience/exposure, alcohol use other substance use, good health habits and food consumption.

Findings were consistent with theoretical expectations in 12 cases (86%) and inconsistent in two cases. Alcohol use (de Vries et al., 1990; McNeill et al., 1989) and other substance use (Ary et al., 1983; Ary & Biglan, 1988) predicted onset consistently in multiple studies. Food consumption (Brunswick &
Messeri, 1984) also predicted onset for females in one study.

In several studies, prior experience with or exposure to smoking was predictive of onset (Ary & Biglan, 1988; Chassin et al., 1984; Goddard, 1990; Krohn et al., 1983; McNeill et al., 1989; Newcomb et al., 1989; Semmer, 1987b) but in one it was not (Charlton et al., 1989). Good health habits were examined in one study (Brunswick & Messeri, 1984) but were non-predictive.

**Discussion**

**Findings**

The longitudinal prospective studies reviewed here provide considerable support for predictors of onset derived from theory and previous empirical findings. Overall support was found for 74% of all measures (193/261). This ranged from a low of 43% for family approval to a high of 100% for refusal skills self-efficacy.

Expected relationships were found for sociodemographic variables 76% of the time. Such relationships were observed in Australia (Alexander et al., 1983); Britain (Goddard, 1990; McNeill et al., 1989; Murray et al., 1983); Germany (Semmer et al., 1987a); the Netherlands (de Vries et al., 1990); and the USA (Ary & Biglan, 1988; Brunswick & Messeri, 1983; Mittelmark et al., 1987; Bauman et al., 1984). However, the small number of studies from any given country precludes any meaningful sub-analysis by country of residence to discern variations. In all cases where theoretically supportive relationships were found, students with compromised sociodemographic status were more likely to become cigarette smokers. This relationship was even more powerful in the German studies (Semmer et al., 1987a,b) than in most other studies.

Social bonding variables received good overall support. Peer bonding and school bonding received consistently positive support (73% and 80% respectively). Family bonding received a low level of support (60%, the second lowest), but it was assessed only 15 times. Chassin et al. (1986) found that higher strictness predicted onset for younger students (perhaps reflecting rebelliousness) and lower strictness predicted onset for older students (perhaps reflecting more mature decision making). Perhaps this interaction explains the inconsistency of other findings.

Social learning variables include parent smoking and approval, other adult smoking and approval, peer smoking and approval, prevalence estimates, and offers/availability. Overall findings provided a high level of support for this set of variables (72%). However, the family approval variables received very low support (43%). Although this is based on only 14 observations, it does represent a lower than chance finding. Family smoking received only moderate support, but closer examination finds a high level of support for sibling smoking as a predictor of onset (88% of tested cases) vs. a lower level of support for parent smoking as a predictor of onset (59%).

It seems that family, particularly parent, behavior and approval variables play a much less consistently important role in predicting onset than most writers have here-to-fore assumed. This may be a function of changing times—maybe parents played a more important role in adolescent socialization prior to the last decade. Or, perhaps parental influences of smoking onset are gender specific. Results showed that at times the gender of the parent smoking mattered in predicting onset, and in one study, the gender of the parent influenced smoking onset but only for one gender. Alternatively, it may be a function of the age of most of the subjects in these studies (median and mode or age 12–13). This is the age of highest peer-group identification. Still another alternative is that onset is predicted more by non-family environmental factors, including peer behavior, while intentions to become a regular smoker or the transition to experimental smoking may be influenced more by family variables.

Intrapersonal variables also received a high level of support (77%). One intrapersonal variable that received high support was rebelliousness/risk-taking. This relationship has probably received support in all studies in which it has been assessed since Stuart & Livson's (1966) hallmark prospective study, though we failed to recognize its importance in our previous review (Flay et al., 1983). In Los Angeles, however, we found rebelliousness/risk-taking to predict for only Blacks, and not for Whites, Hispanics, or Asians (Sussman et al., 1987), suggesting some definite limits to its generalizability.

