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## Momentary Effects of Exposure to Pro-Smoking Media on College Students' Future Smoking Risk

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### Abstract

**Objective**—This study used ecological momentary assessment to examine acute changes in college students' future smoking risk as a function of their exposure to pro-smoking media (e.g., smoking in movies, paid advertising, point-of-sale promotions).

**Methods**—A sample of 135 college students (ever and never smokers) carried handheld computers for 21 days, recording their exposures to all forms of pro-smoking media during the assessment period. They also responded to three investigator-initiated control prompts during each day of the assessment period (i.e., programmed to occur randomly). After each pro-media smoking exposure and after each random control prompt they answered questions that measured their risk of future smoking. Responses between pro-smoking media encounters were compared to responses made during random control prompts.

**Results**—Compliance with the study protocol was high, with participants responding to over 83% of all random prompts. Participants recorded nearly three encounters with pro-smoking media each week. Results of linear mixed modeling indicated that all participants had higher future smoking risk following exposure to pro-smoking media compared with control prompts ( $p < 0.05$ ); this pattern of response did not differ between ever and never smokers ( $p = 0.769$ ). Additional modeling of the variances around participants' risk of future smoking revealed that the response of never smokers to pro-smoking media was significantly more variable than the response of ever smokers.

**Conclusions**—Exposure to pro-smoking media is associated with acute changes in future smoking risk, and never smokers and ever smokers respond differently to these exposures.

### Keywords

Cigarette advertising; smoking; college students; ecological momentary assessment

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Exposure to pro-smoking media, such as to point-of-sale displays, magazine advertising, and portrayals of smoking in movies, increases smoking in adolescents (Wellman, Sugarman, DiFranza, & Winickoff, 2006) and young adults (Rigotti, Moran, & Wechsler, 2005). Cognitive social learning and decision-making theories suggest that exposure to pro-smoking media affects smoking behavior through a gradually unfolding process, whereby

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sequential exposures to pro-smoking media incrementally change and strengthen individuals' risk of smoking over time, for example by gradually strengthening their smoking intentions and eroding their smoking resistance self-efficacy over time. Changes in level of smoking risk over time eventually reach a threshold or "tipping point" after which initial smoking trials begin (DiFranza et al., 2006; Heatherton & Sargent, 2009; Sargent et al., 2002; see also Austin, Chen, & Grube, 2006; Kardes, 1994). This theoretical conceptualization suggests that it is critically important to measure *acute changes* in smoking risk as a function of pro-smoking media exposure to obtain a more complete understanding of the hypothesized sequential process for how pro-smoking media affects smoking behavior. Understanding this process could have important implications for developing and timing interventions to prevent pro-smoking media from exerting its persuasive effects on smoking behavior. This paper reports the results of a study that utilized ecological momentary assessment (EMA; see Shiffman, 2009; Stone & Shiffman, 1994) to measure the effect of acute exposure to pro-smoking media in the "real world" on college students' future smoking risk. Given that so few studies have focused on the effects of pro-smoking media on college students (e.g., Biener & Albers, 2004; Gilpin, White, & Pierce, 2005; Ling, Neilands, & Glantz, 2009; Ridner, Myers, Hahn, & Ciszewski, 2010; Rigotti et al., 2005; Sepe & Glantz, 2002; Song, Ling, Neilands, Glantz, 2007), significantly more research is needed in this domain of inquiry.

Emerging evidence has supported the idea that exposure to pro-smoking media can engage cognitions about smoking in a way that places people at risk for future smoking. For example, exposure to movie smoking is associated with more positive expectancies about smoking and stronger identification with smokers, and these variables, in turn, predict smoking (Tickle, Hull, Sargent, Dalton, & Heatherton, 2006; Wills, Sargent, Stoolmiller, Gibbons, & Gerrard, 2008; Wills et al., 2008). However, this work has not examined acute changes in these putative cognitive mediators as a function of pro-smoking media exposure. Large scale, ecologically valid studies such as these have used global measures of pro-smoking media exposure and measured cognitive mediators of the effects of exposure either concurrently or at some later point in time. In such studies, there is a disconnect between actual exposure to pro-smoking media and measurement of acute changes in target mediators. Laboratory studies that have examined the impact of acute pro-smoking media exposure on hypothesized mediators (e.g. smoking intentions) lack ecological validity (e.g., Pechmann & Knight, 2002; Shadel, Martino, Setodji, Haviland, & Scharf, in press; Shadel, Tharp-Taylor, & Fryer, 2008). As such, there is a need for research to utilize ecologically valid studies and designs that can closely examine how exposure to pro-smoking media acutely affects future smoking risk.

