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The Role of Sensation Seeking and R-rated Movie Watching in Early Substance Use Initiation

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Abstract

Adolescence is a time of heightened impulsivity as well as substantial exposure to the effects of popular media. Specifically, R-rated movie content and sensation seeking have been shown to be individually and multiplicatively associated with early alcohol initiation, as well as to mutually influence one another over time. The present study attempts to replicate and extend these findings to cigarette and marijuana use, considering several peer, parental, and individual correlates, as well as substance-specific movie exposure, among 1023 youth (mean age 12.4 years, 52% female), using a combination of cross-lagged path models, latent growth models, and discrete-time survival models. Changes over time were associated between R-rated movie watching and sensation seeking, and both individually, not multiplicatively, predicted earlier alcohol initiation. R-rated movie watching (but not sensation seeking) also predicted earlier smoking and marijuana initiation. Parental R-rated movie restriction may thus potentially delay smoking and marijuana initiation as well as adolescent drinking.

Keywords

R-rated movies; alcohol use; sensation seeking; smoking; marijuana use; adolescents

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Author's Contributions

Authors are Tim Janssen, Melissa J. Cox, Mike Stoolmiller, Nancy P. Barnett, and Kristina M. Jackson. TJ, MC, MS, NB, and KJ have each made a substantial contribution to the conception, design, gathering, analysis, or interpretation of data and a contribution to the writing and intellectual content of the article. All authors have read and approved the final manuscript for submission.

Conflicts of interest

The authors report no conflict of interests.

Compliance with Ethical Standards

Ethical approval

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent

Informed assent was obtained from all individual participants included in the study, and informed consent was obtained from their parents.

Introduction

A great deal of research is focused on delaying initiation of alcohol use in an effort to reduce underage drinking, with research seeking to understand the joint influence of etiologically relevant internal and external factors (Hawkins et al. 1992). On the side of internal influences, risk-associated personality differences such as high levels of sensation seeking have been associated with early alcohol initiation (Janssen et al. 2014). On the side of external influences, exposure to age-inappropriate content from media, including R-rated movies, has been linked to earlier alcohol initiation, potentially through positive depiction of alcohol use and cigarette smoking in these movies (Sargent et al. 2007; Stoolmiller et al. 2010). Importantly, beyond the unique effects of these factors, multiplicative effects are possible, reflecting the notion that individual and environmental forces interact to shape behavior (Bronfenbrenner and Morris 2006). This idea is supported by prior work on media influences (De Leeuw et al. 2008; Slater et al. 2006; Stoolmiller et al. 2010) demonstrating media's association with both personality and adolescent substance use. Hence, it is important to establish whether R-rated movies and sensation seeking are reciprocally related over time during adolescence, and whether they uniquely or interactively predict initiation of alcohol use, cigarette smoking and marijuana initiation, controlling for additional peer-, parent-, and individual-level correlates of substance use initiation.

The Role of R-rated Movie Watching in Adolescent Substance Use Initiation

The *Motion Picture Association of America (MPAA)* film rating system is a voluntary system in the U.S. that classifies a film's suitability for certain audiences based on the film's content. The classification of R-rated movies, which is defined as "Restricted – under 17 requires accompanying parent or adult guardian", generally marks inclusion of violent, sexual, and adult content matter, including substance use. The R-rated classification therefore serves as a suggestion to restrict adolescent viewing of these movies on that basis. Despite this restriction, studies have shown that either due to parental permissiveness, or through circumventing restriction, a substantial proportion of adolescents report having access to R-rated movies (Sargent et al. 2008) and routinely indicate having seen R-rated movies in the previous year (from 35% at age 10 years, to 72% at age 14 years; Worth et al. 2008). Furthermore, exposure to substance use in films is pervasive, even in films intended for younger audiences (Dal Cin et al., 2008; Polansky et al., 2016; Sargent et al. 2006). Largely, depictions of substance use are positive in nature, with a low proportion of negative representations of use (Sargent et al. 2006; Roberts et al. 1999).

Social cognitive theory suggests that children imitate behaviors they observe elsewhere, particularly when such behaviors are portrayed as realistic and rewarding (Bandura 1994). Thus, witnessing positive portrayals of substance use in media heightens an adolescent's risk for using substances themselves. Indeed, exposure to favorable depictions of substance use has been associated with early initiation of both alcohol and cigarette use (Sargent et al. 2006, Sargent et al. 2004), and the 2012 Surgeon General's report on preventing tobacco use concluded that the evidence was sufficient to establish a causal effect (US Department of Health and Human Services 2012). Beyond the specific effects on substance use, media exert broader influences on risky behavior based on the seemingly personal connections

children make to characters in the media. Superpeer Theory states that children and adolescents identify with behavior from larger-than-life characters that fulfill the role of “super-peers” in terms of their influence on social cognitions (Brown et al. 2005; Strasburger et al. 2009). Such perceptions of these characters normalize inherently risky behavior, leading to a higher likelihood of youth engaging in the risk behavior themselves and/or believe it to be socially acceptable conduct. Adolescents may be particularly vulnerable to the effect of exposure to media, given that adolescence is a developmental period marked by increased proneness to risky activity and a temporary peak in sensation seeking (Littlefield et al. 2014; 2016; Shulman et al. 2015; Steinberg et al. 2008).

The Role of Sensation-seeking in Adolescent Substance Use Initiation

The link between sensation seeking and early substance use is well established. A wide body of literature supports associations between sensation seeking and alcohol use, including initiation of alcohol use (see a meta-analysis by Stautz and Cooper 2013; also see Hittner and Swickert 2006), smoking (Bloom et al. 2014), and marijuana use (VanderVeen et al. 2016). Research suggests that sensation seekers are drawn to exciting and risky experiences that compensate for a differential sensitivity to reward (Cservenska et al. 2013). High sensation seekers are thus predisposed to experimentation with substances, as contact with these substances provides novel and stimulating experiences for the adolescent for whom use of alcohol, cigarettes, and marijuana is illegal and deviant.

Joint influences of R-rated movie watching and sensation-seeking on adolescent substance use initiation

Although prior work has supported media as an external-level influence and personality as an individual-level influence on subsequent risk behavior, little work has explored their joint influence on adolescent problem behavior, despite theoretical notions of interactions between the individual and the environment (Bronfenbrenner, 1979). Development is thought to occur as a continual process of mutual exchange between an individual and his or her environment (Bell 1968; Kuczynski et al. 1997; Sameroff and Mackenzie 2003). These developmental models posit a continuous interdependency between an individual and social change processes (Lerner and Spanier 1978). Applying this notion to our study of sensation seeking and media influences, youth who are high on sensation seeking may seek out risky environments, such as a media environment that supports substance use and other risky behavior. At the same time, a risky media environment may lead to increases in sensation seeking, as adolescents may mimic behavior from sensational characters in such media.

