Dynamic Effects of Self-Efficacy on Smoking Lapses and Relapse Among Adolescents

Rinka M. P. Van Zundert
Radboud University Nijmegen

Stuart G. Ferguson and Saul Shiffman
University of Pittsburgh

Rutger C. M. E. Engels
Radboud University Nijmegen

Objective: The present study examined whether dynamic day-to-day variations in self-efficacy predicted success in quit attempts among daily smoking adolescents. Design: A sample of 149 adolescents recorded their smoking and self-efficacy three times per day during 1 week prior to and 3 weeks after a quit attempt. Main Outcome Measures: The first lapse, second lapse, and relapse after at least 24 hours of abstinence from smoking were the main outcome measures. Results: Self-efficacy was relatively high and moderately variable prior to the first lapse, but decreased and became more variable thereafter. Lower self-efficacy as measured at the lapse assessment significantly increased the risk that a second lapse and relapse would occur. Individual differences in baseline self-efficacy did not predict any of the treatment outcomes. The time-varying analyses, however, showed that lower self-efficacy on a given day predicted the first lapse, the second lapse, and relapse on the succeeding day. Daily concomitant smoking (any smoking on the preceding day) was not significantly related to relapse. Conclusion: The present results emphasize the importance of self-efficacy among adolescents in cessation and highlight the need for dynamic formulations and assessments of adolescents’ self-efficacy and relapse.

Keywords: self-efficacy, smoking cessation, adolescents, relapse, ecological momentary assessment

Relapse is the most probable outcome for the majority of adult smokers who attempt to quit (Kenford et al., 1994; Piasecki, 2006). Outcomes are similar among adolescents: An extensive review of 66 adolescent smoking intervention studies indicated that successful smoking rates do not exceed 19% and are usually much lower (Sussman, 2002). Cessation rates are even lower among youth who smoke daily, with successful unaided smoking cessation rates ranging from no more than 5% (Stanton, McClelland, Elwood, Ferry, & Silva, 1996) to 12% (Sargent, Mott, & Stevens, 1998). These low rates of successful adolescent smoking cessation pose a major difficulty in the treatment of this highly addictive behavior. Intervention programs have not yet addressed the difficulties that adolescents encounter during cessation, as is reflected by figures demonstrating that taking part in a cessation program does not substantially increase the odds of successful adolescent smoking cessation (Garrison, Christakis, Ebel, Wiehe, & Rivara, 2003).

Self-efficacy (SE) to obtain a goal behavior is a key cognitive concept in several major health behavior theories, such as the Social Cognitive Theory (Bandura, 1986), and the Theory of Planned Behavior (Ajzen, 1991), and in relapse models inspired by social learning (Marlatt & Gordon, 1985). These theories posit that one’s belief in their ability to successfully undertake a target behavior (e.g., smoking cessation) predicts the likelihood that the person will successfully achieve the target behavior. In the area of smoking cessation, there is some evidence to support this postulate: SE seems to be an important predictor of smoking cessation in adults. A long line of studies among adults has demonstrated that those who feel highly confident that they are able to reach and sustain smoking cessation are more likely to succeed (for an overview, see Gwaltney, Metrik, Kahler, & Shiffman, in press).

In contrast with such a large number of studies on adult SE and smoking cessation, the research on this association is limited for adolescent samples. To our knowledge, there are only three studies that have tested whether SE predicts smoking cessation among adolescents. SE to resist smoking has been associated with having quit smoking 2 years later (Chang et al., 2006), 3 years later (Engels, Knibbe, De Vries, & Drop, 1998), or as much as 5 years after SE was measured (Tucker, Ellickson, & Klein, 2002). It is notable that these studies do not examine success in a particular quit effort but instead only address long-term change. Moreover, these studies may be limited because they studied a mixture of daily smokers and very low rate smokers (who smoked weekly, monthly, or who had only smoked once in the past year), for whom the process of quitting may be very different.

Perhaps a more significant limitation in the SE literature in general is that it only establishes distal relationships between SE and outcome over months and years, without revealing much about the process by which SE and smoking behavior interact. This is particularly troubling because SE is expected to affect behavior quite proximally (Baer, Holt, & Lichtenstein, 1986; Shiffman et al., 2000), and because SE (Bandura, 1997; Gwaltney et al., 2001)
and adolescent smoking (Colby, Tiffany, Shiffman, & Niaura, 2000) are both quite volatile. In addition, perceived SE is reactive to feedback on the outcome of one’s efforts, such as experiencing a lapse in smoking. Previous research in adult smokers has demonstrated that experiencing a lapse markedly reduces SE (Shiffman et al., 1997; Shiffman et al., 2000). SE is also important to several prominent relapse theories. The dynamic regulatory feedback model proposed by Niaura and colleagues (Niaura, 2000; Niaura et al., 1988), for example, posits that SE is a central component of relapse that is reciprocally related to other major determinants of relapse such as urges, outcome expectations, smoking cues, and coping efforts. Indeed, during a quit attempt, SE has been found to be negatively affected by a higher urge to smoke and by negative affect among adults (Gwaltney, Shiffman, & Sayette, 2005). Although SE is, strictly speaking, not part of the theory on the abstinence violation effect (AVE; Marlatt & Gordon, 1985), SE is thought to be important in that it is associated with people’s attributions for relapse.