Exposure to pro-smoking media affects individuals differently, depending on their level of experience with smoking. Although exposure contributes to smoking initiation (Dalton et al., 2003), progression to more established smoking (Sargent et al., 2007), and serves as a "cue" to smoke for established smokers (Lochbuehler, Engels, & Scholte, 2009), the effects of pro-smoking media on the progression from never smoking to experimental smoking are stronger than the effects of pro-smoking media on the progression from experimental smoking to regular smoking (Wellman et al., 2006). These differences are thought to be a consequence of increasing engagement of processes relating to nicotine dependence as level of smoking increases (Flay, Snyder, & Petraitis, 2009; Shadel & Scharf, in press). That is, early smoking trials are thought to be governed by socio-environmental variables such as exposure to cigarette advertising and marketing whereas progression to heavier levels of smoking are thought to be governed by processes related to nicotine dependence (e.g., craving, withdrawal, cue reactivity; see Shadel et al., 2000).

Differences in how ever and never smokers respond to pro-smoking media may be observed in two ways (see Hertzog & Nesselroade, 2003). First, differences in responsiveness to pro-smoking media may be observed as differences between ever and never smokers in overall mean levels of variables that index future smoking risk (e.g., smoking intentions and smoking resistance self-efficacy; Choi, Gilpin, Farkas, & Pierce, 2001; Tucker, Ellickson, & Klein, 2002; Wakefield et al., 2004) or in smoking behavior; mean level differences are the more commonly measured outcomes (see Wellman et al., 2006). Second, differences in responsiveness to pro-smoking media may be observed in the level of variability around future smoking risk between ever and never smokers; this outcome has not been investigated in this domain of inquiry. To the extent that the development of nicotine dependence resembles a developmental process (Flay et al., 2009; Shadel & Scharf, in press; Shadel et al., 2000), mean differences between individuals who have different levels of experience with smoking may only provide partial insight into underlying processes (see Hertzog & Nesselroade, 2003). Indeed, in a recent study, Hedeker and colleagues (2009) found that adolescents' level of smoking was related both to their mean mood levels (i.e., adolescents experienced less negative affect when they smoked compared to during random prompts) and to their level of variance in mood (i.e., adolescents experienced less mood variability as their level of smoking increased). The differences in variability were taken as evidence of the development of tolerance: mood came under increasing control of smoking as levels of smoking increased, leading to less mood volatility. Extending these findings to the current context, then, never smokers would be hypothesized to demonstrate greater variance in their response to exposure to pro-smoking media whereas ever smokers would be hypothesized to demonstrate less variance. Differences in degrees of variability in future smoking risk would be expected theoretically because pro-smoking media should have more control over never smokers' cognitions about smoking (i.e., risk of smoking as indexed by smoking intentions and smoking resistance self-efficacy) compared to ever smokers whose smoking is theorized to be controlled more by factors relating to nicotine dependence (Shadel et al., 2000).

In the current study, college students carried a handheld computer with them for 21 days to record their exposures to pro-smoking media on each of those 21 days (i.e., what kind of advertising they saw, where they were exposed; see Martino, Scharf, Setodji, & Shadel, in press). They answered questions that indexed their future smoking risk immediately after each instance of exposure to pro-smoking media. They also answered these same future smoking risk questions in response to control prompts during the 21-day study period; the control prompts occurred at random moments when there was no exposure to pro-smoking media. Using a within subjects design (e.g., Shiffman et al., 2002; see Shiffman, 2009), then, we examined whether college students' future smoking risk was higher following exposure to pro-smoking media than in response to control prompts. We also examined whether students' smoking status moderated this effect. We expected that never smokers would respond more strongly to pro-smoking media than would ever smokers, and that this stronger response would be evidenced both by a larger difference in their mean risk of future smoking between moments of pro-smoking media exposure and control moments as well as by greater variability in their future smoking risk in response to pro-smoking media exposures compared to control moments.