Tanski, Stoolmiller, Gerrard & Sargent (2011) advanced the “swing voter” hypothesis to explain accumulating evidence of a variety of interactions of media influence with personality, including sensation seeking, and other external influences on teen substance use initiation. The basic idea of the “swing voter” hypothesis is that there are pre-teens who are already at low and high risk of substance use initiation for a variety of reasons (e.g., sensation seeking, self-control, academic achievement, parent use, peer use, etc.) and both of these groups of pre-teens may not be very susceptible to risky media influence, but for very different reasons. In contrast, a sizeable proportion of pre-teens are not strongly predisposed to either avoid or try substances as they enter adolescence and these teens, like swing voters,

could be more easily swayed by the positive depictions of substance use that they see in entertainment media.

Two studies have examined the joint prediction of adolescent substance use outcomes by risky media content and personality. Wills and colleagues (2010) found that sensation seeking and movie smoking/alcohol exposure and advertising were predictive of subsequent alcohol and tobacco use; further, high self-control reduced the influence of adverse media influences on adolescent tobacco and alcohol use. Pertinent to the present study, Stoolmiller and colleagues (2010) investigated developmental links between R-rated movie exposure and sensation seeking. Their results indicated that these two variables predicted alcohol initiation and that there was a multiplicative effect between the two such that the predictive effect of R-rated movie watching on alcohol initiation was larger for those low rather than high on sensation seeking. Their results also showed that R-rated movie watching and sensation seeking prospectively predicted increases in each other over time, and that developmental increases in each were associated with each other, supporting the idea of a dynamic interplay between individual and environmental factors. These results suggest that both processes may be malleable, and that adolescents may actively shape their environments which in turn actively shape them. Finally, previous work by Stoolmiller and colleagues (2010) demonstrated that R-rated movie watching and sensation seeking offer two crucial predictors of early substance use, and that they may reciprocally influence each other over the course of adolescent development (Slater et al., 2004; 2007). Additionally, it has been shown that these processes may interact in their prospective prediction of substance use, such that for lower levels of sensation seeking, R-rated movie watching exerted a greater effect (Stoolmiller et al., 2010; Sargent et al., 2007).

Current Study

The current study sought to extend work on the “swing voter” hypothesis by attempting to replicate the findings of Stoolmiller et al. (2010) regarding the joint development of sensation seeking and R-rated movie watching and their prediction of drinking, and to extend these findings to examine the initiation of cigarette and marijuana use. Additionally, we provide further control for several well-established peer, parental, and individual correlates of substance use outcomes to investigate whether influences on substance use are indeed solely attributable to individual differences in sensation seeking and R-rated movie watching and substance use as an outcome.

Based on the earlier research demonstrating the developmental link between R-rated movie watching and sensation seeking, we hypothesized that (1) R-rated movie watching and sensation seeking would influence each other reciprocally, such that higher values of one would predict subsequent increases in the other, and vice versa. Further, based on previously observed linear trends in the development of both constructs over time, we hypothesized that (2) greater linear growth over time in one would be associated with greater linear growth in the other. Finally, based on the assumption that R-rated movie watching and sensation seeking form a unique developmental risk factor that applies to substance use broadly, we hypothesized that (3) both R-rated movie watching and sensation seeking would predict earlier initiation of alcohol use, smoking, and marijuana use, controlling for known peer,

parental, and individual correlates of substance use initiation, and investigated whether their effect was interactive. Based on the “swing voter” idea and the prior study of Stoolmiller et al. (2010) we hypothesize that the interactions will be negative such that low sensation seekers are most vulnerable to media influence and that based on problem behavior theory (Jessor 1987) which implicates common deviance/externalizing factors underlying adolescent substance use, this will be true for all 3 substances.

Methods

Participants

Our data were taken from a sample of 1,023 middle school youth enrolled in an ongoing prospective study on drinking initiation and progression (see Jackson et al. 2014; 2015). At enrollment the sample was 52% female, 24% non-White (5% Black, 3% Asian, 2% American Indian, 8% mixed race, 6% other), 12% Hispanic, and was comprised of roughly equal numbers of 6th, 7th, and 8th graders (33%; 32%; 35%, respectively). Mean age at enrollment was 12.5 years (range: 10–15, *SD* = 0.95).

Procedure

Participants were recruited from six local middle schools (one urban, two rural, three suburban) which were enrolled in five school cohorts on a semi-annual basis in the state of Rhode Island. Information about the study was disseminated to students via mail and through teachers, and interested students whose parents provided consent were invited to participate in an after-school orientation session during which they completed a 45-minute baseline survey; participants received \$25 at the end of the session. The sample was largely representative of the schools from which they were drawn with respect to sex and grade, but was more racially diverse than the school populations but also less disadvantaged (see Jackson et al. 2015). A Certificate of Confidentiality was obtained from NIAAA to preserve participant confidentiality. The sample was reflective of the urbanicity of the state of Rhode Island overall.

Participants completed a total of five semi-annual surveys across two years and a follow-up survey one year later; subsequent to this (at the point of re-funding by NIH), surveys were administered on a quarterly basis. All surveys were web-based. In the current study, we used data from three surveys that contained assessments of R-rated movie watching and sensation seeking. The first survey was administered on average one year after enrollment (Wave 1, W1; mean age 13.7 years); subsequent surveys were two (Wave 2, W2; mean age 14.9 years) and three (Wave 3, W3; mean age 16.11 years) years later. For the substance-use outcomes, we used data from one year after the final movie assessment (Wave 4, W4; mean age 17.1 years). Thus, each participant contributed four time points for the present study. For further detail about the study design, see Appendix A. Participants received \$20 for completion of each of these surveys. Response rates were 86% (Wave 1), 81% (Wave 2), 80% (Wave 3), and 71% (Wave 4). Compared to characteristics of the full sample at the time of enrollment, non-response at Wave 1, 2, 3, or 4 was associated with greater age (12.4 years old at enrollment for those with data, versus 12.8 years old for those without data; $t(1021) = -2.75$, $p < .01$) and with being male ($\chi^2(1) = 7.42$, $p < .01$), but not with race, ethnicity, or lunch

subsidy use. In addition, one self-selected parent or guardian completed a 30-minute paper-and-pencil survey at baseline; parents/guardians received a \$30 store gift card for survey completion. Parent-report was obtained from 90% of the study sample (86% were the biological mother).

Measures

Demographic factors—Students reported their date of birth (used to calculate age), gender, racial group, and ethnicity at enrollment. At the same time, parents indicated whether the child received lunch subsidy (reduced- or free lunch).