Another limitation in the relapse literature in general: Very few studies have employed postquit measures of SE, and most did not distinguish the first lapse from a second lapse or full relapse, most probably as a result of a robust consistency in the literature that most lapses end up in relapse anyway (Jarvis, 2003; Kenford et al., 1994). Instead of considering this strong association as an argument to neglect the intervals between lapses and relapse, it actually highlights that the processes that mediate between a lapse and relapse are of major importance in understanding relapse. Moreover, the interval between a lapse and full relapse may in fact be distinctly different from the interval between quitting and the first lapse, and the mechanisms that are at play seem to change from one phase of the quitting process (before the lapse) to another (after the lapse; Gwaltney et al., 2005). The use of nicotine replacement, for instance, appears to have a stronger treatment effect among individuals who have already lapsed in preventing them from progressing to full relapse than that it prevents quitters from lapsing (Shiffman et al., 2006).

The preponderance of the aforementioned studies underscores that SE can be considered as a proximal precipitant of relapse that fluctuates over time in response to changing internal and external contexts, and that both SE and relapse are dynamic constructs. One might therefore expect that changes in SE should foreshadow lapses and relapse. Two studies using ecological momentary assessment among adults seem to confirm this postulate. Shiffman and colleagues (2000) found that daily SE ratings differentiated lapsers and nonlappers. However, this effect seemed to be accounted for by stable individual differences in SE. In the study by Gwaltney and colleagues (2005), the effect of decreases in daily SE on lapses persisted when baseline SE measures and quit day SE ratings were controlled for. In both studies, however, a proximal effect of the preceding day’s SE on relapse the next day was found, which remained after baseline SE and concomitant postquit smoking were accounted for. Thus, dynamics—variations over time in both smoking and its determinants—appear to be very important to the process of smoking cessation and relapse, and yet they have not been examined in adolescents so far.

One motivation to test smoking dynamics for adolescents separate from adults is based on the notion that adolescence is a developmental phase in which impulsivity, novelty seeking, and suboptimal decision making are considered to be normative traits (Chambers, Taylor, & Potenza, 2003). Adolescents are also known to still be in the process of maturing and developing their ability of self-reflection and introspection (Beyth-Marom & Fischhoff, 1991; Steinberg & Cauffman, 1996). Maturational changes in the brain are postulated to account for these transition traits, and are thought to predispose adolescence to being a critical period of addiction vulnerability in the first place (Chambers et al., 2003). Increased impulsivity in adolescents’ smoking behavior is also reflected in findings by Pallonen (1998), who showed that adolescents who are in the early stages of forming a motivation to quit smoking seem to move into action prematurely, and that adolescents tend to move back and forth between motivational stages more than adults. Adolescents’ sensitivity to impulsive behavior and suboptimal decision making may cause them to deal differently with high-risk situations, and to respond differently to the day-to-day variations in SE. In addition, SE is in part shaped by prior experience; the more attempts one has undertaken, the stronger one’s basis for making SE judgments that will have predictive value. Given that adults can be expected to have more experience, their SE judgments may be differentially related to relapse compared with adolescents. Lastly, daily SE is responsive to affect-motivational states (e.g., craving, negative affect) and external contexts (e.g., seeing others smoke, drinking alcohol) (Gwaltney et al., 2005), and the impact of these states and contexts may influence SE in a different manner among adults versus adolescents, because both these states and contexts differ between the two age groups. The present study is the first to examine whether dynamic changes in perceived SE to resist smoking can predict changes in smoking during a quit attempt among daily smoking adolescents.

To capture the day-to-day, or even moment-to-moment variation in cognitions and behavior, which is so essential to the process of relapse, repeated sampling is pivotal. Ecological momentary assessment (EMA) encompasses a variety of diary methods that repeatedly gather real-time data on momentary states of individuals who are in their “real-world” environments at the moment of assessment (Shiffman, 2005; Shiffman, Stone, & Hufford, 2008). EMA studies acquire high temporal sensitivity to fluctuations in behavior by requiring subjects to report on their behavior at least once a day, and usually more frequently. The high frequency of reporting and the real-time nature of EMA designs minimize retrospection bias (Bolger, Davis, & Rafaeli, 2003; Shiffman, 2005; Shiffman et al., 2008). EMA has been used to study adult smoking cessation (e.g., Shiffman, 2005), but has not yet been applied to adolescent smoking cessation (with the exception of a feasibility study by Gwaltney, Bartolomei, Colby, & Kahler, 2008).

