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R-rated Movie Viewing, Growth in Sensation Seeking and Alcohol Initiation: Reciprocal and Moderation Effects

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Abstract The current study employed parallel process and discrete time hazard regressions to examine the interplay among exposure to R-rated movies, sensation seeking, and initiation of alcohol use in a national U.S. sample (N=6255) of adolescents, ages 10–14, who were followed over four waves spanning 2 years. There was a short-term reciprocal relation between watching R-rated movies and sensation seeking, but over the 2-year observation period, exposure to R-rated movies was associated with increases in sensation seeking and not vice versa. Sensation seeking also moderated the effect of watching R-rated movies on initiation of alcohol consumption such that exposure was associated with greater increases in initiation of alcohol use among low sensation than among high sensation seeking adolescents. The study provides empirical evidence of an environmental media effect on sensation seeking, and important new information about the relations among sensation seeking, media exposure, and adolescent alcohol use.

Keywords Sensation seeking · Alcohol use · Media

The emergence of transactional models of development and the statistical methods necessary to test them has generated a more complex and nuanced understanding of the dynamic interplay between a child's personality and the environment (cf., Bronfenbrenner 1995; Collins et al. 2000; Deater-Deckard and Cahill 2006). Three related areas of research have formed the foundation of these new models. First, although previous research and theory conceptualized traits as enduring elements of personality that are stable over time and across situations (Buss and Plomin 1984), contemporary research has demonstrated that traits change in response to environmental influences (Caspi and Moffitt 2001; Johnson et al. 2007). For example, one recent longitudinal analysis of traits revealed that 95% of participants showed reliable change in at least one trait in late adolescence and early adulthood: The modal number of changed traits was three or four (Blonigen et al. 2008). These authors concluded that stability in personality traits can be attributed to genetic influences, whereas changes are largely attributable to environmental influences. Second, a related development is the growing evidence that children vary widely with respect to their reactions to specific environments or environmental events; i.e., environmental influences do not exert uniform effects on all children (Rothbart and Bates 1998; Slater 2007; Tarter and Vanyukov 1999). Third, it has been suggested that the relation between personality and environmental influence is reciprocal; i.e., a child's personality influences his/her preferences for specific environments, and environments can influence the development of the child's personality. For example, it has been suggested that children with high activity levels or sensation seeking are more likely to seek environments that expose them to exciting and risky temptations (Bardo et al. 1996; Wills and Dishion 2004), and that these new environments can shape their personalities. Although all three of these ideas are generally accepted, they are usually addressed separately, and this has led to a significant understatement of the complexity of the relations among personality, the environment, and behavior.

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The current study is designed to employ these theoretical developments to examine the relations between children's personalities, environments, and behavior over time. Specifically, it examines the relations among a dispositional vulnerability to substance use—sensation seeking (a psychological risk factor that measures a tendency to seek out novel experiences; Zuckerman 1979, 2006), an environmental risk factor—exposure to R-rated movies—and subsequent initiation of alcohol use. The study has two aims: to examine the reciprocal relation between exposure to R-rated movies and sensation seeking, and to determine if sensation seeking moderates the relation between R-rated movie exposure and alcohol use.

Transactional Models of Development

Media Exposure and Aggression It is widely accepted that children affect their own socialization, contributing to the continuous construction of the environment that, in turn, affects them (Bandura 1986; Slater et al. 2003; Wills and Dishion 2004). One of the few theoretical models of media effects that incorporates these transactional relations between personality and the environment is the general aggression model (GAM; Anderson and Bushman 2002). A substantial body of research has linked the use of violent media, such as watching violent movies or playing violent video games, to aggression in children (Anderson et al. 2007; Bushman and Huesmann 2001; Sherry 2001; Slater et al. 2003). This line of research has also suggested that repeated exposure to violent video games can result in cognitive and affective changes that lead to the development of a more aggressive personality, and ultimately to increases in aggressive behavior (Carnagey and Anderson 2003). It should be noted, however, that playing violent video games appears to have less impact on the aggressiveness of people who have more, rather than less, experience with the games (Bartholow et al. 2005). This finding raises the possibility that chronic exposure can have the effect of desensitizing players to these games.

Media Exposure and Sensation Seeking Although sensation seeking is primarily viewed as a fixed and stable personality attribute (Kilpatrick et al. 1976; Zuckerman 1979), numerous studies have demonstrated that it changes over time—it peaks during adolescence and then declines between adolescence and young adulthood (Zuckerman 1994). These developmental findings have caused some to propose that sensation seeking, like trait aggression, may also be shaped by environmental cues (Bardo et al. 1996). Specifically, as children in middle childhood and adolescence become more capable of actively selecting their environments, their choices can place them in riskier situations (Scarr and McCartney 1983; Tarter et al. 1995), and these environmental changes can, in turn, maintain or strengthen certain elements of their personality (cf., Bandura 2002; Funder 2001; Mischel and Shoda 1998). This led to the first hypothesis in the current study, which is that the relation between R-rated movie exposure and sensation seeking is reciprocal. Although this type of mutual reinforcement of media exposure and personality is consistent with the GAM, few studies have addressed it directly; in fact, we know of no models of media exposure that address this possibility.