R-rated movie watching—A validated measure of R-rated movie watching (Sargent et al. 2008) was administered at W1 to W3. This instrument was identical to the one used in Stoolmiller and colleagues (2010) with one exception noted below. The assessment drew on the *MPAA* 100 top-rated movies that had been released within the five years prior to the year of the assessment, as well as a subset of movies released in the year of coding, given that the movie assessment was always administered in the Fall. Movie lists were updated annually to use the previous 5 years of movies. Movie selection was stratified by rating at each time point such that on average, across W1 to W3, 30% of selected movies were R-rated, 47% were rated PG-13 19% were rated PG, and 4% were G-rated, based on rating by the *MPAA*.

For each participant, we sampled 50 films randomly from the stratified list. This departed slightly from Stoolmiller et al. (2010) who used stratified sampling by *MPAA* rating to create each list and thus, in this study the number of R movies varied randomly from list to list. For each movie, we asked the question, “How many times have you seen [title of movie]?”. Response options included: 0 times, 1 times, 2 times, 3–5 times, and 6 or more times. To avoid overlap, participants were never presented with a movie they had indicated seeing at a prior wave. R-rated movie watching was then calculated as the percentage of R-rated movies presented that the participant had indicated having seen at least once. For each movie, the DVD cover or poster image was displayed alongside the questions to facilitate recall, which also differed from Stoolmiller and colleagues (2010).

Sensation Seeking—Sensation seeking was assessed as the mean score on six items from the UPPS+P Impulsive Behavior Scale (Lynam et al. 2006; e.g. “I quite enjoy taking risks”). Response options ranged from “disagree strongly” (1) to “agree strongly” (4). Scores were averaged across items, yielding high internal consistency ($\alpha = .82$, $\alpha = .88$, $\alpha = .87$ for W1, W2, and W3, respectively).

Substance use initiation—Participants indicated at each survey whether they had ever consumed a full drink of *alcohol* (1), smoked a full *cigarette* (2), and used *marijuana* (3). We created three distinct periods of initiation encompassing the four waves of data collection (W1 to W2, W2 to W3, W3 to W4), and used the wave of first use to determine whether initiation occurred in each of those periods for alcohol, cigarette, and marijuana use.

Covariates

General: We included known correlates of substance use onset in our adjusted models. All covariates were taken from the time point corresponding to the Wave 1 measurement where possible, and from the time of enrollment otherwise. The 35-item child *externalizing* scale from the Child Behavior Checklist (CBCL; Achenbach et al. 1987; e.g. “Child doesn’t feel guilty after misbehaving”, answer categories “Not true” (0), “Somewhat or sometimes true” (1), or “Very true or often true” (2)) was completed by parents, and a mean score was calculated ($\alpha = .91$). The mean of a set of 4 items assessed adolescents’ *extreme peer orientation*, or willingness to sacrifice talents, school performance, and parents’ rules in order to be popular and have friends (Fuligni & Eccles; 1993). Each item had a 7-point scale; the endpoints differed (e.g., “Never [1]” to “Always [7]”, “Definitely No [1]” to “Definitely Yes [7]”), but all were designed such that higher scores represented greater extreme peer orientation. Internal consistency was adequate ($\alpha = .75$).

Alcohol-specific: We assessed *close friend drinking* with the item “Of your three best friends, how many drink alcohol at least once a month?” Response options ranged from none (0) to three (3) friends (Add Health, n.d.). Specific to alcohol use, we added two additional measures of peer norms: descriptive and injunctive. *Descriptive norms* were assessed with four items taken from a measure of perceived norms developed for college students by Wood and colleagues (2001) but adapted to reflect middle/high school age and customized to reflect peers of their same grade-level and sex. Internal consistency was high ($\alpha = .88$). The Peer Passive Social Influence questionnaire (Wood, Read, Mitchell, & Brand, 2004) was used to assess *injunctive norms*, based on two items: “How do most of your close friends feel about kids your age drinking alcohol?”, and “How do most of your close friends feel about kids your age getting drunk?”. Response options ranged from strongly disapprove (1) to strongly approve (5). Internal consistency of mean scores on these items was high ($\alpha = .94$). *Perceived availability of alcohol* was measured with a binary item from Arthur and colleagues (2000), e.g. “If you wanted to get some beer, wine, or hard liquor (for example: vodka, whiskey, or gin) could you get some?”. Response options were No (0) or Yes (1).

Parents indicated whether the child’s biological mother and/or biological father (first-degree relative) “have/had had a *drinking problem*.” Responses were coded into No (neither) versus Yes (either or both biological parents had a drinking problem). *Parental drinking* was computed based on parent report of the 10-item Alcohol Use Disorders Identification Test (AUDIT; Saunders et al. 1993). This measure screens for excessive alcohol consumption, alcohol-related problems, and signs of alcohol dependence. One additional item was added to the survey, “Have you felt you have a drinking problem?” Parents were also asked to respond to the same set of items asking about their partner. All responses were summed within parent and averaged across parent/partner ($\alpha = .77$ for parent, $\alpha = .75$ for partner).

Movie alcohol exposure was assessed using content coding of all movies used in the assessment of movie watching (see Jackson et al., 2017 for details). Briefly, a measure of scaled alcohol exposure was computed by calculating the number of minutes of alcohol content from movies reported as having been seen by the participant divided by the number of minutes possible in the participant’s group of 50 movies, multiplied by the number of

minutes across the total set of movies and the number of times the participant reported having seen the movie.

Smoking-specific: To assess *peer cigarette smoking*, we used an item from a 19-item scale assessing deviant behavior of respondents' close friends. The items were preceded by the prompt: "Think of your 3 best friends (the friends you feel closest to). In the past 6 months, have any of your friends smoked cigarettes?". Response options were No (0) or Yes (1) (Arthur et al. 2000). *Perceived availability of cigarettes* was measured with a binary item from Arthur and colleagues (2000), "If you wanted to get some cigarettes, could you get some?". Response options were No (0) or Yes (1). To assess *parent cigarette smoking*, we asked parents "Have you ever smoked cigarettes or other kinds of tobacco?" Response options were No (0) or Yes (1). Finally, *movie smoking exposure* was calculated in the same fashion as for alcohol content, above.

Marijuana-specific: To assess *peer marijuana use*, we used an item from a 19-item scale assessing deviant behavior of respondents' close friends, asking: "In the past 6 months, have any of your friends used marijuana?". Response options were No (0) or Yes (1) (Arthur et al. 2000). *Perceived availability of cigarettes* was measured with a binary item: "If you wanted to get some marijuana, could you get some?". Response options were No (0) or Yes (1) (Arthur et al. 2000). To assess *parent marijuana use*, we asked parents "Have you ever smoked marijuana or hashish?". Response options were No (0) or Yes (1).