## Methods

### Participants

Individuals were eligible to participate in this study if they were between 18 and 24 years old and an undergraduate currently enrolled in college. Regular daily smokers were excluded because pro-smoking media are theorized to be more relevant for individuals in the early stages of smoking (Flay et al., 2009; Shadel & Scharf, in press; Wellman et al., 2006). Of the 158 scheduled for a baseline visit, 142 attended. Three individuals dropped out or

were dismissed from the study due to poor compliance with the EMA protocol. Data from four participants were completely lost due to hardware malfunction. Thus, the total sample available for analysis was  $n = 135$ .

This sample consisted of never smokers (never smoked, even a puff;  $n = 52$ ) and ever smokers (reported any level of past smoking;  $n = 83$ )<sup>1</sup>. Ever smokers ( $M$  age = 21.3;  $SD = 1.6$ ) were older than never smokers ( $M$  age = 20.4,  $SD = 1.4$ ;  $p < .01$ ), less likely to be female (56% vs. 73%;  $p < .05$ ), more likely to be Caucasian (73% vs. 56%), less likely to be African American (16% vs. 37%), less likely to be Asian (2% vs. 7%), and more likely to be of another or multiple races (8% vs. 0%) ( $p < .01$ ). Only 37% of ever smokers reported smoking in the past month. Ever smokers who smoked in the past month smoked an average of 6 days in the past month ( $SD = 4.4$ ) and an average of 2.2 ( $SD = 1.3$ ) cigarettes on the days that they smoked.

## Procedures

The study was approved by the Human Subjects Protection Committee at the RAND Corporation. Data collection for the study took place between June 2010 and January 2011. Participants were recruited by advertising in university newspapers and in weekly arts and entertainment newspapers. The recruitment advertising contained no information about smoking or pro smoking-media; individuals responded to an advertisement that had the generic stated goal of using “cell phones to study advertising”. Individuals who responded to the advertising completed a brief telephone screening to determine eligibility. If they met the inclusion/exclusion criteria, they were invited to attend a baseline session. Individuals provided written informed consent at the baseline session after the study was explained to them and all of their questions were answered.

They then received information about the study protocol and were trained in using handheld devices (see device description below) to collect information about their exposure to pro-smoking media (see training procedures below). Participants were provided with additional materials upon exiting the baseline session (e.g., small printed training manual that fit within the handheld carrying case; 24 hr help-line phone number for problems and technical support). They returned all of these materials with the handheld device at the end of their participation.

Participants carried the handheld devices with them for 21 days to record their exposures to pro-smoking media (i.e., what kind of media they saw, where they were exposed; see Martino et al., in press) on each of those 21 days. They answered questions that indexed their future smoking risk immediately after each pro-smoking media exposure entry. They also answered questions about their future smoking risk in response to investigator-programmed random prompts (three per day) during the study measurement period (control prompts). The control prompts were programmed such that they would occur at random times between the hours of 10am and 10pm; none of the control prompts used in the current study occurred in proximity to pro-smoking media exposures. Participants were paid a total of \$8/day or \$168 total for each day of EMA assessment, and \$10 each for the baseline and end of study visit. They were paid an additional \$2/day if they responded to all of the random control prompts on that day within two minutes of the prompt. Thus, participants could be paid up to \$230 if they completed all aspects of the study and adhered closely to the study protocol.

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<sup>1</sup>Ever smokers with and without past month smoking were combined as a single group in the analyses for the sake of parsimony and because the results were essentially unchanged when a three smoking group categorization was utilized.

## EMA Training

During the baseline session, all participants completed a 60-minute training on using the handheld devices and on the study protocol. Each participant was provided with a unique handheld device to accompany the training and instruction and for the duration of their participation in the study. They were instructed: 1) to turn the device on when they awoke in the morning; 2) to take the device with them everywhere they went; 3) to respond to random prompts and to enter any encounter with pro-smoking media, answering all questions posed to them by the device; and 4) to turn the device off at night when they retired for bed, charging it during the time that they slept.