Media Exposure and Sensation Seeking as Components of Substance Use Risk

There is a relatively large literature suggesting that the personality trait of sensation seeking is a predisposing factor for alcohol use and abuse (Andrew and Cronin 1997; Bates et al. 1986; Martin et al. 2002; Stacy et al. 1993). High sensation seeking is associated with a need for intense stimulation and a willingness to take risks in order to satisfy this need, both of which may lead to substance use. In addition, there is growing evidence that various forms of media have important influences on substance use in children and adolescents. For example, several longitudinal studies have linked exposure to movie smoking to adolescent smoking in U.S. and European adolescents (Dalton et al. 2003; Distefan et al. 2004; Hanewinkel and Sargent 2008; Sargent et al. 2007; Titus-Ernstoff et al. 2008). These studies are notable for the consistency of their effects in spite of controls for a number of confounding influences such as parent, sibling, and friend smoking; rebelliousness; and parenting style. Movie alcohol use has similar effects on adolescents' drinking behavior; i.e., exposure to alcohol in movies, including brand depictions, is associated with initiation and escalation of alcohol use (Dal Cin et al., in press; Gibbons et al., manuscript under review; Hanewinkel and Sargent 2008; Sargent et al. 2006). These effects are independent of the effect of sensation seeking (Dal Cin et al., in press; Hanewinkel and Sargent 2009).

Previous research also indicates that young adolescents are frequently exposed to R-rated movies in spite of prohibition of admission without parental consent (Sargent et al. 2002; Worth et al. 2008). According to the Motion Picture Association of America (MPAA) rating system, "An R-rated motion picture may include adult themes, adult activity, hard language, intense or persistent violence, sexually-oriented nudity, drug abuse, or other elements." In addition to these characteristics, R-rated movies also contain more smoking and drinking compared to other

rating categories of movies (Dal Cin et al. 2008; Dalton et al. 2002).

Dynamic Interactions Between Personality and the Environment That Unfold Over Time and Predict Alcohol Use

Given that sensation seeking and movie exposure are independent predictors of alcohol use in adolescents, it is reasonable to suggest that a reciprocal relation between these two predictors could affect how they influence alcohol use over time. Previous research, however, does not provide a clear indication of the nature of that influence. On the one hand one could argue that sensation seeking and R-rated movie exposure reinforce each other, and the result is a kind of unchecked growth in each—what Slater calls "reinforcing spirals of media selectivity and effects" (2007). Alternatively, one could make the equally plausible prediction that increases in movie exposure lead to desensitization to the movie influence, and therefore, end the escalation of their effects on alcohol consumption.

The Case for Sensitization According to Slater's model, the relation between media and risk behavior is stronger among adolescents who are particularly vulnerable; e.g., adolescents who have been victimized, are alienated, or are high sensation seekers (Slater et al. 2004). This argument suggests that the reciprocal relation between sensation seeking and unfamiliar and exciting media may lead to an increase of the effect of R-rated movies on the subsequent alcohol risk behavior of high sensation seeking adolescents. Specifically, novel media increase positive affect among high sensation seeking children (Mellstrom et al. 1976), and high sensation seekers are more vulnerable because they are more responsive to media inputs with high "message sensation value" (Everett and Palmgreen 1995). Consistent with this reasoning, Slater et al. (2004) found that the concurrent relation between violent media and aggression was stronger for youth high in sensation seeking. Violent media did have a positive effect on aggression for low sensation seekers, but these increases were not as large as those for high sensation seeking teens. Thus, this hypothesis is that there are two mutually reinforcing forces, sensation seeking and R-rated movie viewing, which serve to enhance the effect of viewing media images of a deviant behavior on the initiation or growth of that behavior, and this effect is stronger for high sensation seeking adolescents than for low sensation seeking adolescents.

The Case for Desensitization On the other hand, it is possible that R-rated movies (like playing violent video games; Bartholow et al. 2005) have less impact on those who have the most experience with them (e.g., high sensation seekers). Consistent with this idea, Sargent and colleagues (2007) reported that the relation between exposure to movie smoking depictions and the development of established smoking was stronger for low sensation seeking adolescents than for high sensation seekers. This hypothesis, postulates a mutually reinforcing growth process, which, instead of being unchecked, is dampened by eventual desensitization to R-rated movies.

The Current Study

The current study is a prospective test of the hypothesis that the relation between R-rated movie exposure and sensation seeking is reciprocal: Adolescents with high sensation seeking tendencies view more R-rated movies than do adolescents with low sensation seeking tendencies, and, of more interest, exposure to R-rated movies is associated with an escalation of sensation seeking tendencies. In addition, we explore two competing hypotheses regarding the relation among sensation seeking, R-rated movie exposure, and initiation of alcohol use. The first of these is consistent with Slater's (2007) hypothesis of mutually reinforcing spirals of media selection and its influence on behavior. Specifically, the effect of R-rated movie viewing on the initiation of alcohol use is stronger for high than for low sensation seeking adolescents (positive moderation). The second hypothesis (negative moderation) is consistent with Bartholow's finding that individuals with less (rather than more) experience with violent video games are more affected by playing the games, and Sargent's finding that low (rather than high) sensation seeking adolescents are more affected by movie exposure to smoking (Bartholow et al. 2005; Sargent et al. 2007). Thus, the second hypothesis is that the effect of R-rated movie exposure on the initiation of alcohol consumption is greater for low sensation seeking adolescents than it is for high sensation seeking adolescents.

Methods

Sample

Between June and October, 2003, we conducted a random-digit dial (RDD) telephone survey of 6,522 U.S. adolescents aged 10–14 years. The telephone surveys were conducted by trained interviewers who administered the survey in English or Spanish using a computer-assisted telephone interview (CATI) system. We obtained parental

consent and adolescent assent prior to interviewing each respondent; respondents were paid $5.00 for completing each interview. To protect confidentiality, adolescents indicated their answers to sensitive questions by pressing numbers on the telephone, rather than speaking aloud. All aspects of the survey were approved by the institutional review boards at Dartmouth Medical School and the survey research firm (Westat, Rockville MD).