Analytic Strategy

In our analytic approach, we attempted to replicate models from Stoolmiller and colleagues (2010). Broadly, these models were used to assess joint development of sensation seeking and R-rated movie watching and to investigate whether they prospectively predicted initiation of alcohol use. Below, we describe three specific models used in both studies, but also note any differences in our analytic strategy from Stoolmiller and colleagues (2010) given our goal to replicate/extend this prior work. All path- and structural equation models were conducted in Mplus 7.2 (Muthén and Muthén 2010). Missing data were handled through full information maximum likelihood (FIML) under the assumption of missing at random conditional on covariates included in the model (MAR). While it is not possible to confirm this assumption, modeling missing data under MAR has been demonstrated to be preferable to listwise deletion in all instances (Enders and Bandalos 2001) and we note that age and gender, which were significant predictors of missing data are included in all analyses, which helps make the MAR assumption more plausible. Given that school cohorts were enrolled on a semi-annual basis and our movie assessments corresponded to slightly different waves for each of the different cohorts, we controlled for school cohort in all analyses.

Model 1—Using cross-lagged panel models, we sought to establish whether reciprocal relations between sensation seeking and R-rated movie watching occur prospectively. In the current study, this path analysis covered three waves of data, with assessments from earlier time points in one construct predicting changes in the other construct at the subsequent time point (e.g., W1 R-rated movie watching predicting changes from W1 to W2 in sensation

seeking). Models controlled for autoregressive relations by predicting changes within a construct from one time point to the next. At each time point, these models also controlled for sex, age, ethnicity, race, and school cohort.

Model 2—By modeling parallel process latent growth curves (see Bollen and Curran, 2006), indicated by data from three time points of R-rated movie watching and sensation seeking data, we examined whether latent changes in both these processes were associated with each other, evaluating model fit using non-centrality-based fit indices (CFI, RMSEA; Bollen and Curran 2006), and absolute fit indices (SRMR; Barrett 2007). Specifically, given evidence of linear changes over time, we investigated whether there existed significant covariance between the residual individual differences in the slopes of the two straight lines after controlling for the intercept scores, as well as differences in age, sex, ethnicity, race, and cohort. We examined the robustness of such residual covariance by obtaining bias-corrected bootstrapped confidence intervals (Preacher and Hayes 2008).

Model 3—In this model, we used substance use initiation data to conduct discrete-time hazard regression where the log odds of initiation were conditional on the predictors, given that initiation had not occurred at a previous wave (Singer and Willet 2003). Figure 1 illustrates the structural equation model used for this approach. As shown, while the latent factor representing discrete-time initiation was regressed on covariates, wave-appropriate indicators of initiation were regressed on sensation seeking and R-rated movie watching predictors assessed at the previous time point (extending example 6.19 from the Mplus User's Guide, p. 147–148; Muthén and Muthén 2012). Hazard ratios (HR) estimated by the model may be interpreted such that at each time point, for every unit increase in the predictor, there is a proportional increase in the hazard of initiation. After estimating crude effects of the two constructs together, we used progressive models that included additional covariates in three steps: the first step controlled for basic sociodemographic information identical to that from Stoolmiller and colleagues (2010). A second step controlled for additional individual-, peer-, and parent covariates. Finally, a third step controlled for specific substance use content from the movies used to assess R-rated movie watching, in order to establish that the contribution of R-rated movies was independent of the alcohol or smoking content of these movies.

Replication: differences in assessments—First, while Stoolmiller and colleagues (2010) used four waves of R-rated movie data, separated by an eight-month interval, our study included three waves, spaced one year apart. This precluded us from examining growth models with quadratic growth terms, although Stoolmiller and colleagues assumed a linear structure of growth trajectories as well. Second, the sensation seeking measure included in Stoolmiller and colleagues (2010) was a four-item scale developed for the study, with internal consistencies ranging from .58–.64, which had been cubic-root-transformed to correct for distributional skew. In the present study, we used sensation seeking data from a well-validated six-item questionnaire (UPPS+P), and found that transformations were not required to achieve normal distribution. Finally, the R-rated movie measure in this study was a percentage of R movies queried but in Stoolmiller et al. the R-rated movie measure was the

square root of the raw count of R movies viewed (all subjects had the same number of R-rated movies on their lists).

Replication: differences in model specification—In the original parameterization for Model 1 (cross-lagged path model), Stoolmiller and colleagues controlled for all higher-order autoregressive pathways between Wave 1 to Wave 4 of their data, respectively. In our models we did not control for autoregressive relations beyond those to the immediately preceding wave. Stoolmiller and colleagues (2010) used 3 different approaches to bidirectional effects: (1) cross-lagged only, (2) simultaneous only and (3) a combination of cross-lagged and simultaneous effects justified by the nature and timing of the assessments but focused on the 3rd and final model. In contrast, in this work we focus on the first bidirectional model that only has cross-lagged paths and includes a correlation between residual contemporaneous sensation seeking and R-rated movie watching. However, in order to facilitate direct comparison to the final models as specified in Stoolmiller and colleagues, we included such comparisons in Appendix B for Model 1.

In Model 2, Stoolmiller and colleagues adjusted model specifications (added a covariance between the second and third time-specific influences) to account for a lack of fit of a linear growth trajectory to the unconditional growth model for sensation seeking. In our data, no such time-specific influences were evident. Similarly, we required no adjustment to the unconditional growth model representing R-rated movie watching due to any unusual time-point-specific influences observed in the original study.

Results

Table 1 offers sociodemographic data and correlations for the present study sample. Figure 2 shows standardized results for Model 1. We found significant bidirectional, but not fully reciprocal, relations: Wave 1 sensation seeking significantly predicted W2 R-rated movie viewing ($b = 1.25$, 95% CI [0.25 – 2.26], $p < .05$), which in turn predicted W3 sensation seeking [$b = 0.004$, 95% CI: 0.0003 – 0.01, $p < .05$]. No other cross-lagged pathways in the model were significantly different from zero. Appendix B contains results for replication of the model under the original parameterization featuring autoregressive relations with the wave prior to the immediately preceding wave, and with sensation seeking regressed on contemporaneous R-rated movie watching. These results do not show bidirectional relations.

Figure 3 shows results for the parallel process growth models (Model 2). Preliminary analyses revealed that an unconditional linear growth model representing sensation seeking over time fit the data well (CFI: .999, RMSEA < .001, SRMR: .004), and that an unconditional linear growth model representing R-rated movie watching also fit the data well (CFI: .997, RMSEA: .03 SRMR = .01). The slope mean for sensation seeking was positive and significant ($b = 0.10$, 95% CI: [0.07 – 0.13], $p < .001$), whereas the slope mean for R-rated movie watching was non-significant ($b = -0.29$, 95% CI: [-0.84 – 0.26], $p = .30$). In the fully conditional model (CFI: .98, RMSEA: .03, SRMR: .02), the intercepts were significantly associated with each other ($b = 1.50$, 95% bootstrapped CI: [0.58 – 2.49], $p < .01$), as were the slopes ($b = 0.19$, 95% bootstrapped CI: [0.01 – 0.38], $p < .05$). Standardized

values for these estimates are included in the Figure. There were no significant relations between intercepts of one process and slopes of the other.