The present study aimed to examine both between-person differences in SE, and dynamic, within-person variations in SE among 149 daily smoking adolescents who were quitting smoking. The primary interest of this study was to examine whether daily SE on a given day predicted the first lapse, progression to the second lapse, and progression to relapse the next day. We expected that lower ratings of SE at baseline, as well as daily decreases in SE, would predict each of these milestones. Individual differences in baseline SE and daily smoking after a lapse were controlled for (cf. Baer et al., 1986; Shiffman et al., 2000, 1997).
Method

Overview

The present study used daily measures to monitor adolescents who embarked on an unaided quit attempt. Participants were monitored for 1 week prior to and for 3 weeks after the designated quit day (4 weeks in total). Their smoking and SE were reported three times a day via an Internet-based survey.

Participants

Participants (n = 176) were Dutch adolescent daily smokers recruited for the study by means of community advertisements and newspaper articles. To qualify, candidates had to be between 15 and 19 years of age, smoke at least one cigarette per day, and not be currently enrolled in a cessation program. In addition, adolescents aged 15 needed to report having been a daily smoker for at least 1 consecutive year to be eligible for study enrollment. A total of 272 interested candidates contacted the study site and were sent a detailed description of the study. After reading the detailed description, 189 candidates were scheduled for a telephone screening, of which 176 were eventually enrolled (Figure 1).

To be eligible for the analyses presented in this article, subjects needed to (a) achieve 24-hour abstinence at least once during the study, and (b) provide data on at least 80% of the 28 study days. A total of 84.6% (n = 149 of 176) participants met these criteria and were analyzed for this article. Of the 27 participants who were excluded, 17 were removed because they dropped out of the study before achieving 24 hours of abstinence, nine provided data on less than 80% of all study days, and one participant was removed because of failure to reach abstinence at least once during the study. The final sample consisted of 149 adolescents. Figure 1 shows the flow and disposition of participants. Detailed participant characteristics are summarized in Table 1. Briefly, the average participant was female, White, 17 years old, and smoked 11 to 20 cigarettes per day. Written consent from the participants and their parents was not required. Participants did not receive any kind of treatment to aid them in quitting smoking. This study was approved with the Dutch Committee on Research Involving Human Subjects.

Procedures

Participants were asked to complete a baseline questionnaire that included items on general demographic characteristics, smoking history, nicotine dependence (multidimensional measure based on the modified Fagerström Tolerance Questionnaire [mFTQ] and the Hooked on Nicotine Checklist [HONC] (Kleinjan et al., 2007), and smoking-specific cognitions (Van Zundert, Van de Ven, Engels, Otten, & Van den Eijnden, 2007). Participants were monitored for a total of 4 weeks. The first day of monitoring was always a Monday. Participants started the monitoring period with 7 days of baseline monitoring, during which they were instructed to smoke ad lib. The eighth day was the assigned quit day for each participant. Following the quit day, subjects were monitored for an additional 3 weeks.

On each day of monitoring, participants were asked to complete three Internet-based questionnaires—in the morning (to be completed between 10 a.m. and noon), the afternoon (3 p.m.–5 p.m.), and evening (8 p.m.–10 p.m.). Each questionnaire was identical and asked participants questions about smoking since the previous questionnaire, motivation, SE, withdrawal symptoms, and situational stimuli (e.g., alcohol/coffee consumption, seeing others smoke). The questionnaires were in Dutch (participants spoke Dutch) and took approximately 3 min to complete. Questionnaires were automatically time-stamped with the time that they were completed online. Participants who failed to complete a questionnaire within the designated sampling window were sent a text message to remind them. If a participant did not have access to the

Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean or percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>63.8%</td>
</tr>
<tr>
<td>Age</td>
<td>17.2 (1.2)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>96.3%</td>
</tr>
<tr>
<td>Other</td>
<td>3.7%</td>
</tr>
<tr>
<td>Cigarettes per day</td>
<td></td>
</tr>
<tr>
<td>1–5</td>
<td>11.9%</td>
</tr>
<tr>
<td>6–10</td>
<td>34.3%</td>
</tr>
<tr>
<td>11–20</td>
<td>47.0%</td>
</tr>
<tr>
<td>20–30</td>
<td>3.7%</td>
</tr>
<tr>
<td>31 or more</td>
<td>3.0%</td>
</tr>
<tr>
<td>Years smoked daily</td>
<td>2.9 (1.6)</td>
</tr>
<tr>
<td>Age smoking first puff</td>
<td>12.3 (1.9)</td>
</tr>
<tr>
<td>Age started daily smoking</td>
<td>14.3 (1.6)</td>
</tr>
<tr>
<td>Number of prior serious quit attempts</td>
<td>1.9 (1.2)</td>
</tr>
<tr>
<td>Nicotine dependence (range = 1–4)</td>
<td>2.63 (.49)</td>
</tr>
</tbody>
</table>

