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Self-Reported Use of Alcohol, Marijuana, and Hard Drugs and Aggression: A Structural Equation Modeling Analysis of an Internet Survey of Long-Term Marijuana Users

Thomas F. Denson ^a; Mitch Earleywine ^b

^a University of New South Wales, ^b University at Albany, State University of New York,

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Self-Reported Use of Alcohol, Marijuana, and Hard Drugs and Aggression: A Structural Equation Modeling Analysis of an Internet Survey of Long-Term Marijuana Users

Thomas F. Denson
Mitch Earleywine

ABSTRACT. In the largest study to date investigating aggressive behavior among long-time adult concomitant marijuana and alcohol users, respondents completed an Internet survey on substance use and aggressive behavior. Aggressive acts following alcohol consumption were more frequent than aggressive acts following marijuana consumption. Structural equation modeling demonstrated that there was no relationship between marijuana and aggression once recent alcohol use, hard drug history, gender, and age were taken into account. Alcohol use and history of hard drug

Thomas F. Denson is a lecturer of Social Psychology at the University of New South Wales. He is interested in the many causes and consequences of anger and aggressive behavior.

Mitch Earleywine is Associate Professor of Clinical Psychology at the University at Albany, State University of New York. He is interested in substance abuse and has published numerous scholarly works on alcohol and marijuana.

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Address correspondence to: Thomas F. Denson, University of New South Wales, School of Psychology, Sydney, NSW 2052, Australia (E-mail: t.denson@unsw.edu.au).

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use were associated with increased aggression. It also appears that increased aggression among males is partially mediated by alcohol use. This model fit the data better than plausible alternative models. Although the sample characteristics limit the generalizability of these findings, our data suggest that marijuana use does not lead to aggressive behavior in adults, even among frequent, long-time users.

KEYWORDS. Marijuana, cannabis, alcohol, hard drugs, aggression, substance abuse

Perhaps the earliest popular association between marijuana and aggression began nearly 1,000 years ago with Hasan-ibn-Sabah, whose assassins, according to legend, would smoke hashish before committing murder. In the 1930s in the United States, officials at the Federal Bureau of Narcotics cited gory murders committed by mentally deranged marijuana users in an attempt to prohibit the plant. More recently, media portrayals of violent “gangsta” rappers intoxicated on marijuana continue to implicate cannabis as a causal factor in aggressive behavior. Despite these media images, the large majority of empirical research, including many large-scale surveys and laboratory experiments, does not support the notion that cannabis increases aggression in adults (Zimmer & Morgan, 1997). In the current study, we provide additional evidence from several thousand concomitant alcohol and marijuana users demonstrating that there is no evidence of a relationship between marijuana and self-reported aggression when controlling for several known influences on aggression (i.e., current alcohol consumption, history of hard drug use, gender, and age).

ALCOHOL, DRUGS, AND AGGRESSION

Alcohol and marijuana remain among the most frequently consumed psychoactive substances in the United States. There is no question that in the presence of provocation, alcohol intoxication increases aggressive behavior. Numerous meta-analytic reviews have confirmed this truth (Bushman & Cooper, 1990; Hull & Bond, 1986; Ito, Miller, & Pollock, 1996; Steele & Southwick, 1985). Alcohol has also been implicated in violent crime (Kyriacou et al., 1999; Pernanen, 1991; Roizen, 1993, 1997). Hard drug use has also been associated with aggressive behavior (Licata, Taylor, Berman, & Cranston, 1993; Wright & Klee, 2001).

Research has demonstrated that alcohol, marijuana, and hard drug use tend to covary with aggression and other antisocial behaviors among certain adolescent populations (e.g., Sussman, Simon, Dent, Steinberg, & Stacy, 1999). Whereas these findings might arise from a causal link between marijuana and aggressive behavior, other factors, including underlying personality characteristics or environmental variables, might play a large role (e.g., Sussman, Skara, Weiner, & Dent, 2004). In other words, deviant individuals may use illegal drugs and be more aggressive than their nondeviant peers. A longitudinal study following teenagers into adulthood found support for this “deviance” explanation (White & Hansell, 1998). Although fighting following marijuana consumption was less common than fighting following alcohol consumption, teenage use of marijuana was associated with aggressive behavior later in life, suggesting possible delayed effects (White & Hansell, 1998). Other research has demonstrated a relationship between marijuana use and aggressive behavior in adolescents even when controlling for alcohol use (Monshouwer et al., 2006). Although the data regarding adolescents demonstrate links between marijuana use and aggression, very little research has investigated the relationship between recreational marijuana use and aggression in adult populations.