Table 2 shows results for Model 3, which tested main effects of sensation seeking and movie watching as well as the interaction between the two on initiation of alcohol, cigarette, and marijuana use. Both crude and adjusted estimates are given; Step 1 adjusted for sociodemographic variables previously used in Stoolmiller and colleagues, Step 2 adjusted for additional individual-, peer-, and parent-level predictors, and Step 3 adjusted for movie alcohol and smoking exposure in the associated outcomes. Estimates from the final models for all three substances exclude the interaction between sensation seeking and R-rated movie watching, as the interaction was not significant in any of the models. Assuming time-variant effects (i.e. relaxing the proportional hazards assumption) did not significantly improve model likelihood for alcohol initiation (adjusted: $\chi^2(4) = 3.725, p = .44$), cigarette smoking initiation (adjusted: $\chi^2(4) = 1.79, p = .77$) or marijuana initiation (adjusted: $\chi^2(4) = 3.64, p = .46$). For this reason, we limit our interpretation to results from time-invariant models. Estimates from Step 1 models indicate that standardized R-rated movie watching uniquely predicted increased hazard of alcohol initiation ($HR = 1.49$, 95% CI: [1.32 – 1.68], $p < .001$), cigarette smoking initiation ($HR = 1.30$, 95% CI: [1.05 – 1.62], $p < .05$), and marijuana initiation ($HR = 1.25$, 95% CI: [1.08 – 1.45], $p < .01$). Standardized sensation seeking significantly predicted alcohol initiation ($HR = 1.44$, 95% CI: [1.25 – 1.66], $p < .001$), but not cigarette smoking initiation ($HR = 1.32$, 95% CI: [0.98 – 1.77], $p = .06$) or marijuana initiation (Sensation seeking: $HR = 1.04$, 95% CI: [0.87 – 1.25], $p = .66$).

In the Step-2-adjusted models, standardized R-rated movie watching uniquely predicted increased hazard of alcohol initiation ($HR = 1.48$, 95% CI: [1.30 – 1.69], $p < .001$), cigarette smoking initiation ($HR = 1.28$, 95% CI: [1.03 – 1.60], $p < .05$), and marijuana initiation ($HR = 1.24$, 95% CI: [1.07 – 1.45], $p < .01$). Standardized sensation seeking significantly predicted alcohol initiation ($HR = 1.41$, 95% CI: [1.22 – 1.64], $p < .001$), but not cigarette smoking initiation ($HR = 1.31$, 95% CI: [0.97 – 1.77], $p = .07$) or marijuana initiation ($HR = 1.03$, 95% CI: [0.86 – 1.23], $p = .77$). As the non-significant negative estimate for the interaction suggests, however, these effects may be mutually suppressive, and are both significant in the presence of this interaction predicting smoking initiation.

In the Step-3-adjusted models, which additionally controlled for movie alcohol exposure in the prediction of alcohol initiation, the effects of R-rated movie watching ($HR = 1.43$, $p < .001$) and sensation seeking ($HR = 1.41$, $p < .001$) predicting alcohol initiation remained significant. After adjusting for movie smoking exposure, the effects of R-rated movie watching ($HR = 1.28$, $p = .07$) were no longer significant. However, as in Step 2, when including the interaction between R-rated movie watching and sensation seeking, both main effects were significant at both steps (See Table 2 note).

Discussion

Previous work by Stoolmiller and colleagues (2010) demonstrated that R-rated movie watching, an important external influence, and sensation seeking, an important individual-level influence, were two crucial predictors of developmental risk of early substance use that

may reciprocally influence each other over the course of adolescent development (Slater et al., 2004; 2007). Additionally, it has been shown that these processes may interact in their prospective prediction of substance use, such that for lower levels of sensation seeking, R-rated movie watching more strongly predicted alcohol use onset (Stoolmiller et al., 2010; for similar findings regarding the onset of smoking, see Sargent et al., 2007). Tanski et al. (2011) advanced the “swing voter hypothesis” to explain such negative interaction effects involving risky media exposures. In this view, only teens who are not at high or low risk for substance use are susceptible to media influence, much like swing voters are susceptible to media influence in elections. In the current study, we investigated the prospective relation of R-rated movie watching, and sensation seeking, with each other and investigated their prediction of subsequent substance use initiation. Based on our results, we found (1) evidence of bidirectional, but not fully reciprocal, influences of each one on the other. These relations indicated that higher sensation seeking prospectively predicted increases in R-rated movie watching, which in turn prospectively predicted increases in sensation seeking. We also found (2) evidence for a positive association between linear changes in sensation seeking and R-rated movie watching, but not between linear changes and initial values. This indicates that over time, those who tended to increase in sensation seeking, tended to decrease less in R-rated movie watching. Finally, we found that (3) sensation seeking and R-rated movie watching each put adolescents at risk for early alcohol initiation, but contrary to hypothesis, we did not find a multiplicative effect of R-rated movie watching based on levels of sensation seeking. We extended previous findings in Stoolmiller and colleagues (2010) by demonstrating that this relation of R-rated movie watching and sensation seeking to alcohol initiation persisted when also controlling for several known correlates of adolescent substance use: externalizing behavior, lunch subsidy use as a proxy for socio-economic status, close friend substance use, injunctive and descriptive peer norms (for alcohol), parent substance use, and substance availability. We further extended findings regarding alcohol initiation to cigarette smoking and marijuana initiation, where we found that R-rated movie watching, but not sensation seeking, uniquely predicted early initiation of cigarette and marijuana use when controlling for relevant social, parental, and individual predictors.

Dynamic Interplay among Sensation Seeking and R-rated Movie Exposure

The present study sought to understand the transactional relations between an important individual difference variable, personality, and an environmental variable, the media, extending from theoretical models in child development that support the shared importance of the individual and the environment. Our findings indicated that changes in R-rated movie watching and sensation seeking were prospectively linked, which furthers the notion that internal and external influences are mutually responsive, potentially resulting in a compounding of resultant risk for adverse outcomes. Developmental cascade models posit that early levels and changes in functioning or competence in one domain (e.g., personality and behavioral indices of behavioral undercontrol) impact healthy functioning in a different domain (e.g., the broader socio-cultural environment including popular media) (Masten and Cicchetti, 2010); this is a similar concept to Slater’s (2007) model of mutually reinforcing spirals of media selection and effects. A key component of sensation seeking is the tendency to seek out novel, exciting stimuli (Zuckerman, 1994) and sensation seeking is linked to a preference for stimulating messages in the media; for example, Slater (2003) notes that

individuals characterized by disinhibition and thrill seeking experience greater vicarious excitement from violent media content, which is likely one component of R-rated films.