Note. Of the 149 participants included in the present sample, 14 participants did not provide demographic and smoking history data. Nicotine dependence was measured with a multidimensional scale including the modified Fagerström Tolerance Questionnaire (mFTQ) and the Hooked on Nicotine Checklist (HONC) (Kleinjan et al., 2007).
Internet during the sampling window, they were asked to complete a paper version of the questionnaire—which included a question on the date and time of completion—and to transcribe the paper version online as soon as they had access to Internet again. Analysis showed that 85.1% of all assessments were completed within the allotted time windows (Table 2). Of the assessments that were completed outside of the assessment windows (1497 of 10501; 14.3%), 99.6% were entered or reported to have been completed within 3 hours of the assessment window. Of all the assessments that were completed on a paper diary and later entered on the Web site, 60.5% was recorded online on the same day. All data were collected between October 2006 and March 2007.

### SE Measures

**Daily measure of SE.** At each assessment, SE was assessed with the item “How confident are you that you can continue your quit attempt today?” (1 = *not at all confident*, 5 = *very confident*). Because the quit attempt had not yet been initiated during the first week of the study, participants could tick a box saying “I am in the first week of the study, so this question does not yet apply.”

**Baseline SE questionnaire.** Baseline SE was measured using a SE measure that was specifically designed for adolescents (Kremers, Mudde, & de Vries, 2001). The instrument of 12 items originally showed high loadings on three subscales and showed high internal consistency (Kremers et al., 2001). Respondents were asked: “When you have quit, how difficult or easy do you expect it will be not to smoke in the following situations?” Example items are “When you’re with friends who smoke,” “When you’re doing homework,” and “When you feel depressed.” Participants could answer on a 5-point Likert scale, ranging from 1 = *very easy* to 5 = *very difficult*. A higher score represents high SE. The Cronbach’s alpha observed in this sample was .80, indicating a high degree of internal consistency.

### Outcomes: First Lapse, Second Lapse, and Relapse

For the purposes of the analyses presented in this article, we were interested in three treatment outcomes: The first lapse, the second lapse, and relapse (e.g., Gwaltney et al., 2005; Shiffman et al., 2000, 2006). A participant’s first lapse day was defined by any report of smoking (even if only a puff), after having accomplished 24 hours of abstinence. Similarly, the second lapse day was defined by any report of smoking after the first lapse. The first and second lapse may coincide on the same day. The literature on adolescent smoking does not provide standard definitions of relapse that are suitable for adolescents specifically. Common definitions of relapse as applied to adult smokers may be too stringent in adolescent samples (e.g., smoking at least five cigarettes for three consecutive days; Shiffman et al., 1996) given that adolescents have shorter histories of smoking and may not smoke five cigarettes daily even before quitting. For the purposes of these analyses, we defined relapse as smoking at least one cigarette per day for 3 consecutive days. The first day of the relapse episode was counted as the relapse day.

**Analytic plan.** The following analyses, modeled after those in Shiffman and colleagues (2000), used days as the primary unit of analysis—a study day was defined as the period between two consecutive morning reports. To test the impact of SE on risk of lapse and relapse, we used a series of proportional hazards regression survival analyses (Cox, 1972). Such analyses evaluate the risk of a target event (lapses or relapse) occurring per unit of time, while taking into account that some observations are censored because participants’ status after the study ended is unknown.

To assess the relationship between baseline questionnaire SE and progression to lapse and relapse, we used Cox proportional hazards survival analysis. We also used the SE report during the first lapse assessment as a static predictor of time to the second lapse. Finally, in addition to static measures of SE, we calculated daily SE scores and used these values as time-varying covariates to test whether daily variations in SE predict the following day’s risk of lapsing or relapsing. To obtain daily measures of SE, we aggregated the three daily measures (or as many as were nonmissing—82.4% of daily measures were based on data from all three measures; only 3.6% of days had only one observation) of SE into a single, daily SE score. In the relapse analyses, we controlled for baseline SE as well as daily smoking, which was used as a time-varying covariate. Of the final 149 participants, 14 participants failed to complete and/or to successfully return the baseline questionnaire. These 14 participants are excluded from the analyses in which we examine the effect of baseline SE on all outcome variables. Attrition analyses between those 14 subjects and those who were included in the analyses showed no differences in smoking rates during the first week of ad lib smoking, nor in relapse rates. All analyses were conducted using SAS Version 9.1.3.