Our definitions of pro-smoking media were based, in part, on definitions advanced by the Federal Trade Commission (FTC, 2011). *Media advertising* was broadly construed as advertisements in the following outlets: newspapers; magazines; outdoors (i.e., includes billboards, signs and placards in arenas, stadiums, and shopping malls; and any other advertisements placed outdoors, regardless of its size); retailer point-of-sale advertisements (i.e., those inside or outside of cigarette retailer property); and advertisements placed in adult-oriented (i.e., bars) and general audience entertainment/recreational venues (e.g., concerts). *Promotional materials* included direct to consumer coupons; general consumer mailings; and branded and non-branded products (e.g., shirts). Promotional materials also included retailer incentives that permit cigarettes to be purchased at less than retail price; although this is not an advertisement per se, the consequence of these incentives may result in advertised sale prices at a point of sale location (e.g., a window display for two for one special on cigarette packs). As such, signs that promoted discounted products were included. *Sponsorships* included concert or sports event support, or support of individual athletes or musicians/actors. Although direct endorsements and internet advertising (i.e., not on a company website) are not supported by money from the tobacco industry (according to the FTC report), we assessed exposure via these means (e.g., sponsored on social networking sites; on YouTube). Similarly, we assessed exposure to smoking in movies and television programs even though the tobacco industry denies product placement in films and television programs; these outlets are under increasing scrutiny as potential media outlets through which individuals are exposed to cigarettes and smoking (see Wellman et al., 2006). Participants were provided with multiple visual representations of each form of advertising during training (via PowerPoint). Descriptive information on the frequency of exposure to these different types of pro-smoking media and validity information has been provided elsewhere (Martino et al., in press).

## EMA Assessments

After encounters with pro-smoking media and at random prompts, participants answered questions that indexed their future smoking risk. Future smoking risk was assessed using a reliable 3-item scale adapted from items used by Choi and colleagues (2001): “Do you think you will try a cigarette anytime soon;” “Do you think you will smoke a cigarette anytime in the next year;” and “If one of your best friends offered you a cigarette, would you smoke it?” Responses to these questions were made on a 1 (Definitely Not) to 10 (Definitely Yes) scale and averaged to produce a total future smoking risk scale score (range from 1 – 10), where higher scores indicate higher risk of future smoking. This set of items, conceptualized as an index of future smoking risk, is a potent predictor of future smoking (Choi et al., 2001).

## Handheld Devices and Software

Data were collected on Palm® Treo 755p smart phones. These devices ran the Palm OS Garnet v5.4.9 and used a 312 MHz Intel PXA270 processor. Data could be entered either via touch-screen or using a stylus. The Pendragon 5.1 forms application was programmed to

collect the pro-smoking media exposure events and random event data (<http://pendragonsoftware.com/index.html>).

## Results

### Descriptive Information and Protocol Compliance

Across the 21-day EMA monitoring period, participants reported an average of 8.24 ( $SD = 7.85$ ) exposures to pro-smoking media, or nearly three exposures per week. The total number of pro-smoking media exposures across all participants during the monitoring period was 1,112. Nearly 66% of all exposures occurred at point-of-sale locations and via exposure in movies and on television (20%). There were no differences in the number of reported pro-smoking media exposures between ever and never smokers, and no differences in media outlet for exposure between ever and never smokers. Additional information on the context and outlets of these exposures, the brands to which participants were exposed, and about the validity of using EMA methods to collect information on exposure to pro-smoking media can be found in Martino et al. (in press).

A key index of compliance in EMA studies is how reliably participants respond to randomly triggered prompts (Shiffman, 2009). In the current study, participants responded to a total of 6,902 random prompts during the monitoring period, a compliance rate of 83% (i.e., they did not respond to 17% of the random prompts issued). Of the completed random prompts, over 95% were completed within two minutes. These data indicate a high level of compliance with the study protocol and compare favorably with other EMA studies of college-aged populations (Piasecki, Richardson, & Smith, 2007) and of other populations (see Shiffman, 2009).