To recruit the sample we first generated a list-assisted random sample of 377,850 residential phone numbers, identified households with age-eligible adolescents, and enrolled them into the study. Through screening interviews, we identified 9,849 eligible households with adolescents between 10 and 14 years of age, obtaining permission from 77% (N=7,492) of the parents to interview their child, and 87% (N=6,522) of adolescents to participate in the study, for a completion rate of 66%. The CASRO response rate (which includes estimates of households lost during the screening process) of 32% is typical for a contemporary RDD survey with two levels of consent needed to complete an interview (for a complete description of the sample recruitment and calculation of response rates, see Sargent et al. 2005). Demographics for the baseline sample mirrored the U.S. adolescent population (as assessed by the 2000 U.S. Census) with respect to age, sex, household income and census region but with a slightly higher percentage of Hispanics and slightly lower percentages of Blacks.

Missing data at the baseline survey were minimal for all variables, less than 1%. The sample was followed up by telephone for three consecutive waves, each 8 months apart, resulting in three observation periods which we designate T1→T2, T2→T3, and T3→T4. Approximately 10% of the sample at risk for alcohol initiation was lost to follow up for each observation period: N=608 (10%) T1→T2; 350 (7%) T2→T3; 542 (14%) for T3→T4. Thus, subject retention by T4 was still 70% of the original baseline sample. For growth and panel models, subjects with partial data were included and estimation was carried out using full information maximum likelihood (FIML). Missing data were assumed missing at random (MAR), that is, conditional on covariates included in the model, the fact of missingness was assumed to not be related to the missing data. Note that this implies that (a) the covariates included in the model could be strong predictors of both missingness and the outcome and (b) there are no additional omitted variables that would predict both missingness and the outcome. MAR is not directly testable because it is an assertion about variables not included in the model unless the missing data could somehow be recovered. For the hazard model predicting the initiation of alcohol use, the risk set, described below, included subjects who had not initiated alcohol use at baseline (N=5,828) with complete baseline data (N=5,827). Subjects who dropped out before initiating alcohol use or who were still non-drinkers when the follow-up period ended (T4) were censored at their last wave of observation; that is, they were still included in the analysis using all the information that was known about them, namely, that they had not started using alcohol before dropping out or the study ended. Estimation was carried out using FIML assuming MAR or non-informative censoring; that is, conditional on covariates in the model, the fact of censoring was assumed to be unrelated to alcohol initiation status. Although the MAR assumption is not likely to be completely true, MAR based methods are still the current recommended standard (Schafer and Graham 2002) because they perform better (more power, less bias) than older methods based on using only subjects with complete data.

Measures

R-rated Movie Viewing We estimated adolescents' R-rated movie viewing using previously validated methods (Sargent et al. 2008). We selected the top 100 U.S. box-office hits per year for each of the 5 years preceding the baseline survey (1998–2002, N=500), and 32 movies that earned at least $15 million in gross U.S. box-office revenues during the first 4 months of 2003. The CATI survey was programmed to randomly select 50 movie titles from the larger pool of 532 movies for each adolescent interview. Movie selection was stratified by the MPAA rating so that the distribution of movies in each list reflected the distribution of the full sample of movies (19% G/PG, 41% PG-13, 40% R). Respondents were asked whether they had ever seen each movie title on their unique list. To assess the possibility of false positive responses, we asked all adolescents whether they had seen a sham movie title, "Handsome Jack," and fewer than 2% reported seeing it. We have previously demonstrated that adolescents reliably remember movies they have seen 1–2 years prior to a survey (Sargent et al. 2001). The R-rated movie viewing variable is simply the number of R-rated movies the adolescent reported seeing of the approximately 20 R-rated titles included on the list of 50 movies that they were asked about. The movie pools at waves two to four were created by including new box office hit movies and movies released to video/DVD since the prior wave. To avoid possible overlap (created for example by a box office hit from the prior wave being released to video/DVD for a current wave) subjects were never given a list of 50 movies that included a movie they had already indicated seeing at an earlier wave.

Sensation Seeking We developed a four-item sensation seeking scale for younger children, tapping two of four constructs identified by Zuckerman (1994) as important components of sensation seeking: thrill/adventure seeking ("I like to do scary things" and "I like to do dangerous

things"), and boredom susceptibility ("I often think there is nothing to do"), and also tapping intensity seeking ("I like to listen to loud music"), a component of the Arnett Inventory of Sensation Seeking (AISS; Arnett 1994). Response categories included "not like you," "a little like you," "a lot like you" and "just like you." The first category was given a score of 1 and the last a score of 4, and scores for the index were summed across categories. The four-item scale had alphas of 0.60, 0.58, 0.64, and 0.63 and average inter-item correlations of 0.27, 0.26, 0.31, and 0.30 at waves 1 to 4, respectively. We chose this measure over two published short measures of sensation seeking. We felt the language in the four-item Brief Sensation Seeking Scale (BSSS4; Stephenson et al. 2003) was too advanced (e.g., "I prefer friends who are exciting and unpredictable") for the reading ability of our younger participants (10–11 years); the BSSS4 has little advantage over the measure we chose in terms of reliability, as the reported coefficient alpha for that measure is 0.66. In addition, we felt that Stephenson's two-item scale (SS2; Stephenson et al. 2003), which has a higher reliability, was too narrow because it assessed the thrill seeking component but not boredom susceptibility and intensity seeking.

Alcohol Initiation At each wave, adolescents were asked if they had ever tried alcohol that their parents were not aware of. We included the clause "that your parents were not aware of" to exclude those who "initiated" with parentally sanctioned sips of alcohol in order to focus more on problematic drinking that typically occurs in the company of peers rather than family.