Generally, increases in sensation seeking in adolescence are believed to function evolutionarily as a method of encouraging adolescents to engage in experimentation and social behavior. Greater brain reward center responses have been observed in adolescents who are in the presence of peers (Crone and Dahl 2012). This can be particularly risk-inducing for adolescents, as association with deviant peers is strongly associated with greater substance use involvement (Marshall and Chassin 2000; Prinstein et al. 2001). Indeed, sensation seeking shapes social interaction with peers, including greater affiliation with deviant peer groups (Hampson et al. 2008; Mann et al. 2015; Yanovitzky 2005). This may extend to affiliation with the characters portrayed in popular media who serve as “super-peers” and convey societal norms.

Contrary to previous work, in the current data, cross-lagged relations between R-rated movie watching and sensation seeking in our study were not consistent over time. Between wave 1 and 2, sensation seeking predicted R-rated movie viewing but not vice versa but between wave 2 and 3, the opposite pattern held. This may suggest that as adolescents mature, the effects of R-rated movie watching and sensation seeking become more stable (which is supported by increases in the autoregressive relations between assessments of these constructs over time) and the stability weakens or completely displaces the bidirectional effects. Alternatively, if viewed from an assessment perspective, an increasing familiarity with the questionnaire may have prompted students to respond to these items more consistently. At the same time, our findings indicated that R-rated movie viewing influenced sensation seeking, supporting contemporary research positing that personality is influenced by the environment (Caspi and Moffitt 2001; Johnson et al. 2007). Bardo and colleagues (1996) suggest that both genetic and environmental influences determine individual differences in novelty seeking. Furthermore, we observed joint change over time in R-rated movie watching and sensation seeking (linear longitudinal changes in both processes were linked over time), suggesting concomitant change between personality and media influences. Although studies have empirically linked correlated changes between self-reported impulsivity and alcohol use and alcohol-related problems (e.g., Littlefield et al. 2009; Quinn and Harden 2013), to date only this study and the study by Stoolmiller and colleagues has examined correlated change between facets of impulsivity and exposure to risk behavior in the media.

Sensation Seeking and R-rated Movie Exposure as Predictors of Initiation

Our study demonstrated that R-rated movie watching and sensation seeking were each associated with alcohol initiation, consistent with findings by Stoolmiller and colleagues (2010) that link substance use initiation to between-person differences in exposure to mature media content and sensation seeking. Further, this association persisted when controlling for a wider array of social, parental, and individual predictors (including externalizing behavior, lunch subsidy use as a proxy for socio-economic status, extreme peer orientation, peer substance use, parent substance use, and substance availability, in addition to peer injunctive and descriptive norms in predicting alcohol initiation). We further extended findings

regarding alcohol initiation to cigarette smoking and marijuana initiation, where we found that R-rated movie watching, but not sensation seeking, also uniquely predicted early initiation of cigarette and marijuana use. Based on our results, consistent with Stoolmiller and colleagues (2010), we suggest that R-rated movie watching and sensation seeking exert their effects consistently across adolescence. Our evidence fits closely to a nascent body of literature linking media exposure prospectively to initiation as well as increases in substance use (also see Jackson et al., 2017). The analyses presented in the current manuscript controlled for the effect of substance-specific exposure in the prospective prediction of substance initiation by R-rated movie watching. This suggests that R-rated movie watching confers broader risk than that imparted by exposure to substances in movies alone. Our finding that R-rated movie watching forms such a risk factor has important implications for developmental models that posit reciprocal effects with sensation seeking (and potentially, other individual-level traits that themselves form risk factors for subsequent substance onset) as a mechanism for heightened risk. Thus, the straightforward approach of reducing substance use exposure in R-rated movies would plausibly not serve to eliminate the risk presented by R-rated movie watching, possibly due to other sensationalized, larger-than-life occurrences and characters in this movie type.

Our null finding for the prediction of substance use by sensation seeking stands in contrast to studies showing associations between sensation seeking and smoking and marijuana use (Bloom et al. 2014; Janssen et al. 2015; VanderVeen et al. 2016). In addition, we did not find support for an interaction between sensation seeking and R-rated movie viewing, which does not replicate results from Stoolmiller and colleagues (2010) and is contrary to work by Wills and colleagues (2010) on self-control and exposure to tobacco and alcohol content in films and subsequent adolescent tobacco and alcohol use. Other work has shown that associations between exposure to movie smoking depictions were *weaker* at high levels of sensation seeking (Sargent et al., 2007), and likewise the link between exposure to video game violence and aggressive behavior was weaker in high sensation seekers (Bartholow et al. 2005). Our results are in the same direction as previously reported studies but fall short of significance for smoking initiation but offer no support for this interaction in the prospective prediction of initiation of either alcohol or marijuana use.

Strengths and Limitations

We benefited in our study from a rich, relatively large longitudinal dataset that included multiple assessments of movie-related and other known etiological risk factors for adolescent substance use initiation. We employed a rigorous coding method for assessing exposure to alcohol in movies, and a well-validated measure to assess sensation seeking. Strengths to our approach include using adolescents from a developmentally appropriate timeframe and including multiple substance use outcome measures. We applied complementary models that offer insight into both short-term directional associations and longer-term co-evolution of change in sensation seeking and R-rated movie exposure, as well as examination of how these constructs jointly shape alcohol substance use. We applied statistically appropriate methodology for our inquiry, and offer both conceptual and direct interpretations of our findings based on alternative models. We included a wide array of peer- and parent-behaviors that are known risk factors for early initiation of substance use.

We examined whether the effect of R-rated movie watching was independent from the alcohol and tobacco-specific content in these movies. Finally, we used a well-validated questionnaire with good psychometric properties to assess sensation seeking.

However, our sample was smaller than that of Stoolmiller and colleagues (2010), and whereas their sample was recruited nationally, ours was representative of the adolescent population of a single state, and thus may not generalize broadly to the US. The low overall occurrence rate of cigarette smoking may limit the generalizability of the findings regarding prediction of initiation of cigarette smoking and may explain why we failed to detect an effect of sensation seeking on smoking, which stands in contrast to prior literature. Several of the peer-effects pertained to perceived norms of close friends, however, participants may not have reported on the same friends consistently over time, and others may not have had three close friends to draw from in their response. Although we prospectively predicted the initiation of substance use in substance-naïve adolescents, the study provides partial evidence for causation but cannot rule out the possibility of an omitted confounder.