Experimental studies with adult participants have produced little evidence of any causal role of marijuana in producing aggression. In one laboratory experiment, participants consumed a low, medium, or high dose of THC and were subsequently provoked by an experimental confederate. Only participants in the low dose condition evidenced increased aggression as measured by electric shocks (Myerscough & Taylor, 1985). In fact, those who consumed the medium or high doses of marijuana did not show increased aggression despite repeated provocation. In other laboratory work, Taylor et al. (1976) found that high doses of THC failed to increase aggressive responding, as have other researchers (Cherek & Dougherty, 1995). In addition to the experimental evidence, large-scale surveys have also failed to confirm a relationship between marijuana use and aggressive behavior (Goode, 1972). Indeed, in a recent examination of the literature on drugs and aggression, Boles and Miotto (2003) noted that “. . . scientific reviews have concluded that violent behavior is either decreased or unaffected by marijuana use” (p. 166).

CURRENT RESEARCH

To our knowledge, the study described here represents the first and largest study to use structural equation modeling (SEM) to investigate

aggressive behavior among adult concomitant marijuana and alcohol users. SEM offers considerable advantages over traditional multiple regression methods. Specifically, SEM illustrates complex relationships among variables such as multiple dependent measures and indirect effects. More importantly, SEM allows competitive model testing, whereby a proposed model is tested against plausible alternative models and goodness-of-fit is assessed to determine which model best fits the observed data. We demonstrate that even among long-time users, marijuana use had no relation to self-reported aggressive behavior once gender, age, alcohol, and hard drug history were taken into consideration. Moreover, this proposed model fit the data better than two alternative models. The two models explored alternative explanations that could be attributed to personality. Because it is possible that individuals who drink, smoke marijuana, and have a history of hard drug use may have an underlying “substance abuse-prone personality” or a “sensation-seeking personality,” we specified a model to explore this avenue. Finally, we specified a model of a “deviant personality” that would account for all three substance use patterns as well as aggressive behavior.

METHOD

Participants

In an effort to target frequent cannabis users, three organizations committed to altering drug laws (The Marijuana Policy Project, The National Organization for the Reform of Marijuana Laws, and The Drug Policy Alliance) were asked to send a query to their mailing lists for participation in a survey in return for the chance to win a cash prize. A total of 9,810 individuals completed the survey. Only those participants who reported both smoking marijuana and drinking alcohol in the previous 30 days were included in the study, leaving a total sample size of 6,910 ($M = 30.69$, $SD = 12.23$ years; 65% male). Participants were 89% White, 5% multiracial, 3% Latino/a, and approximately 2% Asian, 1% African American, and 1% American Indian. The median education level was *some college coursework*. Participants reported drinking alcohol a mean of 2.17 ($SD = 1.98$) days per week and smoking marijuana a mean of 4.98 ($SD = 2.37$) days per week. On average, participants began using marijuana at age 16.34 ($SD = 4.16$). Participants had been smoking marijuana an average of 14.24 ($SD = 11.22$) years. On each drinking occasion,

participants reported consuming a mean of 4.55 ($SD = 3.59$) drinks and rated how high they got on each occasion as 3.13 ($SD = 1.80$) on a Likert-type scale ranging from 1 (*very little*) to 6 (*very much*). Participants were also asked if they had ever used hard drugs in their lives: 56% reported using cocaine, 13% crack, 29% methamphetamine, 40% speed, and 8% heroin.

Materials and Procedure

Participants completed the survey at a time and place of their choosing via the Internet. In addition to demographic information and information about marijuana, alcohol, and hard drug use, participants answered questions asking if they had ever committed 12 different acts of aggression in their lives. The aggressive acts, which were the main dependent variables of interest, were slapping, kicking, pushing, insulting, pulling hair, twisting an arm, throwing things, yelling, breaking things, arguing, fighting, and threatening someone. Respondents could answer 1 (*never*), 2 (*once*), 3 (*a couple of times*), or 4 (*more than a couple of times*). For each aggressive act, two separate items assessed whether they had ever committed these same acts after using alcohol or marijuana. These latter items were dichotomous outcomes (0 = *never*, 1 = *yes*).