Statistical Analysis

The available data consist of a baseline survey and three consecutive follow up assessments at 8-month intervals. We developed three four-wave panel models to examine the wave-to-wave synchronous and bidirectional lagged effects of R-rated movie viewing on sensation seeking and vice versa (Fig. 1). To understand the 2-year developmental trends for these variables, we used a four-wave dual-process linear growth model, which allowed us to examine the between-subjects effects of baseline R-rated movie viewing on subsequent linear growth in sensation seeking and vice versa. The growth model (Fig. 2) also allowed for a test of whether, at any given wave, the adolescents' individual deviations from their predicted growth curves were correlated (within subjects association between R-rated movie viewing and sensation seeking).

We were able to ascertain the onset of alcohol use only at the T2, T3, and T4 surveys. Discrete time hazard regression was used to test hypothesized effects on the hazard of alcohol onset at each of these time points. A convenient and now standard approach for conducting discrete time hazard regression is to use logistic regression and model the log hazard odds of the event where hazard odds means the odds of the event happening in the current discrete time interval given that it has not happened yet (Willett and Singer 1993). A path diagram of the proposed hazard model is shown in Fig. 3. All analyses included age, gender and ethnicity as control variables.

Results

Descriptive Statistics

Table 1 gives descriptive statistics for R-rated movie viewing and sensation seeking at each of the survey waves. As can be seen in Table 1, the raw measures are moderately skewed; to remedy this, R-rated movie viewing was square root transformed and sensation seeking was cube root transformed. Sensation seeking increased over time in this cohort as has been described in other cohorts (Crawford et al. 2003). Square root transformed R-rated movie viewing declined over time (with the exception of T2), a reflection of the fact that a smaller proportion of newly released movies were rated R after our initial survey in 2003. The increase in R-rated movie viewing at T2 was accompanied by a substantial drop in the percentage of the sample that reported seeing no R-rated movies; this was largely due to

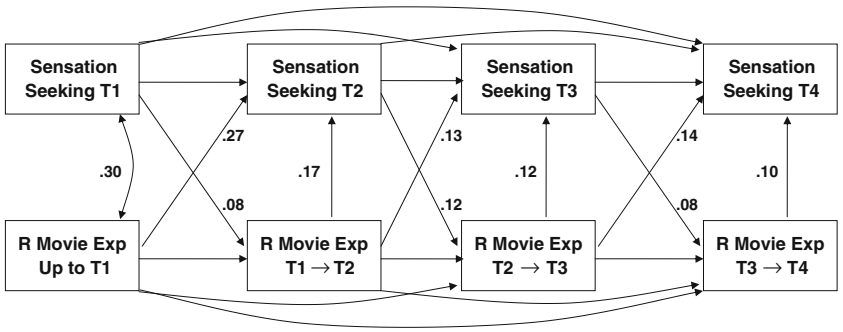

Fig. 1 Four-wave panel model with cross-lagged paths and synchronous path from R-rated movies to sensation seeking at T2, T3 and T4. Estimates of stability effects and paths for background covariates of age, gender and ethnicity are not shown to avoid cluttering the diagram. All estimated parameters in the figure are standardized coefficients and are significant at $p<0.05$

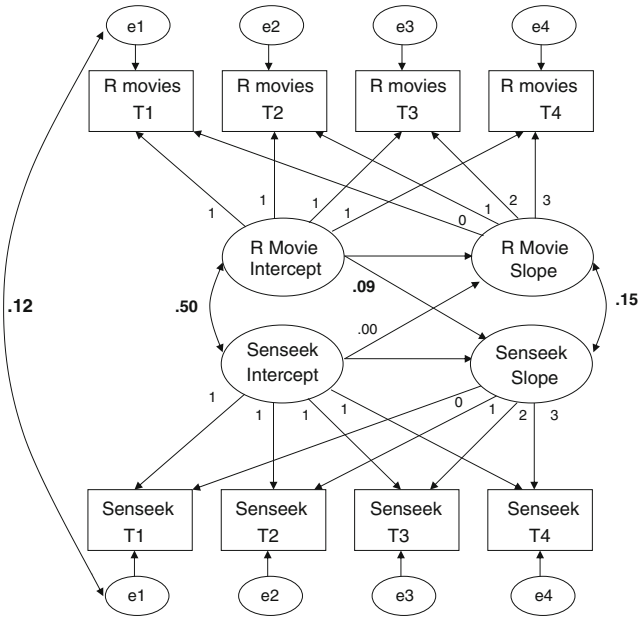

Fig. 2 Parallel process growth model for R-rated movies and sensation seeking. Correlations between time-specific influences at T2, T3 and T4, and effects of background covariates of age, gender and ethnicity are not shown to avoid cluttering the diagram. Fixed constants to define the growth-curve factors are shown as integers with no decimal points. Estimated parameters have two digits following the decimal point. Estimated parameters in *bold* are significant at $p<0.05$

one movie, "Old School" that was widely seen by adolescents in our sample. The higher viewership rate at T2 also caused the variance at T2 to shrink compared to T1, accentuated further by the square root transformation. This issue was addressed later in the growth models.

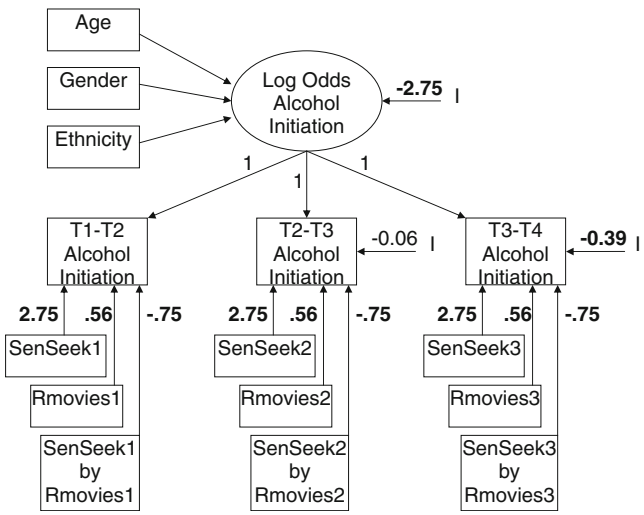

Fig. 3 Discrete time hazard regression model for alcohol initiation. *Upper case I* indicates regression intercept parameter. Fixed constants to define the overall log odds hazard are shown as integers with no decimal points. Estimates of effects for background covariates are not shown to avoid cluttering the diagram. Estimated parameters in *bold* are significant at $p<0.05$

The correlations between the square root of R-rated movie viewing and cube root of sensation seeking are shown in Table 2. Correlations among the repeated measures for R-rated movies and sensation seeking ranged from 0.54 to 0.64 and 0.54 to 0.73, respectively, and were highest for assessments closest in time. Cross-construct correlations ranged from a high of 0.40 at T1 to a low of 0.28 between T2 R-rated movie viewing and T4 sensation seeking.