Over the course of this replication attempt, we dealt with challenges that we believe to be universal to many such attempts using survey data to replicate etiological findings: differences in distribution, differences in timing of assessment, and differences in selected measures. For example, our results did not perfectly replicate those from Stoolmiller and colleagues (2010) perhaps because the interactive, reciprocal effects observed in that study are more evident among younger adolescents, and occluded when the majority of the typical adolescent increase in sensation seeking has already occurred, as was the case in our study (see our findings reported in Littlefield et al. 2016). Future research will be devoted to testing such developmental hypotheses. It is also worth noting that although Stoolmiller and colleagues' sensation seeking scale included single indicators for intensity seeking and boredom susceptibility, whereas our sensation seeking construct reflected mainly risk taking.

In providing supplementary materials that do allow direct comparison between our findings and those of Stoolmiller and colleagues (2010) (showing that modeling decisions impacted our capacity to identify bidirectional relations in cross-lagged panel models), we attempt to offer all possible avenues of interpretation of our findings. As demonstrated in the current study, it is possible with differing, sometimes extended, assessments to provide conceptual replication of mechanisms posited by an original work. In the interest of advancing the field of developmental psychology, we believe such efforts at conceptual replication will continue to increase in relevance and impact as the field moves forward. Researchers from many areas have argued that as psychology progresses, there is an ever greater and more pressing need for replication in as many areas as possible (Sijtsma et al. 2016), and that replication bears the promise of yielding more lasting, meaningful findings in the field of personality psychology (Reis and Lee 2016).

Conclusion

The current study shows that R-rated movie watching appears to form a unique and specific risk factor for substance use initiation, broadly, across substances and controlling for substance specific exposure, and thus media influence should be treated as a broad risk

factor in policy and prevention planning for delaying initiation of alcohol, tobacco and marijuana use. As R-rated movie watching has been demonstrated to predict alcohol initiation, so has stricter parental R-rated movie restriction been shown to delay alcohol initiation (Tanski et al. 2010), as well as smoking initiation (De Leeuw et al. 2010). We show that the benefits of parental restriction of R-rated movie content (which continues to contain references to substances other than alcohol, see Polansky et al. 2016) may effectively delay initiation of marijuana use, as well.

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Appendix A

Grade begin Q assess	Fall 2009	Winter 2010	Spring 2010	Summer 2010	Fall 2010	Winter 2011	Spring 2011	Summer 2011	Fall 2011	Winter 2012	Spring 2012	Summer 2012	Fall 2012	Winter 2013	Spring 2013	Summer 2013	Fall 2013 plus parent	Winter 2014	Spring 2014	Summer 2014	Fall 2014 plus parent	Winter 2015	Spring 2015	Summer 2015	Fall 2015 plus parent	Winter 2016	Spring 2016
C1 Gr10 n=73	t1	t2	t3		T4				T5				T6				Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
C1 Gr11 n=61	t1	t2	t3	t4					T5				T6				Q	Q	Q	Q	Q	Q	Q	Q			Q
C1 Gr12 n=97	t1	t2	t3	t4					T5				T6				Q	Q	Q	Q							
C2 Gr10 n=71		t1	t2	t3					t4	T5					T6		Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
C2 Gr11 n=55		t1	t2	t3					t4	T5					T6		Q	Q	Q	Q	Q	Q	Q	Q			
C2 Gr12 n=66		t1	t2	t3					t4	T5					T6		Q	Q	Q	Q			Q	Q			
C3 Gr9 n=94			t1	t2					t3	t4			T5				T6	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
C3 Gr10 n=99			t1	t2					t3	t4			T5				T6	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
C3 Gr11 n=91			t1	t2					t3	t4			T5				T6	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
C4 Gr10 n=26				t1					t2	t3			t4	T5					T6		Q	Q	Q	Q	Q	Q	Q
C4 Gr11 n=38				t1					t2	t3			t4	T5					T6		Q	Q	Q	Q	Q	Q	Q
C4 Gr12 n=25				t1					t2	t3			t4	T5					T6		Q	Q	Q	Q	Q	Q	Q
C5 Gr9 n=74									t1	t2			t3		t4	T5					T6	Q	Q	Q	Q	Q	Q
C5 Gr10 n=75									t1	t2			t3		t4	T5					T6	Q	Q	Q	Q	Q	Q
C5 Gr11 n=78									t1	t2			t3		t4	T5					T6	Q	Q	Q	Q	Q	Q

Figure. Original data collection timeline
W1, W2, W3 marked in grey for each cohort

Appendix B

Figure. Cross-lagged path model as parameterized by Stoolmiller et al. (2010), applied directly to current data

Note: As compared to Figure 2 in the manuscript, the original cross-lagged path model from Stoolmiller et al. includes second-order autoregressive parameters within panels.

Additionally, contemporaneous relations between W2 and W3 parameters were modeled directionally rather than as covariances. Results differ such that instead of residual covariances between W2 indicators being significant and positive, W2 R-rated movies now has a positive effect on W2 sensation seeking after controlling for a negative effect of W1 R-rated movie watching.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Biographies

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Kristina M. Jackson, Ph.D. is a professor at the Center for Alcohol and Addiction studies. Her research has an emphasis on quantitative methods and their application to health-related behaviors through analysis of both epidemiological and experimental intervention data. Her research examines the initiation of alcohol use and progression through early drinking

milestones among middle-schoolers, with particular focus on the contextual influences on these transitions.

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Figure 1.

Example discrete-time survival model with main effects of sensation seeking and R-rated movie watching predicting initiation of substance use in the matching discrete time period, adjusted for additional peer, parental, and individual covariates.

Note: Standardized coefficients shown. W1 =Wave 1. W2 = Wave 2. W3 = Wave 3, W4 = Wave 4.

*** $p < .001$.

Figure 2.

Cross-lagged path model of development of sensation seeking and R-rated movie watching.

Note: Analyses controlled for age, sex, ethnicity, race, and cohort differences. W1 = Wave 1.

W2 = Wave 2. W3 = Wave 3.

* $p < .05$, *** $p < .001$.

Figure 3.

Parallel process growth model of sensation seeking and R-rated movie watching

Note: Analyses controlled for age, sex, ethnicity, race, and cohort differences

* $p < .05$. ** $p < .01$.

Table 1Sample descriptive information and correlations ($N=1,023$).

	<i>M</i> or %	<i>SD</i>	<i>W1 SS</i>	<i>W2 SS</i>	<i>W3 SS</i>	<i>W1 R-seen</i>	<i>W2 R-seen</i>	<i>W3 R-seen</i>
W1 Sensation Seeking	2.3	0.8	–	.66***	.58***	.10*	.08*	.09*
W2 Sensation Seeking	2.3	0.9		–	.63***	.03	.12**	.08*
W3 Sensation Seeking	2.4	0.8			–	.07	.14**	.12**
W1 average % R-rated movies seen	12.7	15.0				–	.50***	.40***
W2 average % R-rated movies seen	11.6	13.6					–	.41***
W3 average % R-rated movies seen	11.8	13.4						–
Age at W1	13.7	1.0						
Female (%)	52.2							
Hispanic (%)	12.4							
Non-White (%)	17.0							
Received Lunch Subsidy	36.0							
			Initiation by Wave 1				Initiation by Wave 4	
Alcohol (%)			13.6				43.2	
Smoking (%)			6.1				13.2	
Marijuana (%)			12.9				30.4	

Note. SS = Sensation seeking. R-seen = R-rated movies seen.