### Responses to Pro-Smoking Media

We used the analytic methods proposed by Hedeker and colleagues (Hedeker et al., 2009) to compare responses between random control prompts and pro-smoking media exposures and to determine whether never smokers and ever smokers responded differently. The linear mixed model we used related individual pro-smoking media encounters to the measure of future smoking risk while accounting for participant characteristics and the overall frequency of encounters with pro-smoking media. Above and beyond modeling average change in measures of future smoking risk as a function of pro-smoking media encounters, person-to-person variability in this effect was also modeled as a function of participants' smoking status (ever vs never smoker). Formally, the Hedeker et al. (2009) method specifies the following model:

$$\begin{aligned}
 \text{Smokingrisk}_{it} &= (\beta_0 + \mu_{0i}) + (\beta_1 + \mu_{1i}) \text{Event}_{it} + \beta_2 \text{AvgEvent}_i + \beta_3 X_{it} + \varepsilon_{it} \\
 \mu_{0i} &\sim N(0, \sigma_{0i}^2), \quad \mu_{1i} \sim N(0, \sigma_{1i}^2), \quad \text{Cov}(\mu_{0i}, \mu_{1i}) = \sigma_{01} \\
 \sigma_{0i}^2 &+ \exp(\alpha_{00} + \alpha_{01} W_i), \quad \sigma_{1i}^2 = \exp(\alpha_{10} + \alpha_{11} W_i)
 \end{aligned}$$

In this model, the outcome  $\text{Smokingrisk}_{it}$  is person  $i$ 's future smoking risk recorded at time  $t$ . The variable  $\text{Event}_{it}$  represents either a random control prompt (coded as 0) or an encounter with pro-smoking media (coded as 1).  $\beta_1$  is the overall population slope, which estimates the average change in future smoking risk as a function of exposure to pro-smoking media.  $\mu_{1i}$  is the slope deviation for person  $i$ ; it measures how person  $i$ 's response to pro-smoking media (in terms of change in future smoking risk) differs from the overall population response. The heterogeneity of change in smoking risk associated with exposure to pro-smoking media is characterized by  $\sigma_{1i}^2$ . The variance parameter  $\alpha_{11}$  indicates the degree to which smoking status influences variation in exposure-related change in future smoking

risk, with  $\alpha_{11} > 0$  suggesting that the person-to-person variability in exposure-related change in future smoking risk is greater for never smokers compared to ever smokers. Similarly,  $\beta_0$  estimates the average future smoking risk in the population when there is no pro-smoking media exposure and the individual deviation from this average is estimated by  $\mu_{0i}$ . Individual variation in future smoking risk in this non-exposure setting is characterized by the variance parameter  $\sigma_{0i}^2$ , which is also assumed to differ between ever and never smokers. The variance parameter  $\alpha_{01}$  indicates the degree to which individual variation in future smoking risk in situations of non-exposure to pro-smoking media depends on smoking status.  $\alpha_{01} > 0$  indicates greater variability for never smokers compared to ever smokers. In addition, and as noted, the models controlled for a number of participant-level variables (characterized by  $X_i$ ) measured at time  $t$  that could have an impact on future smoking risk. All of the control variables have been associated with responses to smoking-related media: overall pro-smoking media exposures and smoking status (Wellman et al., 2006), gender (DiRocco & Shadel, 2007), race (Hafez & Ling, 2006), and whether the exposure occurred on a weekend or a weekday (Martino et al., in press). An interaction between smoking status and exposure to smoking-related media was evaluated in this model as well, given that overall mean levels of future smoking risk are hypothesized to differ by exposure and by smoking status.<sup>2</sup>

Table 1 presents the results of these analyses. Participants experienced higher mean levels of their future smoking risk in response to pro-smoking media compared to randomly sampled moments ( $\beta = 0.11, p < .05$ ). The adjusted mean level of future smoking risk for pro-smoking media event exposures was 3.14 ( $SD = 2.62$ ) and the adjusted mean level of risk for randomly sampled control moments was 2.63 ( $SD = 2.35$ ). Never smokers experienced lower overall levels of future smoking risk ( $\beta = -2.35, p < .001$ ). The adjusted mean level of future smoking risk for never smokers was 1.24 ( $SD = 1.02$ ) and the adjusted mean level of risk for ever smokers was 3.56 ( $SD = 2.55$ ). The lack of a significant interaction between smoking status and pro-smoking media exposure ( $\beta = -0.04, p = .769$ ), indicates that ever smokers and never smokers experienced similar mean increases in their future smoking risk in response to pro-smoking media compared to random control times of the day. Participants' smoking status was, however, associated with variability in their future smoking risk at times of pro-smoking media exposure as well as at the random prompts. Compared to ever smokers, never smokers reported greater (about 7 times more) variability in their future smoking risk in response to pro-smoking media ( $\alpha = 1.91, e^\alpha = 6.75, p < .001$ ) and less variability (about 11 times less) in their future smoking risk in response to random control prompts ( $\alpha = -2.37, e^\alpha = 0.09, p < .001$ ).