### Results

**Monitoring and Participant Disposition

Participants completed an average of 25 (SD = 4.5) days of monitoring, during which they completed a total of 10501 assessments. Compliance with assessment taking was high—participants completed an average 88.3% of all possible assessments (taking into account that some dropped out of the study prematurely), and 87.2% of participants completed 75% or more of all possible assessments. On average, participants completed 70.5 (SD = 14.9)
assessments each during the monitoring period. Most (83.9%) participants included in the present analyses remained enrolled in the study until the last day of the four-week period. Of the remaining 16.1%, 4.0% dropped out within the first week after the target quit day, 4.7% in the second week after the target quit day, and 7.4% stopped completing assessments during the last week of the study. On average, participants remained in the study for 18.3 days (SD = 4.4) out of a possible 21 days after achieving 24 hours of abstinence.

Participant disposition is shown in Figure 1. The majority of the participants reached 24 hr abstinence on the target quit day (72.5%, n = 108 of 149) or on the following day (13.4%, n = 20 of 149), an additional 13 participants (8.7%) quit on or after Day 10. Although participants were instructed to smoke ad lib during the first week of monitoring, eight participants (5.4%) quit smoking before the target quit day. The day that they reported non-smoking at three consecutive assessments was counted as their actual quit day even if that was prior to the target quit day (thus, “quit day” was set as day zero). The SE question was completed only once participants started their quit attempt.

The majority of the participants (71.8%, n = 107 of 149) experienced at least one lapse during monitoring, typically, soon after achieving initial abstinence (M = 4.0 days; SD = 3.37; range = 0–20 days), and 83.2% of these (n = 89 of 107) reported a second lapse. The average number of days between the first and second lapse was 2.2 (SD = 3.11; range = 0–15); however roughly a third of the second lapses (31.5%; n = 28 of 89) occurred on the same day as the first lapse. Relapse occurred for 52 participants (34.9%, n = 52 of 149). For more than half of the subjects who lapsed (59.6%), the first lapse constituted the onset of a relapse. For the remaining 40.4%, the average number of days between the initial lapse day and relapse was 4.7 (SD = 3.32; range = 1–12 days).

**Progression to a First Lapse**

**Individual differences in baseline self-efficacy as a predictor of lapse risk.** We first tested whether the baseline questionnaire measure of SE predicted the risk of suffering a first lapse. Participants who reported a first lapse reported equal levels of baseline questionnaire SE compared with those who did not lapse, 2.49 (SD = .60) versus 2.47 (SD = .64). In a survival analysis, baseline SE scores did not predict time to first lapse (Hazard Ratio [HR] = 0.98, confidence interval [CI] = 0.70–1.37, p = .904).

**Daily SE as a predictor of an initial lapse.** First, to examine the variability in SE between achieving abstinence and experiencing the first lapse, we calculated the overall coefficient of variation (which is the SD, expressed as a percentage of the mean: \(\frac{SD}{M} \times 100\)) across assessments. Participants reported moderately high SE during the quit-to-lapse interval (M = 3.74, SD = 0.89) on the 5-point scale. There seemed to be a modest amount of variability in overall SE during that interval; the average within-subject SD for average SE (ASE) was .92, and the coefficient of variation was 24.6%. To test whether daily measures of SE predicted the risk of suffering a first lapse the following day, we entered daily measures of SE as time-varying covariates. Lower daily SE significantly predicted a first lapse on the subsequent day—for each 1-point decrease in daily SE, the risk of lapsing the following day increased by 48% (HR = 1.48, CI = 1.24–1.78, p < .0001). Controlling for baseline levels of SE showed that baseline SE did not account for this relation (adjusted HR = 1.56, CI = 1.28–1.88, p < .0001).

**Progression From First Lapse to Second Lapse**

**SE reported at a first lapse as static predictor of second lapses.** The average SE score reported at the assessment during which participants reported their first lapse was 2.9 (on a 5-point scale; SD = 1.5). SE scores at the first lapse were lower among participants who later reported suffering a second lapse, 2.8 (SD = 1.5) versus 3.3 (SD = 1.5), but this difference was not statistically significant, \(t(101) = 1.21, p = .223\). In a survival analysis, lower SE scores at the first lapse assessment significantly predicted second lapses (HR = 1.23, CI = 1.06–1.43, \(p = .006\))—for each 1-point decrease in SE at the first lapse, the risk of suffering a second lapse increased by 23%.