RESULTS

Socially undesirable behaviors such as substance abuse and aggression often violate the assumptions of normality and homoscedasticity necessary for traditional statistical methods. We therefore conducted our analyses using modern robust statistical methods. Modern methods accurately control Type I error rate, provide increased power, and tolerate violations of the homogeneity and normality assumptions (Wilcox, 2003; Wilcox & Keselman, 2003).¹ For any given test, data were analyzed for only those participants with complete data. Recent advances in SEM also allowed us to test our model via robust covariance estimation methods and significance testing with robust standard errors (see Bentler, 2005).

Our analytic strategy consisted of two phases. First, we conducted repeated measures analyses to determine whether there were differences in the frequency of self-reported aggressive acts when individuals were under the influence of alcohol or marijuana. We expected that the number of aggressive acts reported following alcohol consumption would be greater than the number of aggressive acts reported following marijuana consumption. Second, we conducted SEM analyses to determine the

relative roles of marijuana and alcohol use in predicting aggressive behavior. As previously mentioned, SEM offers a number of advantages over traditional least squares regression such as allowing multiple dependent variables, assessment of overall model fit, as well as assessment of the reliability and construct validity of latent variables.

Because of our inclusion criteria (i.e., concomitant marijuana and alcohol use in the past 30 days) and statistical limitations, slightly different analytic samples were examined in the current study. Participants who had consumed alcohol and marijuana in the previous 30 days ($N = 6,910$) reported more aggressive behavior and, as would be expected, more lifetime hard drug use than those who did not use marijuana and alcohol in the past 30 days (all $p < 0.05$). Repeated measures analyses addressing links between alcohol and aggression as well as marijuana and aggression focused on this large sample of users. A closer look at links between drug use and aggression required SEM, an analytic approach that does not tolerate missing data. Although approaches for imputing missing data of this type exist, they make the tenuous assumption that data are missing at random. Tests of random missing data are themselves influenced by large samples sizes, and in our sample it is likely that those who refused to answer questions about one aggressive act likely refused to answer several. We thus focused on the 4,655 cases with complete data. This sample was slightly less aggressive, approximately three years younger, more likely to be male, and more involved with hard drugs than the excluded participants (those who had not used alcohol and marijuana in the previous 30 days). Compared to the 6,910 participants in the repeated-measures analyses, the 4,655 who had complete data did not differ in age, gender, alcohol use, or hard drug use, but they used slightly more marijuana and were slightly less aggressive (all $p < 0.05$). Although there were significant mean differences among the analytic samples, the range of scores on all variables was comparable.

Prevalence of Self-Reported Aggression Following Alcohol and Marijuana

For the repeated measures analyses, we added the number of aggressive acts that each participant endorsed for the *ever in lifetime* ($M = 3.02$, $SD = 2.63$), *post-alcohol* ($M = 1.00$, $SD = 1.81$), and *post-marijuana* items ($M = 0.46$, $SD = 1.20$) to create three separate additive measures of aggressive behavior for each participant. Friedman's nonparametric test for dependent groups revealed differences among the groups, $\chi^2(2) = 8472.79$, $p < 0.001$, as did a robust repeated measures ANOVA on 20%

trimmed means, $F(1.29, 5342.31) = 5038.44$, $p < 0.001$. Post hoc linear contrasts on 20% trimmed means revealed, not surprisingly, that the number of reported lifetime aggressive acts was greater than the number of aggressive acts reported both after consuming alcohol, $\psi = 62.82$, $p < 0.001$, and after consuming marijuana, $\psi = 68.58$, $p < 0.001$. More importantly, the number of aggressive acts reported after consuming alcohol was greater than the number of aggressive acts reported after consuming marijuana, $\psi = 14.67$, $p < 0.001$.