Reciprocal Relation Between Sensation Seeking and R-rated Movie Exposure: A Panel Model

In order to test the hypothesis that the relation between sensation seeking and movie exposure was reciprocal, we developed a panel model with a synchronous and a cross-lagged effect of R-rated movie viewing on sensation seeking and vice versa at T2, T3 and T4. This model, illustrated in Fig. 1, takes into account the nature and timing of the assessments to specify the direction of the synchronous cross-construct paths at T2-T4. Specifically, R-rated movie exposure at any given wave is the accumulation of exposure to movies released between interviews, and sensation seeking is assessed at the time of the interview. Accordingly, the model includes synchronous paths from R-rated movies to sensation seeking at each wave T2–4. Cross-lagged paths are fit at each wave as well. Because there are both synchronous and lagged effects of R-rated movies on sensation seeking at any wave, the synchronous R-rated movie path represents the effect of change in R-rated movie exposure controlling for earlier R-rated movie exposure and the lagged effect represents the effect of earlier R-rated movie exposure controlling for change in R-rated movie exposure.

The model included all possible stability paths from prior assessments of the same measure and included age, gender and ethnicity as background covariates, with paths to all measures of sensation seeking and R-rated movies. This model had an excellent fit (cross-lagged uni-directional synchronous $\chi^2=8.442$, $df=6$, $p=0.207$, TLI=0.999, RMSEA=0.008). With the exception of the T1–T2 period, there were statistically significant bidirectional cross-lagged effects, similar in magnitude in each direction. The T1–T2 cross-lag indicated that each 1 standard deviation increase in R-rated movie exposure was associated with a 0.27 standard deviation increase in sensation seeking at T2, an effect that was more than three times larger than the influence of T1 sensation seeking on T2 R-rated movie exposure.

As a sensitivity check, we fit two other versions of the model, one with only bidirectional synchronous effects and one with only cross-lagged effects. These models also fit well (bidirectional synchronous $\chi^2=4.678$, $df=6$, $p=0.586$, TLI=1.00, RMSEA=0.000, cross-lagged $\chi^2=8.382$, $df=6$, $p=0.211$, TLI=0.999, RMSEA=0.008), indicating signifi-

Table 1 Descriptive statistics for R-rated movie viewing and sensation seeking at each wave

Variable	Survey wave	*N*	Mean	SD	Skewness
R-rated movie viewing[a]	T1	6,522	2.75	3.16	1.45
	T2	5,503	3.81	2.89	0.93
	T3	5,019	2.42	2.48	1.31
	T4	4,575	2.17	2.34	1.35
Sensation seeking	T1	6,521	7.95	2.47	0.61
	T2	5,503	8.06	2.40	0.51
	T3	5,019	8.27	2.53	0.49
	T4	4,575	8.44	2.53	0.43
Square root R-rated movies	T1		1.28	1.06	0.23
	T2		1.76	0.84	−0.30
	T3		1.25	0.93	0.01
	T4		1.16	0.91	0.10
Cube root sensation seeking	T1		1.98	0.20	0.16
	T2		1.99	0.20	0.09
	T3		2.00	0.21	0.05
	T4		2.02	0.20	−0.01

[a] Number of R-rated movies seen

cant bidirectional effects in both cases. In summary, these panel models provided evidence for reciprocal effects of R-rated movies on sensation seeking. They did not, however, allow for an understanding of the relations among the longer-term (2 year) developmental trends for R-rated movie viewing and sensation seeking.

Reciprocal Relation Between Sensation Seeking and R-rated Movies: A Parallel Process Growth Model

We fit a parallel process growth model to decompose and summarize the association between sensation seeking and R-rated movie viewing. As a prelude to fitting the parallel process model, we fit a linear growth model to each construct separately. For sensation seeking (results not shown) a standard linear growth model fit reasonably well (χ^2=51.554, *df*=3, p<0.001, TLI=0.990, RMSEA=0.050). Model diagnostics suggested slight curvature to the growth curves but rather than complicate the model with another growth factor, we added a covariance between the second and third time-specific influences, which resulted in an excellent fit (χ^2=5.719, *df*=2, p=0.056, TLI=0.999, RMSEA=0.017). A model with the background predictors suggested one interaction between gender and age such that older girls had significantly lower slopes than younger girls, but there were no other interactions.