**Progression From First Lapse to Relapse**

**Individual differences in baseline and lapse day SE as static predictors of relapse risk.** Similar to the first lapse, baseline SE scores among those who relapsed did not differ from those who did not, 2.47 (SD = .62) versus 2.49 (SD = .61). Furthermore, baseline scores did not predict relapse risk in a survival analysis (HR = 0.95, CI = 0.58–1.53, \(p = .822\)). Lower SE scores at the first lapse assessment, however, significantly predicted relapse (HR = 1.43, CI = 1.16–1.76, \(p = .0006\))—for each 1-point decrease in SE at the first lapse, the risk of relapse increased by 43%. Figure 2 shows this association as a survival curve, where one can see that by about one week after the lapse, subjects with low postlapse SE are about twice as likely to have relapsed (50% vs. 25%). Controlling for baseline SE did not substantially affect this relationship (HR = 1.46, CI = 1.18–1.82, \(p = .0006\)).

**Daily SE as a dynamic predictor of relapse.** Following the first lapse, overall SE declined (M = 2.89, SD = .80), and became more variable than it had been prior to the first lapse; the average SD for SE over days was 1.30, the coefficient of variation was 45.0%. Daily variations in SE significantly predicted relapse risk (HR = 1.48, CI = 1.24–1.78, \(p < .0001\)).

![Figure 2. The relationship between postlapse self-efficacy (SE) and risk of progression to relapse. To construct discrete groups for the Kaplan-Meier curve, SE was dichotomized into low (<4) and high (≥4; 37% of subjects) SE groups.](image-url)
Daily self-efficacy and concomitant smoking. The occurrence of smoking between the first lapse and full relapse was quite variable. (On average, subjects smoked on 21% of the days in the interval between the first lapse and relapse. This figure of 21% is based on only 16 participants since most subjects relapsed on either the same day as the first lapse or on the adjacent day, leaving no days in between to calculate the rate of smoking between lapse and relapse). Any smoking on a given day was not related to relapse the following day (HR = 1.44, CI = 0.44–4.72, p = .545). Concomitant smoking was moderately and negatively correlated with daily SE during the time between the first lapse and the relapse (−0.27, <.0001). We assessed whether the daily effect of SE would remain significant when both baseline SE and concomitant smoking (yes/no) as time-varying covariates were added to the model. Controlling for these variables decreased the effect of prior day’s SE and it became nonsignificant, though the HR decreased only slightly (adjusted HR = 1.29, CI = 0.99–1.68, p = .058).

Additional analyses. To test whether quitting experience enhances the predictive power of baseline reports of SE, we modeled the number of previous quit attempts as an independent covariate predicting (re)lapse, and as a moderator in the association between baseline SE and (re)lapse. We found no main effects of number of previous attempts on outcomes nor significant interactions with baseline SE.

Discussion

Although the dynamics of SE and relapse are known to play an important role in adult smoking cessation, no study has hitherto examined dynamics among adolescent smokers who are trying to quit. The present study examined dynamics in SE and relapse among 149 adolescent daily smokers who embarked on a quit attempt. Findings show that within three weeks, the majority of the participants (71.8%) experienced at least one lapse, and a third relapsed. Whereas baseline SE did not predict any of the milestones, daily variations in SE predicted the first lapse, as well as progression from first lapse to relapse. Surprisingly, concomitant smoking did not predict outcomes on the next day.

To start with, the finding that individual differences in baseline SE did not predict abstinence is in contrast with prior studies among adolescents in which high SE predicted smoking cessation a few years later (Chang et al., 2006; Engels et al., 1998; Tucker et al., 2002). This discrepancy may well be because of the large difference in time intervals, but also to the fact that these other studies included large proportions of irregular and sporadic smokers. For sporadic smokers, refraining from smoking is presumably less of a challenge and SE may therefore automatically be high in those samples. In addition, only 19% of teenagers who report experimental smoking will continue their use (Tucker, Ellickson, & Klein, 2003), and “cessation” is therefore a very probable outcome for these experimenters. As such, the relation between SE and smoking cessation as found in the above studies may be artificial. Alternatively, and more generally, the lack of predictive power of baseline SE in the present study might be explained by the timing of assessment. In their meta-analysis of 54 studies on the association between SE and smoking abstinence, Gwaltney and colleagues (in press) found that this association was substantially lower among studies using prequit SE measures, especially when postquit smoking was controlled for. The authors postulated that a better understanding of the challenges as well as knowledge of the resources available to maintain abstinence are achieved more so after quitting than before, which may lead postquit SE to comprise more accurate judgments and to yield larger effect sizes.

The present results on baseline SE did not mirror the preponderance of studies on SE and smoking abstinence among adults either (Gwaltney et al., in press). One reason that our results differ from those of studies on adult quitters could be that SE judgments are partly based on experience, and adolescents have less experience with quitting. However, in our analyses, the number of prior quit attempts did not affect SE judgments or their ability to predict outcomes. This could mean that lack of (or less) experience does not necessarily make adolescents poorer predictors of how capable they will be in resisting smoking after quitting. Further research is warranted to disentangle to what extent adolescents make use of their previous quitting experience in forming SE judgments as well as in undertaking the quit effort, and whether appropriate use of past experiences supports them in maintaining abstinence or not.