Structural Equation Modeling Analysis

The mean composite of the 12 ordinal lifetime aggressive behavior items formed an acceptably reliable composite, $\alpha = .84$, $M = 1.85$, $SD = 0.65$. As expected, men were more aggressive than women, $M = 1.88$ ($SD = 0.69$, $N = 3,809$) vs. $M = 1.79$ ($SD = 0.58$, $N = 1,849$), $T^*_Y = 2.80$, $p = 0.003$ (Yuen's bootstrap t -test; Keselman, Othman, Wilcox, & Fradette, 2004). We therefore included gender in our model. Because age is also related to aggressive behavior in both men and women, we also included age as a variable of interest in our model (Book, Starzyk, & Quinsey, 2001; Dabbs & Hargrove, 1997).

We assessed alcohol and marijuana use with the previously mentioned quantity and frequency items. For alcohol, these items were how many drinks they usually had (quantity) and how many days per week respondents drank alcohol in the past 30 days (frequency). For marijuana, these items were how high they got when they consumed the drug (quantity) and how many days per week respondents used marijuana in the past 30 days (frequency). Such quantity and frequency variables are commonly used in substance use research (e.g., Calahan, Cisin, & Crossley, 1969; Quigley, Corbett, & Tedeschi, 2002). We multiplied the frequency and quantity variables to create separate use indices for alcohol and marijuana and standardized these new variables. Lifetime hard drug use was assessed by computing the number of hard drugs (i.e., cocaine, crack, methamphetamine, speed, and heroin) individuals had reported ever doing in the past or present. Along with gender and age, these three substance-use variables served as the predictors of aggressive behavior.

For our measure of self-reported aggressive behavior, based on an initial examination of our measurement model, we used the six most reliable items as indicators (i.e., slap, kick, push, throw, fight, and threaten). Such two-step modeling has been advocated by quantitative researchers (e.g., Keith, 2006). Table 1 presents the zero-order correlations among the measures. All six indicators were significantly related to the aggression latent variable.

TABLE 1. Zero-order Pearson's correlations among the observed variables (N = 4,655)

	Age	Gender	Slap	Kick	Push	Throw	Fight	Threaten	Marijuana Use	Alcohol Use	Hard Drug Use
Age	1.00										
Gender	-0.02*	1.00									
Slap	-0.24*	0.04	1.00								
Kick	-0.18*	0.03	0.55*	1.00							
Push	-0.27*	0.06*	0.62*	0.50*	1.00						
Throw	-0.20*	-0.03	0.44*	0.41*	0.47*	1.00					
Fight	-0.10*	0.06*	0.52*	0.43*	0.47*	0.33*	1.00				
Threaten	-0.14*	0.08*	0.44*	0.39*	0.46*	0.40*	0.45*	1.00			
Marijuana Use	-0.18*	0.04	0.08*	0.07*	0.09*	0.10*	0.05	0.09*	1.00		
Alcohol Use	-0.10*	.16*	0.14*	0.13*	0.18*	0.12*	0.14*	0.14*	0.09*	1.00	
Hard Drug Use	0.23*	0.04	0.03	-0.00	0.00	0.03	0.09*	0.07*	0.11*	0.08*	1.00

*p < 0.001.