For R-rated movies (results not shown) a standard linear model did not fit adequately (χ^2=175.310, *df*=3, p<0.001, TLI=0.955, RMSEA=0.094). Model diagnostics suggested a problem with the lower variance of the T2 measure and the covariances of the T2 measure with T1, T3 and T4 measures, as discussed above. The unusual effect of the one extremely popular R-rated movie was noted in our examination of the means and, accordingly, to fit the data, we estimated a single proportionality shrinkage constant that affected the T2 variance and all of its covariances. This resulted in a

Table 2 Correlations among repeated assessments of square root-transformed R-rated movies and cube root-transformed sensation seeking

		R-rated movie viewing				Sensation seeking			
		T1	T2	T3	T4	T1	T2	T3	T4
R-rated movie viewing	T1	1.00							
	T2	0.57	1.00						
	T3	0.56	0.57	1.00					
	T4	0.54	0.55	0.64	1.00				
Sensation seeking	T1	0.40	0.30	0.32	0.29	1.00			
	T2	0.36	0.34	0.35	0.32	0.63	1.00		
	T3	0.31	0.30	0.34	0.31	0.59	0.69	1.00	
	T4	0.30	0.28	0.33	0.34	0.54	0.64	0.73	1.00

dramatic improvement in fit (χ^2=4.271, *df*=2, *p*=0.116, TLI=0.999, RMSEA=0.013).[1]

Key results for the parallel process model are shown in Fig. 2 (complete results are available from the first author). Although the χ^2 is significant, due to the large sample size, the model fits well judged by the TLI and the RMSEA (χ^2=61.489, *df*=36, *p*<0.005, TLI=0.997, RMSEA=0.010). There are several correlations and paths of theoretical interest.

The residual correlation between intercept factors was 0.50 and the correlation between slope factors was 0.15. Thus, R-rated movies and sensation seeking were closely related initially, and long-term linear trends on both were correlated. The effects of intercept factors on slope factors across constructs showed that there was a prospective effect of R-rated movie viewing on growth in sensation seeking, but there was no prospective effect of sensation seeking on R-rated movie viewing. This suggested that the long-term result of the reciprocal relation described in the panel model was one of R-rated movie viewing affecting sensation seeking. Finally, the correlations at specific time points among residual influences (illustrated for T1 in Fig. 2) represented the tendency for an individual to be higher or lower than their fitted individual linear trajectories on both constructs simultaneously. For example, if some time-specific influence resulted in a particular teen being above their own long-term linear trajectory at T2 for R-rated movie viewing, a positive correlation indicated that they also tended to be above their own long-term linear trajectory at T2 for sensation seeking. The association between time-specific influences at T1 was significantly stronger than at the other three time points (χ^2=8.943, *df*=1, *p*=0.003), which were not significantly different from each other (χ^2=2.126, *df*=2, *p*=0.345).

In summary, the association between R-rated movie exposure and sensation seeking was pervasive, at both the longitudinal and time-specific levels. In addition, there was a prospective effect of initial R-rated movie viewing on sensation seeking slope but none from initial level of sensation seeking to growth in R-rated movie viewing, indicating that the long-term effect of the reciprocal relation between R-rated movie viewing and sensation seeking is one of R-rated movie viewing prompting higher sensation seeking growth. Thus, there is stronger support for a causal path from R-rated movie exposure to higher sensation seeking than vice versa.

Predicting Alcohol Initiation from Sensation Seeking and R-rated Movie Exposure: A Discrete Time Hazard Model

Starting with a baseline sample of never drinkers, some 10% initiated alcohol that their parents did not know about at each subsequent wave: *N*=493 (9% initiation hazard rate) T1→T2; 372 (8%) for T2→T3; 370 (11%) for T3→T4. Table 3 shows results for a discrete time hazard regression[2] for alcohol initiation. The model includes the background covariates, age, gender and ethnicity, as time-fixed predictors and also includes sensation seeking, R-rated movies and their interaction as time-varying predictors of alcohol initiation. For this model, sensation seeking and R-rated movie exposure were mean-centered to make the main effects more interpretable.[3] Likelihood ratio tests on initial fits (results not shown) indicated that for both time-fixed and time-varying predictors only the effect of African American ethnicity varied across time, with African American teens having a significantly lower hazard of alcohol initiation in the T2→T3 period compared to whites (cf. Gibbons et al., manuscript under review). More importantly, there were significant main *and* interaction effects for R-rated movie exposure and sensation seeking. The main effects indicated that higher levels of each predictor were associated with a higher hazard of alcohol initiation. The interaction was negative, indicating that as sensation seeking increased the effect of R-rated movies decreased (or vice versa).

To better understand the interaction, we probed it by computing the probability of T3→T4 alcohol initiation at various levels of R-rated movie exposure and sensation seeking. The results of this analysis are shown in Fig. 4 (results for T1→T2 and T2→T3 showed the same relationships and are therefore not included). The fitted probabilities were for low, average, and high levels of sensation seeking at each time point and across levels of R-rated movie viewing, ranging from 0 (23rd percentile) to 3.5 (99th percentile) on the

[1] The time-fixed predictors of age and gender were strongly related to initial status of both constructs (girls and younger teens were lower on both) but gender did not relate to either slope. Younger teens had higher slopes for R-rated movies than older teens. All three non-white ethnic groups were higher initially on R-rated movies than whites but for initial status of sensation seeking ethnic differences were minimal with Hispanics slightly lower than whites. For the R-rated movie slope, African American teens were lower and Hispanic teens were higher. There were no ethnic differences for the sensation seeking slope. These racial differences are replications of other analyses on this dataset (Gibbons et al., manuscript under review).

[2] Readers are probably familiar with a standard mortality hazard or survival model typically used in assessing the effect of risk factors on mortality. The standard (Cox) survival model assumes the time when the event occurred is known. For mortality, this information is obtained from the death certificate. In repeated measures survey work, one only knows that the event occurred sometime during the interval period, and that is the assumption behind a discrete-time hazard model.

[3] Mean-centered coefficients are scaled so that the mean=0. In the context of an interaction, the hazard ratio for each variable is the effect of that variable on alcohol use for the typical adolescent; i.e., one who scored at the mean.