It is noteworthy that self-esteem received fairly consistent support from the reviewed longitudinal studies. This is better than we would have expected from our reading of previous cross-sectional studies. Both Ahlgren et al. (1982) and Semmer et al. (1987a,b) used very broad measures of self-esteem. Ahlgren used the "Self Appraisal Inventory" (Instructional Objectives Exchange, 1972), which includes four aspects of self concept—family (gets
along well with family which cares for and is considerate), peer (others like, and get along well), school (a good student and emotionally comfortable in school), and general (trustworthy, attractive, smart). The first three categories seem to be measures of social bonding as much as self-esteem. Semmer et al. used a summary measure made up of measures of anxiety (Piers & Harris, 1969), depression (Reynolds & Richmond, 1978), self-esteem (Rosenberg, 1965, 1979), life events and daily hassles (Kanner et al., 1981; Newcomb, Huba & Bentler, 1981), family climate (Randolph & Dye, 1981), and popularity (acceptance by and influence on peers). This indicator clearly combines a wide range of anxiety, depression, and stress measures with more traditional measures of self-esteem and social acceptance. In both these studies, then, it is impossible to know what aspects of the very broad measures of self-esteem were responsible for predicting smoking onset.

The role of refusal skills or, more correctly, self-efficacy regarding the use of refusal skills, in the prediction of smoking onset was assessed in only three studies. In all three, the predictive relationship was confirmed. This is a case where a prediction hypothesized from theory, and for which there was not previous prospective evidence, was confirmed.

The role of knowledge/beliefs, attitudes, intentions, and other behaviors in predicting smoking onset was confirmed in 76% of tests. As we would have expected (Flay et al., 1983), intentions and other behaviors were more consistently confirmed, attitudes less so, and knowledge/beliefs even less so.

Methodological issues
We chose to look for consistency of findings from multivariate analyses rather than attempt to estimate effect sizes for univariate relationships. This decision was based on our belief that relationships found consistently in multivariate analyses will be the important ones for future prevention efforts. From a methodological perspective, however, it simply would have been impossible to estimate effect sizes reliably because there was too much inconsistency in how results were reported. If the data allowed, it would have been informative to examine variation in outcomes by such factors as age, country of residence, and time lapse between pretest and posttest. The magnitude of correlations of a predictor variable with onset varies with question wording, length of time between assessment periods, and reliability and scaling of the variable. Unlike longitudinal studies of drug use (see methodological critique by Miller, Flay & Petraitis, 1992), most researchers of predictors of smoking did appear to report all of their measured variables and acknowledged negative or null findings.

Multivariate analyses also provide more promise for understanding how or why variables predict onset. The most promising approach for such understanding is, of course, structural equation modeling (LISREL and its related techniques). Such analyses require, however, that (a) the dependent variable be continuous or else the matrix of polychoric correlations be analyzed, and (b) the investigator have a theory or model to test. They are not useful when fishing for relationships (basic correlational analyses) or the relative important of predictors (regression analyses). However, for an investigator with a model to test, an appropriate covariance structure analysis can confirm or disconfirm the importance and role of a predictive variable. For example, a distal variable may be very important, as evidenced by its indirect effect, even though its univariate correlation with onset may be small. In addition, structural analysis can correct for unreliability of measurement when one has multiple indicators, each of which may be unreliable. We encourage much more use of structural analysis, now that the methods have been made more accessible by inclusion in SAS (1990).

Few researchers have tested competing theoretical models. Only Chassin et al. (1984) tested more than one theory on the same data set. Most studies have been based on different, unstated, or a theoretical orientations, so it is difficult to see a consistent pattern across studies. It is important that future research test competing theories. Few of the studies reviewed included any model or theory of the relationships between predictors and smoking onset. Future prospective research needs to be theory-driven. A key role for theory is to explain the developmental process and time frame between the onset of the predictor variable and the onset of cigarette smoking.