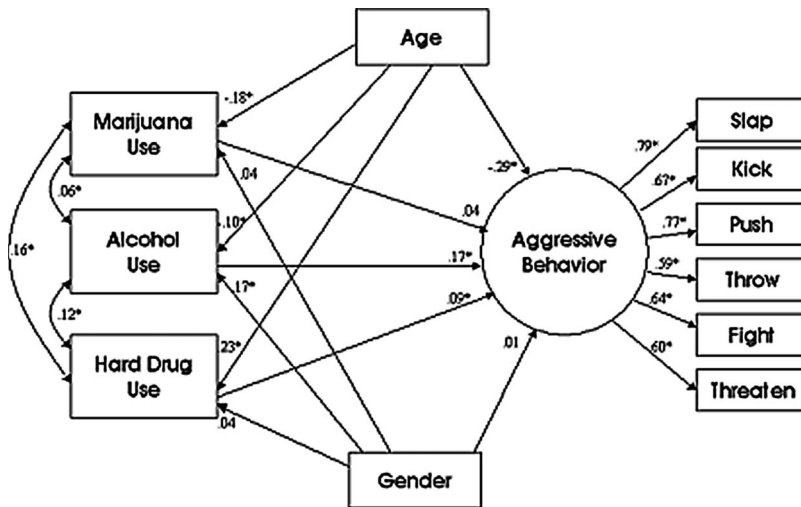
The Proposed Model

As expected, Mardia's (1970) test of multivariate normality revealed a departure from this assumption, the normalized estimate equal to 208.10. We therefore conducted all SEM analyses with robust covariance estimation and testing of parameter estimates with robust standard errors with the EQS 6.1 program (Bentler, 2005). Our model tested the following two hypotheses: 1) When controlling for age, gender, alcohol use, and hard drug history, marijuana use would not predict aggressive behavior, and 2) alcohol use, hard drug use, gender, and age would remain significant predictors of self-reported aggressive behavior. Our hypothesized model proved to be a good fit to the data. As is common with large samples, the residual-based chi-square goodness-of-fit test (Yuan & Bentler, 1998) was significant, $\chi^2(35) = 343.06, p < 0.001$. However, multiple fit indices revealed a good model fit, $CFI = 0.951, IFI = 0.951, MFI = 0.968, RMSEA = 0.043$ (95% confidence interval equaling 0.039 to 0.047). CFI, IFI, and MFI values in the mid .90s represent good model fit as do RMSEA values less than .06 (Ullman, 2001). The hypothesized model with standardized parameter estimates is presented in Figure 1.

Inspection of the path coefficients revealed more or less the expected pattern of results. Because of our large sample size and multiple significance tests, we reduced our alpha level for these tests to $p < 0.001$. Power analysis indicated that this conservative alpha level still provided sufficient power to detect small effects while reducing the chance of making Type I errors. Of primary interest was the finding that alcohol use and hard drug use predicted aggressive behavior whereas marijuana use did not. In fact, among the substance use predictors, the largest direct effect on self-reported aggression was for alcohol use; the next largest direct effect was for hard drug use. Together with age and gender, these five variables explained 13% of the variance in aggressive behavior. Age and gender explained 4% of the variance in marijuana use, 4% of the variance in alcohol use, and 6% of the variance in hard drug use.

Although the model was a good fit, significance tests of the path coefficients revealed two deviations from our predictions. Specifically, gender was unrelated to self-reported aggression, marijuana use, and hard drug use. We had expected that males would use more marijuana and engage in more aggressive behaviors even after controlling for the remaining variables. This was not supported by our data. Our data suggest that the effects of gender on aggressive behavior were mediated through alcohol consumption. Indeed support for this mediated relationship was obtained by a significant test of

FIGURE 1. Structural relationships among marijuana use, alcohol use, hard drug use, gender, age, and aggressive behavior ($N = 4,655$). Alcohol use significantly predicted aggressive behavior, but marijuana use did not. Alcohol and marijuana use as well as aggressive behavior were less common among older respondents, while lifetime hard drug use was more common among older respondents. Males reported consuming more alcohol than females. Asterisks (*) indicate significant parameter estimates, $p < 0.001$.



indirect effect for gender, standardized $IE = 0.03$, $Z = 5.20$, $p < 0.001$. Age did not exert a significant indirect effect on aggressive behavior.

Alternative Model Testing

Having established that our hypothesized model was a good fit to the data, we also sought to rule out two plausible alternative explanations. First, it is conceivable that adults who are aggressive by nature drink or use illegal drugs excessively as part of an underlying “problem” personality dimension, such as a substance-abuse-prone or sensation-seeking personality. We therefore tested a second alternative model whereby a latent problem personality factor was specified with alcohol, marijuana, and hard drug use as its three indicators. This problem personality factor was hypothesized to predict aggressive behavior, as were age and gender. Again, this model proved to be a poor fit, $\chi^2(43) = 953.59$, $p < 0.001$,

CFI = 0.861, *IFI* = 0.862, *MFI* = 0.913, *RMSEA* = 0.065 (95% confidence interval = 0.061 to 0.069). A chi-square difference test relative to the hypothesized model confirmed this alternative model's poor fit, $\Delta\chi^2(8) = 610.53, p < 0.001$ (see Figure 2).

Second, we tested a model where an underlying personality dimension was introduced to account for aggressive behavior and all three substance-use variables. Such a personality dimension would be consistent with a deviance explanation, such as one of those often cited in research with adolescents (e.g., White & Hansell, 1998). Age and gender were specified as predictors of substance use and aggressive behavior. As was the case with the previous two models, this model also proved to be a worse fit to the data than our proposed model, $\chi^2(37) = 377.55, p < 0.001, CFI = 0.945, IFI = 0.945, MFI = 0.965, RMSEA = 0.044$ (95% confidence interval = 0.040 to 0.048), $\Delta\chi^2(2) = 34.49, p < 0.001$ (see Figure 3).