Table 3 Discrete time hazard regression for alcohol initiation

Effect	Estimates	S.E.	Est./S.E.	Hazard ratio
Alcohol initiation affected by				
Age	0.418	0.028	15.082	2.65
Girl	0.202	0.069	2.921	1.19
African American	0.132	0.174	0.757	1.07
Hispanic	0.024	0.092	0.256	1.02
Other	−0.280	0.133	−2.102	0.88
R-rated movies	0.563	0.045	12.504	1.30
Senseek	2.751	0.203	13.574	1.29
R-rated movies by senseek	−0.745	0.199	−3.738	0.93
Alcohol initiation T2–T3 affected by				
African American	−0.185	0.267	−0.693	0.98
Alcohol initiation T3–T4 affected by				
African American	−0.811	0.331	−2.448	0.90
Intercepts				
Alcohol initiation	−2.745	0.078	−35.146	0.01
Specific time intercepts				
Alcohol initiation T2–T3	−0.056	0.086	−0.655	0.97
Alcohol initiation T3–T4	−0.385	0.088	−4.367	0.84

square root scale. The probability of alcohol initiation for low R-rated movie exposure-low sensation seeking adolescents (whose probability of initiating alcohol=0.03) is shown at the right and to the front of the graph and high R-rated movie exposure-high sensation seeking adolescents (whose probability of initiation=0.42) are at the left and to the back of the graph. In low sensation seeking adolescents, R-rated movie exposure raised the probability of alcohol initiation to the level of a highly exposed-high sensation seeker and nullified the effect of sensation seeking. Viewed another way, sensation seeking level was an important predictor of alcohol use given low R-rated movie exposure, but relatively unimportant in the context of high exposure. Thus, sensation seeking was a powerful moderator of the R-rated movie effect on the risk of alcohol initiation.

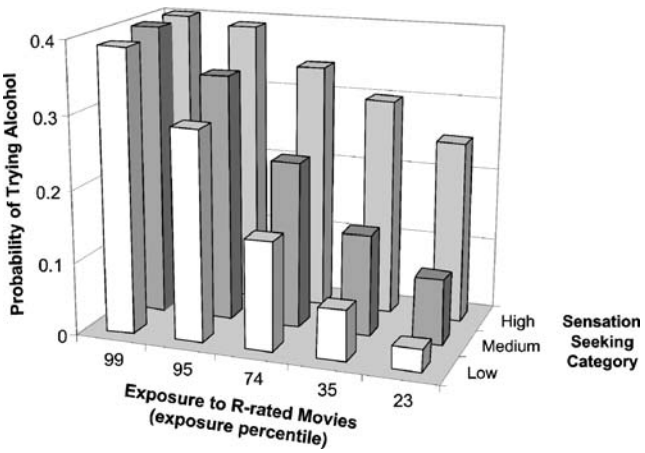

Fig. 4 Probability of trying alcohol as a function of sensation seeking and R-rated movie exposure. The probabilities for trying alcohol between T3 and T4 were predicted from T3 sensation seeking and T2→T3 R-rated movie exposure using the hazard model in Fig. 2. Sensation seeking was set at low (sensation seeking score=4), medium (sensation seeking score=8) and high (sensation seeking score=12) levels. The values for R-rated movie exposure correspond to 0, 1, 2, 3, and 3.5 on the square root-transformed scale and are therefore expressed as percentile rank to be more meaningful

Discussion

Summary

This study adds to the growing literature on the effects of media on adolescent risk behavior, specifically on the relation between exposure to movies and alcohol use. It demonstrates a short-term reciprocal relation between R-movie exposure and sensation seeking that evolves into a longer-term process of R-rated movie exposure increasing sensation seeking over time. It also provides evidence that exposure to R-rated movies has more influence on initiation of drinking among adolescents who are less inclined toward sensation seeking than among those who are more inclined toward sensation seeking. These findings have significant methodological, theoretical, and applied implications relevant to the development of adolescent personality and risk behavior.

Reciprocal Effects: Personality and Environment

Previous research has suggested that personality traits like sensation seeking develop over time and their course is, in

part, the result of interaction with the social environment (Bronfenbrenner 1979, 1995; Collins et al. 2000; Deater-Deckard and Cahill 2006). Previous studies designed to examine these reciprocal relations between personality and environment, however, have seldom provided adequate tests of directionality (Slater 2007). The current study addresses this issue by including both a short-term panel analysis and a long-term growth curve analysis of the directionality of the relation between sensation seeking and R-rated movie exposure. The panel model indicates that the short-term (8M) effects operate in both directions and are of about equal magnitude (sensation seeking influences R-rated movie exposure and vice versa). Thus, these analyses suggest that high sensation seeking adolescents are more likely to view R-rated movies, *and* exposure to these movies strengthens sensation seeking tendencies.

The growth curve models demonstrate that higher levels of R-rated movie viewing at T1 were associated with escalation of sensation seeking over the ensuing 2 years, and that adolescents who increased their R-rated movie viewing over the course of the study were likely to increase their tendency toward sensation seeking. These findings are notable because they reveal a prospective effect and because this is one of only a small number of studies to offer evidence supporting the hypothesis that exposure to environmental stimuli can affect sensation seeking tendencies (Bardo et al. 1996). It is also noteworthy because contrary to what one would expect if sensation seeking was primarily a genetically-determined trait, we did not find a long-term effect of initial sensation seeking on increases in R-rated movie viewing. Thus, our findings provide information about the natural course of sensation seeking that could inform similar dynamic phenotype/environment interaction models. More specifically, they demonstrate that individual variations in environmental exposures affect a personality phenotype (i.e., sensation seeking), but that these relations are more complex than previously thought because they also involve moderation effects on risk behaviors.