Theories of onset hypothesize different predictors for different stages of becoming a smoker (Flay et al., 1983; Leventhal & Cleary, 1980; Skinner et al., 1985). When writing our last review, we observed that "no studies to date have attempted to determine the different antecedents for the different stages of the process of becoming a smoker" (Flay et al., 1983, p. 136). Very few investigators have done so since. Most notable is the work of Chassin and her
behavioral medicine, and substance abuse. To get a more comprehensive view of the factors that may predict smoking onset have been concentrated assessing similar or different constructs. However, confusion regarding whether reported variables are factor analysis or other exploratory predictors. Most of the studies reviewed did not. Perhaps the interactions found by Ary et al. will not generalize from groups where prevalence and incidence are very low. Results concerning gender and ethnicity are also too few and too inconsistent for any firm conclusions. We urge investigators to report analyses by these variables in future research.

Most investigators used measures of hypothesized predictor variables of unknown validity and reliability or they used measures of known validity to assess exploratory predictors. Most of the studies reviewed here did not include factor analysis or other assessments of scale properties. The lack of factor analysis in this area of research has contributed to confusion regarding whether reported variables are assessing similar or different constructs.

It appears that the longitudinal studies examining predictors of smoking onset have been concentrated in the areas of education, psychology, public health, behavioral medicine, and substance abuse. To get a more comprehensive view of the factors that may influence cigarette smoking acquisition, we need to incorporate other perspectives and methodologies. For example, two studies examined the influence of advertising, with mixed results (Alexander et al., 1983; Charlton & Blair, 1989). Econometric and marketing-type studies may add significant new information on how this important factor may influence onset. All the studies reviewed were quantitative in nature. Qualitative approaches may provide rich new insights into understanding how the predictors work. We suggest that the potential contributions from other types of studies be sought and incorporated into work in this area.

Conclusions

Though the 27 available prospective studies of predictors of the onset of cigarette smoking are far from perfect, we believe that this review has confirmed the importance of many well-accepted predictors and raised some questions about others. In particular, family smoking, bonding, and approval each received unexpectedly low support. It is not clear whether this lack of support reflects reality as it has always been, is due to a changing reality, reflects developmental changes, either in the age of subjects or the stage of onset, or is due to poor measurement and too few tests.

Four groups of constructs received highly consistent support. These were: (a) refusal skills; (b) intentions and other behaviors; (c) peer influences (use, approval and prevalence estimates); and (d) offers/availability. Of these, refusal skills had little empirical support from previous research but its theoretical derivation supports its importance. Other predictors for which consistently positive results were obtained include (e) peer and school bonding, and (f) knowledge, beliefs and attitudes toward smoking. A wide range of personality and self-esteem variables also received fairly consistent positive support, particularly (g) rebelliousness/risk-taking and independence, and (h) aggressiveness and shyness.

Future prospective studies need to be theory-driven, designed to support or disconfirm a theory or to test two or more theories against each other. They need to use measures of known reliability and validity, report analyses of scale properties, and use statistical methods appropriate to the hypotheses or theories under study. Finally, we encourage more investigations of the potentially different predictors of transitions to experimental or regular cigarette smoking. This will require multi-wave studies and
careful measurement of changes in smoking behaviour (Miller et al., 1992). Such multi-wave studies may consider the mediating effect of pharmacologic factors, the one domain in our previous model (Fig. 1) not examined here.

Acknowledgements

Brian Flay's work on this paper was supported by grants DA03468 and DA86037 awarded to him from the National Institute on Drug Abuse and grant CA34622 awarded to Steve Sussman from the National Cancer Institute. Our thanks to Cynthia Britton, Jacqueline Walcott-McQuigg, and Anne Williams for help in locating and annotating studies and to Betty Bady for manuscript assistance.

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