## Discussion

This study utilized EMA to examine acute changes in college students' future smoking risk in response to their exposure to pro-smoking media compared to control prompts, and evaluated the extent to which their prior experiences with smoking moderated both the overall mean level of these changes as well as the variability around those changes. Exposure to pro-smoking media was associated with higher overall mean levels of future smoking risk in all individuals, regardless of their level of experience with smoking. This finding is generally consistent with the extant literature. Although the effects of exposure to pro-smoking media are stronger when moving individuals from never smoking to ever smoking (Wellman et al., 2006), it is true that pro-smoking exposure contributes independently to both smoking initiation (Dalton et al., 2003) and progression to established

<sup>2</sup>Previous iterations of the analyses controlled for time of day of exposure and the results were unchanged; previous analyses also matched the random prompts to the pro-smoking media event prompts on characteristics like time of day and context and found that it made no difference in outcome. As such, we opted for a simpler, more straightforward approach to presenting the results.

smoking (Sargent et al., 2007). Moreover, ever smokers in our sample had relatively little experience with smoking and smoked at very low rates (i.e., a total of less than a week of smoking about 8 cigarettes in the past month). In this context, it may not be surprising that smoking status failed to moderate the effects of exposure on mean levels of future smoking risk.

However, despite the relatively low levels of smoking in ever smokers in this sample, smoking status was associated with level of variability in future smoking risk in response to pro-smoking media: The response of never smokers to pro-smoking media was significantly more variable than the response of ever smokers. This finding is consistent with the theoretical position that individuals with heavier levels of smoking (even experimental smoking) are thought to be controlled more by processes related to nicotine dependence which may necessarily restrict variability in responding to socio-environmental stimuli like pro-smoking media (Flay et al., 2009; Shadel & Scharf, in press). Alternatively, pro-smoking media may have functioned as a conditioned smoking cue in ever smokers (because they had previous experience with smoking) and thus contributed to more uniform, focused levels of risk responding (see Lochbuehler et al., 2009; Upadhyaya, Drobles, & Thomas, 2004). Never smokers, in contrast, are thought to be controlled more by socio-environmental variables such as exposure to cigarette advertising and marketing (Flay et al., 2009; Shadel & Scharf, in press), which may contribute to more variability in their levels of risk responding. For example, individual never smokers may have responded differently to the diversity of pro-smoking media to which they were exposed (e.g., point-of-sale, movie smoking), contributing to increased variability. In any case, the increased level of variability among never smokers suggests that their levels of risk may be particularly susceptible to incremental change over time as a function of exposure to pro-smoking media in a way that influences later smoking trials (see DiFranza et al., 2006; Heatherton & Sargent, 2009; Sargent et al., 2002).

Alternative explanations that expand beyond this broad conceptual frame are possible. For example, never smokers and ever smokers are thought to differ biologically from one another in important ways (Shadel & Scharf, in press) and such individual differences could have contributed to the observed differences in smoking risk variability as a function of exposure to pro-smoking media. For instance, basic differences in brain circuitry involved in reward sensitivities and reward processing may differ between ever and never smokers and could promote differences in how each responds to the (generally positive) stimulus features associated with pro-smoking media (see Sargent et al., 2007; see also Fischer, Greitemeyer, Kastenmuller, Vogrincic, & Sauer, 2011; Stephenson & Southwell, 2006). In any case, future research needs to pursue the specific theoretical mechanisms that contribute to individuals' responses to pro-smoking media and the individual difference factors that determine who is most responsive to it.