FIGURE 2. An alternative model to testing the hypothesis that a latent "problem" personality variable (e.g., substance-abuse-prone or sensation-seeking personality) would predict aggressive behavior. This model was a significantly worse fit than the proposed model. Asterisks (*) indicate significant parameter estimates, $p < 0.001$.

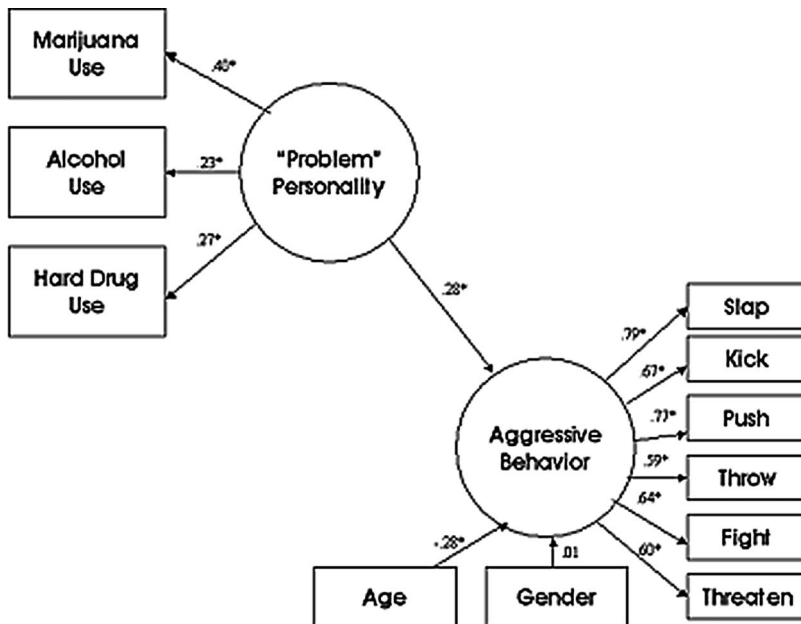
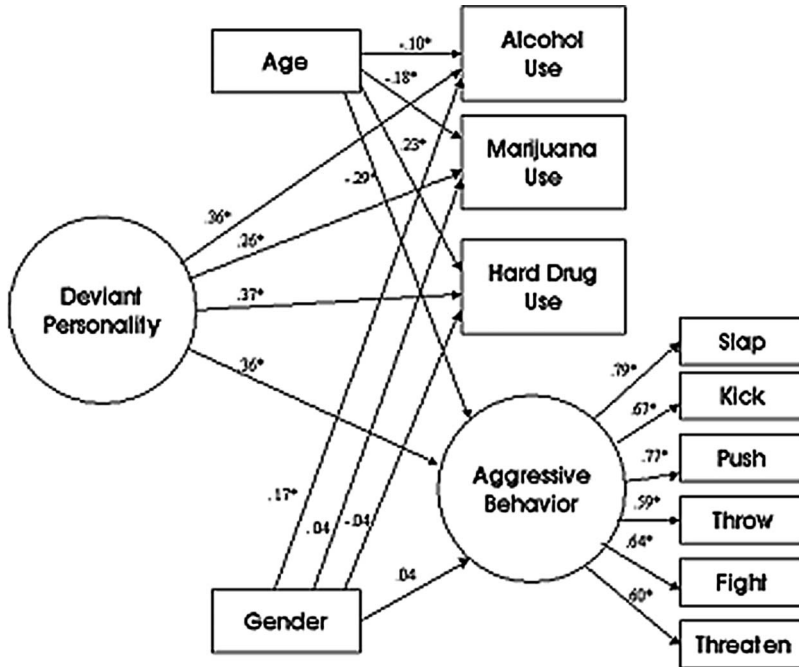


FIGURE 3. An alternative model to testing the hypothesis that a latent “deviant” personality variable would account for all three substance use variables and aggressive behavior. This model was a significantly worse fit than the proposed model. Asterisks (*) indicate significant parameter estimates, $p < 0.001$.