Whereas adolescents’ baseline SE did not predict treatment outcomes, the effects of daily variations in SE on the first lapse and relapse appeared to be quite robust. Drops in daily SE posed a substantial risk of lapsing after achieving abstinence and of relapsing after lapsing, which is in line with findings among adults (Gwaltney et al., 2005; Shiffman et al., 2000). The effect of daily SE on relapse was attenuated to a trend effect when concomitant smoking was accounted for, which may be explained by the moderate but significant correlation between smoking and SE on the same day, but the magnitude of the coefficient remained almost the same. Thus, these findings have an important implication for future research in that they support the notion that static measures of SE and smoking cessation provide insufficient information for understanding relapse among adolescents. In fact, SE dynamics seem to be even more important to adolescents than their individual differences in SE, which has important implications for intervention that we will discuss below.

Concurrent smoking has been found to be a strong predictor of further postquit smoking and relapse in its own right, at least among adults (Gwaltney et al., in press; Piasecki, 2006; Shiffman et al., 2000). Shiffman and colleagues (2000) proposed that the act of smoking after quitting may reactivate the pharmacological and behavioral addictive processes that were at play before quitting, thus reigniting psycho-physiological barriers to successful cessation. Strikingly, the present results show that among adolescents, smoking on a given day did not predict relapse the next day. This implies that during cessation, as during ad libitum smoking, adolescents’ smoking can be intermittent rather than continuous. This implies that their smoking is not necessarily driven by a need to have nicotine continuously, which in turn implies that therapies like nicotine patches may not be suitable. The few studies available that have tested the effects of nicotine patches among adolescents have not distinguished between initial lapses and relapse, and have found that use of nicotine patches fails as an effective aid in tobacco use cessation (Hanson, Allen, Jensen, & Hetu, 2003; Hurt et al., 2000; Killen, Robinson, Ammerman et al., 2004; Moocolhan, Robinson, Ernst et al., 2005). In the light of the notion
that smoking might reactivate addictive processes, it is possible that when adolescents smoke after achieving abstinence it does not incite when withdrawal symptoms nor prime further smoking to the same extent as in adults. Future research is recommended to test to what extent withdrawal symptoms are evoked by abstinence and postabstinence smoking among adolescents, and whether daily variations in withdrawal symptoms can predict relapse outcomes. Furthermore, the finding that smoking did not predict relapse the next day whereas SE did implies that the effect of SE is not just a side effect of smoking, which could have been possible if smoking had been found to promote further smoking (cf. Baer et al., 1986).

Summarizing, it appears that daily SE operates independently of concomitant smoking and that cognitive processes might even be more important than behavioral addictive processes in understanding relapse among adolescents.

One of the reasons to test dynamic SE in relation to abstinence among adolescents specifically was that adolescence is a developmental phase in which impulsivity, novelty seeking, and suboptimal decision making are considered to be normative traits (Chambers et al., 2003). These characteristics may cause adolescents to deal differently with high-risk situations, and to respond differently to the day-to-day variations in SE. Given that the coefficients of variation (CV; which allow comparison between scales with different response choice ranges) for daily SE between the quit-to-lapse, and lapse-to-relapse intervals appeared higher in the present study than in the study by Shiffman and colleagues (2000), there is some reason to believe that adolescents indeed experience more volatility in their daily SE. Although several methodological issues compel us to be tentative in drawing comparisons between the present study and the ones among adults (Gwaltney et al., 2005; Shiffman et al., 2000), it seems that relapse interventions that are designed for adults and that target SE may be suitable for adolescents as well. However, there may be differences in behavioral and psycho-physiological responses to cessation and postquit smoking between adolescents and adults. More practically, considering that daily variations in SE affected the first lapse, intervention programs for adolescents might need to be active as soon as 24 hours of abstinence is achieved. Interventions could implement cognitive strategies to help adolescents maintain higher and more stable levels of SE. In addition, the finding that changes in daily SE were relevant to both the first lapse and relapse suggest that intervention might be most fruitful if implemented immediately after quitting and to last for at least several weeks. However, despite that some recommendations regarding relapse intervention programs can be suggested, we acknowledge that existing programs that target SE among adults have provided limited success (Lancaster, Hajek, Stead, West, & Jarvis, 2006), and focusing on SE may therefore not guarantee success in adolescents either. Although the treatment effect of targeting SE on a daily basis is unknown, this may improve existing treatments. Moreover, we cannot establish with certainty that SE is the causal agent responsible for lapse and relapse (rather than being a mediator, e.g.), because SE could not be (and was not) systematically manipulated in this study. Conclusively, while crucial information has been brought forward by the present study, important questions remain unanswered. For example, we do not know if and how adolescents’ daily SE responds to external stimuli (such as drinking coffee, caffeine, and alcohol, seeing others smoke) and affect-motivational states (Gwaltney et al., 2005). More fundamentally, we do not understand very well, either for adults or for adolescents, how SE judgments are formed, and further research into situational correlates of adolescents’ daily abstinence SE is needed.