This research is distinguished by its focus on college students. The vast majority of research has focused on the effects of pro-smoking media exposure on middle and high school students (see Wellman et al., 2006). The majority of the research on college students' exposure to cigarette advertising and marketing has measured college students' exposure to promotions in bars and pubs (Biener & Albers, 2004; Gilpin et al., 2005; Ridner et al., 2010; Rigotti et al., 2005; Sepe et al., 2002). Two cross sectional studies have found that increased exposure to smoking in movies (Song et al., 2007) and receptivity to cigarette advertising and marketing (Ling et al., 2009) are related to increases in smoking in college students and young adults. Above and beyond findings from these studies, very little is known about how cigarette advertising and marketing (pro-smoking media) affect college students. This study makes a contribution to this literature in this regard.



There are limitations to this study that need to be considered. First, EMA as an assessment technique has limitations (see Piasecki et al., 2007); a commonly cited limitation is that EMA requires a technologically sophisticated sample that is motivated to carry handheld data collection devices. Second, this study only covered a three week “snapshot” of college students’ exposure to pro-smoking media; it is not known how the changes observed in smoking risk would influence dynamic changes in smoking behavior over time, for example to predict (possibly repeated) changes in smoking uptake and desistence over the long term. Relatedly, it is important to note that this study did not establish a relationship between acute changes in smoking risk and actual smoking behavior. Third, although participants recorded a non-trivial number of exposures to pro-smoking media that would not be captured with generic, broad-based questions about exposure (see Martino et al., in press for details) and there was a high level of compliance with the study protocol, it is possible that not every encounter with pro-smoking media was recorded. Fourth, all of the measures used during EMA were self-report; different results may have been obtained if implicit or behavioral measures were used (e.g., see Dal Cin, Gibson, Zanna, Shumate, & Fong, 2007). Finally, this study provided information on a college-aged sample; it is not known whether similar relationships would be found with younger adolescents or older adults.

Nonetheless, this study provides important information about the extent to which exposure to pro-smoking media is associated with acute changes in future smoking risk in college students. These findings support the notion that there is likely value in targeting all young adults, regardless of their level of smoking experience, with smoking prevention interventions that include media literacy (e.g., Primack, Fine, Yang, Wickett, & Zickmund, 2009), but that different processes may need to be targeted in ever and never smokers. More broadly and taken together with other recent research (Hedeker et al., 2009; Weinstein, Mermelstein, Shiffman, & Flay, 2008), the current research highlights the importance of investigating both means and variances in studies that relate to the development of nicotine dependence. Future research should move toward a more fine-grained level of analysis to obtain a more complete understanding of how exposure to pro-smoking media affects smoking uptake.

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**Table 1**

Results predicting future smoking risk from pro-smoking media exposure events versus random prompts.

Model Effects	Estimate (S.E.)	<i>p</i>
Average Change Estimates (Fixed Effects)		
Intercept	3.10 (0.30)	< 0.001
Smoking Media Exposure <sup>a</sup>	0.11 (0.06)	< 0.050
Never smoker <sup>b</sup>	-2.35 (0.29)	< 0.001
Smoking media exposure X never smoker	-0.04 (0.14)	0.769
Mean smoking media exposures	3.40 (0.71)	< 0.001
Female <sup>c</sup>	0.03 (0.22)	0.884
Minority Status <sup>d</sup>	0.17 (0.20)	0.405
Weekend <sup>e</sup>	0.04 (0.02)	< 0.050
Variance Component Estimates		
Smoking Risk at Random Prompt		0.033
Intercept ( $\alpha_{00}$ )	1.76 (0.16)	<0.001
Never Smoker ( $\alpha_{01}$ )	-2.37 (0.28)	<0.001
Smoking Risk at Pro-Media Exposures		
Intercept ( $\alpha_{10}$ )	-2.28 (0.36)	<0.001
Never Smoker ( $\alpha_{11}$ )	1.91 (0.44)	<0.001
Covariance between intercept and exposure	-0.11 (0.08)	0.142
Error variance	0.65 (0.01)	<0.001

Notes. Number of observations = 7,649.

<sup>a</sup>Exposure to smoking media event vs random prompt (random prompt is the reference category)

<sup>b</sup>Never smoker vs ever smoker (ever smoker is the reference category)

<sup>c</sup>Female vs male (male is the reference category)

<sup>d</sup>Minority vs nonminority (nonminority is the reference category)

<sup>e</sup>Weekend (Friday, Saturday, Sunday) vs Weekday (Monday, Tuesday, Wednesday, Thursday) (Weekday is the reference category)