* $p < .05$.** $p < .01$.*** $p < .001$.

Table 2

Discrete time survival regression for alcohol, smoking, and marijuana initiation

	Sensation Seeking				Alcohol Initiation (<i>n</i> = 833)				Smoking Initiation (<i>n</i> = 897)				Marijuana Initiation (<i>n</i> = 843)			
	<i>HR</i>	95% LB	95% UB	<i>p</i>	<i>HR</i>	95% LB	95% UB	<i>p</i>	<i>HR</i>	95% LB	95% UB	<i>p</i>	<i>HR</i>	95% LB	95% UB	<i>p</i>
Crude																
R-rated movie watching	1.49	1.32	1.68	<.001	1.39	1.14	1.70	<.001	1.32	1.15	1.52	<.001	1.52	1.23	1.83	<.001
Sensation Seeking	1.44	1.26	1.64	<.001	1.30	0.99	1.70	.06	1.05	0.89	1.23	.58	1.05	0.89	1.23	.58
SS * R-watching	1.04	0.92	1.17	.53	0.87	0.70	1.09	.24	1.04	0.91	1.19	.58	1.04	0.91	1.19	.58
Adjusted Step 1																
R-rated movie watching	1.54	1.35	1.74	<.001	1.39	1.13	1.71	<.01	1.31	1.13	1.51	<.001	1.31	1.13	1.51	<.001
Sensation Seeking	1.46	1.27	1.68	<.001	1.27	0.96	1.67	.09	1.07	0.91	1.27	.41	1.07	0.91	1.27	.41
Age	1.38	1.19	1.59	<.001	1.42	1.09	1.84	.01	1.21	1.03	1.43	<.05	1.21	1.03	1.43	<.05
Gender (1=Male)	0.47	0.36	0.61	<.001	0.70	0.43	1.13	.14	0.60	0.44	0.81	<.001	0.60	0.44	0.81	<.001
Race (1=White)	1.45	0.99	2.12	.06	0.99	0.49	1.99	.97	0.69	0.46	1.03	.07	0.69	0.46	1.03	.07
Ethnicity (1=Hispanic)	0.92	0.67	1.26	.59	0.52	0.20	1.39	.19	0.85	0.56	1.29	.44	0.85	0.56	1.29	.44
SS * R-watching	1.01	0.89	1.13	.93	0.85	0.68	1.08	.19	1.03	0.89	1.19	.67	1.03	0.89	1.19	.67
Adjusted Step 2																
R-rated movie watching	1.48	1.30	1.69	<.001	1.28	1.03	1.60	<.05 ^a	1.24	1.07	1.45	<.01	1.24	1.07	1.45	<.01
Sensation Seeking	1.41	1.22	1.64	<.001	1.31	0.97	1.77	.07 ^a	1.03	0.86	1.23	.77	1.03	0.86	1.23	.77
Externalizing	1.04	1.02	1.06	<.001	1.03	0.99	1.07	.12	1.02	0.99	1.05	.103	1.02	0.99	1.05	.103
Lunch Subsidy Use	0.83	0.59	1.16	.28	1.65	0.94	2.89	.08	1.51	1.05	2.17	<.05	1.51	1.05	2.17	<.05
Extreme Peer Orientation	1.15	1.01	1.30	<.05	1.43	1.14	1.79	<.01	1.24	1.07	1.44	<.01	1.24	1.07	1.44	<.01
Alcohol Availability	1.34	0.96	1.87	.08												
Close Friend Drinking	1.08	0.92	1.28	.36												
Parental Drinking	1.07	1.01	1.12	<.01												
Parental AUD	1.15	0.90	1.46	.26												
Injunctive Norms	1.19	1.09	1.31	<.001												
Descriptive Norms	1.08	0.94	1.24	.28												
Cigarette availability					1.39	0.75	2.58	.30								
Peer smoking					2.78	1.25	6.15	<.05								
Parental smoking					1.31	0.76	2.27	.34								
Marijuana availability									2.10	1.36	3.24	<.001	2.10	1.36	3.24	<.001

Sensation Seeking	Alcohol Initiation (<i>n</i> = 833)				Smoking Initiation (<i>n</i> = 897)				Marijuana Initiation (<i>n</i> = 843)			
	<i>HR</i>	95% LB	95% UB	<i>p</i>	<i>HR</i>	95% LB	95% UB	<i>p</i>	<i>HR</i>	95% LB	95% UB	<i>p</i>
Peer marijuana use									2.09	1.05	4.16	<.05
Parental marijuana use									1.17	0.84	1.63	.34
SS * R-watching	1.01	0.89	1.15	.82	0.83	0.64	1.07	.15 ^a	1.02	0.88	1.18	.81
Adjusted Step 3												
R-rated movie watching	1.43	1.23	1.66	<.001	1.28	0.98	1.67	.07 ^a	<i>b</i>			
Sensation Seeking	1.41	1.22	1.63	<.001	1.31	0.98	1.77	.07 ^a	<i>b</i>			
Movie Alcohol Exposure	1.01	0.99	1.03	.33								
Movie Smoking Exposure					1.00	0.86	1.15	.97				
SS * R-watching	1.01	0.89	1.15	.85	0.83	0.65	1.07	.16 ^a	<i>b</i>			

Note: Analyses are conducted among those who indicated being substance-naïve at Wave 1 (W1). Hazard ratios (*HR*) indicate the change in risk of alcohol initiation at any time point for each unit increase in the predictor, given that onset did not occur at the previous time point. R-rated movie watching and sensation seeking predictors were standardized in these models. Models shown assume a time-invariant effect of the time-varying predictors, as in Stoolmiller and colleagues; (2010). Adjusted step 1 matches covariates used in Stoolmiller and colleagues, step 2 further controls for peer, parental, and individual correlates of substance use outcomes. Finally, step 3 controls for movie substance use exposure.

^aThe main effects of R-rated movie watching and sensation seeking on smoking initiation were not consistently significant in the Step 2 and Step 3 models featuring main effects only. However, in the interaction models, both main effects were significant at both steps (Step 2: R-rated movie watching *HR* = 1.36, *p* < .01; sensation seeking *HR* = 1.38, *p* < .05, Step 3: R-rated movie watching *HR* = 1.37, *p* < .05; sensation seeking *HR* = 1.40, *p* < .05).

^bMovie marijuana exposure was not assessed in the current study, so this step is skipped for the prediction of marijuana initiation.