The abovementioned results must be considered in light of the following limitations. First and foremost, roughly half of all assessments were entered on paper diaries, which bears the risk of back-filling or forward-filling where participants fill out a number of questionnaires at once. Studies in which compliance with paper-and-pencil diaries has been tested have revealed high rates of falsification: in adult pain patients, Stone, Shiffman, Schwartz, Broderick, and Hufford (2002) found that subjects often hoarded the diaries and apparently completed them in batches days later, which raises critical questions about timely compliance. In the present study, while the timing of the paper diary reports cannot be ascertained exactly, examination of their subsequent entries online did not reveal the sort of massive problems identified by Stone et al. The majority of paper diary records (60.5%) were subsequently entered online on the same day and, further, were not bunched together at the end of the day. It is less clear how timely the remaining 39.5% of these paper diaries were, but the pattern of same-day entries is somewhat reassuring. To test whether results would differ if all paper entries were excluded from the analyses, we completed the analyses of dynamic SE for progression to the first lapse and to relapse. We found that the effect of dynamic SE on the first lapse remained unchanged, and the hazard ratio for the effect of daily SE on relapse did not change much (although the p value decreased to a trend level). Thus, the use of paper diaries remains an important issue to be reminded of in interpreting the present results. In addition, 24 hours of abstinence was not biochemically verified. However, it was emphasized with the participants that failure to achieve 24 hr abstinence on the target quit day (Day 8) would not be regarded as “failure” by the research team and that participants would not be discontinued if they did not achieve 24 hours of abstinence on the target quit day. The observation that 27.5% of the participants did not show 24 hours of abstinence on the target quit day (as indicated by at least three consecutive reports of nonsmoking) suggests that participants felt the freedom to honestly report whether or not they had smoked for 24 hours. Last, a core component of ecological momentary assessment (EMA) is the intensive self-monitoring, which raises concern about reactivity, particularly when subjects want to change their behavior and are able to exert control over it, which is the case in smoking cessation. Despite continuing concerns about reactivity, the EMA literature shows little evidence of it (Shiffman et al., 2008). Nevertheless, it remains possible that the intensive self-monitoring has contributed to the degree of SE and rates of abstinence success as found in the present study.

In a review on adolescent smoking cessation Mermelstein (2003) stated that the most basic questions about relapse among adolescent ex-smokers still needed to be answered; questions concerning the patterns, timing, and predictors of relapse. In 2008, Gwaltney, Bartolomei, Colby, and Kahler reported that we still know very little about the natural history of quit efforts among adolescents, while such information is crucial to tailor psychosocial and pharmacological treatments to this particular group. Despite the abovementioned limitations, the present study has been the first to use daily measures over an extended period of time to examine smoking cessation and relapse among adolescents. The findings emphasize the role of both the concept of SE and the need to use dynamic formulations and assess-
ments of SE and cessation outcomes among adolescents. Future research on adolescent relapse is encouraged to approach and assess other known determinants of relapse (e.g., withdrawal symptoms, outcome expectations, smoking cues and coping efforts) as dynamic constructs as well.

References


Stone, A. A., Shiffman, S., Schwartz, J. E., Broderick, J. E., & Hufford,


---

**Members of Underrepresented Groups: Reviewers for Journal Manuscripts Wanted**

If you are interested in reviewing manuscripts for APA journals, the APA Publications and Communications Board would like to invite your participation. Manuscript reviewers are vital to the publications process. As a reviewer, you would gain valuable experience in publishing. The P&C Board is particularly interested in encouraging members of underrepresented groups to participate more in this process.

If you are interested in reviewing manuscripts, please write APA Journals at Reviewers@apa.org. Please note the following important points:

- To be selected as a reviewer, you must have published articles in peer-reviewed journals. The experience of publishing provides a reviewer with the basis for preparing a thorough, objective review.

- To be selected, it is critical to be a regular reader of the five to six empirical journals that are most central to the area or journal for which you would like to review. Current knowledge of recently published research provides a reviewer with the knowledge base to evaluate a new submission within the context of existing research.

- To select the appropriate reviewers for each manuscript, the editor needs detailed information. Please include with your letter your vita. In the letter, please identify which APA journal(s) you are interested in, and describe your area of expertise. Be as specific as possible. For example, “social psychology” is not sufficient—you would need to specify “social cognition” or “attitude change” as well.

- Reviewing a manuscript takes time (1–4 hours per manuscript reviewed). If you are selected to review a manuscript, be prepared to invest the necessary time to evaluate the manuscript thoroughly.