Initial Sensation Seeking, R-rated Movie Exposure, and Alcohol Initiation

Although the current results replicate previous research indicating that both sensation seeking and R-rated movie viewing are powerful predictors of alcohol initiation, they do not support the hypothesis that exposure to exciting and novel stimuli are more likely to elicit risk behavior in young people with high sensation seeking tendencies (Glik 2007). Instead, the effect of R-rated movie viewing on alcohol initiation was stronger for teens with lower levels of sensation seeking; i.e., for low sensation seeking teens, the risk of initiating alcohol use was about 0.03 at an R movie exposure of 0, 23rd percentile; but the risk increased to about 0.39 at an R-rated movie exposure of 12, 99th percentile, representing a 13-fold increase. In contrast, for high sensation seeking teens, the same change in R-rated movie exposure produced only a 1.7-fold increase in the risk of initiating alcohol use (compare the low sensation seeking row in front to the high sensation seeking row in back in Fig. 4). Another way to appreciate the strength of the interaction is to note that high exposure to R-rated movies made low sensation seekers act like high sensation seekers with respect to their risk of alcohol use (compare 99th percentile R-rated movies exposure column from front to back in Fig. 4). A plausible explanation for this finding is that, as growth occurred in sensation seeking over time, the adolescents became less responsive to the media input because the risk behavior was driven by other factors related to their dispositions (e.g., affiliation with others who are engaging in risky behaviors).

The results paint a more complex and interesting picture of the interplay between personality and the environment that affects alcohol initiation. Media choices, like watching R-rated movies, have both immediate and delayed consequences for teen personality, which, in turn, affect future media choices. This appears to be a clear example of a short-term positive feedback mechanism that could ultimately lead to maintenance or escalation of sensation seeking and R-rated movie viewing. As sensation seeking evolves over time, however, this process reduces the extent to which the teen's risk of trying alcohol is associated with R-rated movie viewing. Thus, the process we have observed is consistent with a dampened spiral model of media selection and effects, where the growth spiral between media exposure and personality risk is paired with a longer-term negative moderation that eventually results in lower responsiveness to the media input.

An additional contribution of this study is the demonstration of combining statistical models that can be used to test transactional hypotheses. Specifically, previous research designed to test the hypothesis that environmental stimuli can shape the development of personality (cf., Rothbart et al. 1995) has two common shortcomings. The first is the failure to test for reciprocal effects, and the second is the failure to consider different timeframes. The current study provides a model for avoiding these limitations. In addition, it suggests that the long- and short-term patterns of reciprocal relations between personality and environmental influence may not be the same, and thus, analyses that employ a single time frame may provide an incomplete picture of how these complex relations evolve over time.

Limitations

Several limitations warrant caution in interpreting prospective self-report studies like the current one. First, evidence

from non-experimental designs can support but cannot provide the strongest evidence of causal relations. Thus, future research would benefit from experimental studies designed to examine transactional relations between sensation seeking and short-term R-rated movie exposure and potential mediators of these processes. Second, the current study involves sample self-selection and attrition—we do not know the extent to which these factors may have biased the results of this study. These concerns are mitigated somewhat, however, by the fact that attrition bias was minimized by using subjects with partial data in all models. Moreover, attrition and self-selection tend to work against finding significant effects for substance use. Also, the growing literature on media effects suggests that sensation seeking and media effects on substance use can be generalized to a variety of populations. Third, the reliability of the sensation seeking scale was marginal, a result of our desire to capture several sensation seeking domains with just four items. Low reliability, however, would also tend to attenuate effects, especially moderation effects (Aiken and West 1991), making them more difficult to detect. The fact that we did find moderation suggests that this is not as serious a limitation in this large sample as it would be in more modest samples, although the actual magnitude of the interaction is probably biased back toward zero. Fourth, our sample, although a random digit dial sample, had slight over- and under-representation of Hispanics and Blacks respectively compared to US census data. The differences, although relatively minor, could lead to some bias.

Directions for Future Research

One issue in transactional models that the current study cannot directly address is the extent to which high sensation seekers in this study actively sought R-rated movies, or were passively exposed to them. Although theories relevant to both sensation seeking and aggression suggest that high sensation seeking adolescents actively select or create environments that influence subsequent changes in their sensation seeking tendencies and behavior, other models assume a more passive, non-volitional, and non-systematic form of selection into experiences (McCartney et al. 1990; Scarr and McCartney 1983). Most likely both active and passive selection are at work. The current analyses, however, suggest that, at least in relation to initiation of alcohol consumption, the question is somewhat academic because R-rated movie exposure is associated with a significant increase in low sensation seeking adolescents' initiation, and as a result they ultimately "catch up" with their high sensation seeking peers.

Although the current study provides evidence that repeated exposure to R-rated movies can alter personality and behavior, it does not address important questions about potential mediators of this process. A number of researchers have suggested a variety of cognitive, emotional, and behavioral patterns as potential mediators of environmental effects on behavior (cf. Bandura 2002; Bartholow et al. 2005; Funder 2001; Mischel and Shoda 1998). Current theory and research specific to movie exposure effects on adolescent alcohol use have suggested that changes in expectancies about alcohol use (Dal Cin et al., in press), and changes in images or prototypes of drinkers (Gibbons et al., manuscript under review) are important mediators of these environmental effects on behavior. Future research is necessary to understand the mechanisms by which these effects operate.

Conclusions

The current study expands our understanding of the complexity of the relations between individual differences in personality and the environment over time, showing that media exposure can shape sensation seeking propensity and providing evidence for a Dampened Spiral Model as a modification of Slater's reinforcing spirals of media selectivity and effects (Slater 2007). From an applied perspective, it is tempting to view the current results as a good thing—there appears to be a saturation point for high sensation seeking teens such that another R-rated movie or two is not likely to make much difference in their alcohol initiation. The other side of the coin, however, is the finding that low sensation seeking teens are highly sensitive to the number of R-rated movies they see, at least with respect to initiating alcohol use.

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