In sum, our data appear consistent with causal effects of alcohol and hard drug use in predicting aggression and inconsistent with the suggestion that aggressive personality traits may account for alcohol, marijuana, hard drug consumption, and aggressive behavior in adults.

DISCUSSION

As the largest study to use SEM to investigate marijuana use and aggression in long-time adult concomitant alcohol and marijuana users, the current study demonstrated that recreational users were not likely to engage in aggressive behavior once other known predictors of aggression

(i.e., alcohol use, history of hard drug use, gender, and age) were taken into consideration. In fact, self-reported aggression following marijuana consumption was less likely than self-reported aggression following alcohol consumption. Due to the large-scale nature of our study, we should have been able to detect a relationship between marijuana and aggression if such a relationship existed. While some studies with adolescents have demonstrated a link between marijuana use and aggression, our results are consistent with other empirical work that has failed to find support for this relationship (Myerscough & Taylor, 1985; Taylor, 1976; Zimmer & Morgan, 1997).

A novel aspect of the present study was the use of SEM to test competing alternative explanations for the observed relationships among the variables. Specifically, we were able to rule out competing personality explanations. Such evidence lends confidence to our model. The use of SEM also identified alcohol as a pathway that partially explains why men are often more aggressive than women.

There are several limitations to the current research that are worth noting, the first of which is the cross-sectional nature of our data. Cross-sectional data cannot definitively address whether aggressive behavior is a cause or effect of substance use. Longitudinal research could greatly increase our understanding of the relationship between substance use and aggression. Recording the covariance of individuals' alcohol and drug consumption and aggression would likely contribute to the causal path of this relationship. Second, many of our measures relied on memory. Such retrospection is fraught with biases. Again, longitudinal, diary research could potentially ameliorate such biases. Moreover, the accuracy of the self-report measures may have been influenced by the motivation to disavow negative associations with marijuana use. Another concern is the relatively small effects observed in the current study. We argue that although these effects were small, they are of practical significance given the harmful social costs associated with aggressive behavior. Identification of even small contributors to antisocial behavior is surely an important research goal.

Additional limitations concern the characteristics of the sample. Because our survey was Internet-administered and examined primarily White, college-educated, long-term concomitant alcohol and marijuana users, these findings may not generalize to other populations, such as (a) those who do not have access to the Internet (e.g., very low-income or homeless populations), (b) people who are reluctant to admit to marijuana use, (c) non-English-speakers, (d) marijuana users

who drink very little or no alcohol, (d) users who recently initiated marijuana and alcohol use, and (e) more ethnically or socioeconomically diverse populations. In addition, because the sample was recruited through organizations devoted to drug law reform, these findings should be replicated with potentially less biased samples such as romantic partners of alcohol and marijuana users or census-based stratified samples.

Although our research demonstrated that marijuana was unrelated to self-reported aggressive behavior when controlling for known causes, we maintain that marijuana may be associated with aggression under certain circumstances. For instance, Budney, Moore, Vandrey, and Hughes (2003) found temporary increases in anger and aggression following marijuana cessation. The role of drug withdrawal in aggressive responding needs more work. The negative emotions that characterize withdrawal from any drug, including legal ones like caffeine and nicotine, might play an important role in hostile responses. It is also possible that chronic marijuana use might lead to depression, dysphoria, or irritability, which might increase aggressive acts. For instance, meta-analytic evidence indicates that depression is moderately associated with the use of physical aggression toward one's romantic partner (Stith, Smith, Penn, Ward, & Tritt, 2004). In a recent review, Degenhardt, Hall, and Lynskey (2003) identified a modest relationship between marijuana use and depression among problem users. Nevertheless many studies do not show a link between marijuana and depression (e.g., Denson & Earleywine, 2006; Fergusson & Horwood, 1997; Fergusson, Lynskey, & Horwood, 1996; Green & Ritter, 2000; Kouri, Pope, Yurgelun-Todd, & Gruber, 1995; McGee, Williams, Poulton, & Moffitt, 2000; Musty & Kaback, 1995; Rowe, Fleming, Barry, Manwell, & Kropp, 1995).

In the current study, we provided a large-scale investigation into the relationship between self-reported substance use and aggressive behavior. Although alcohol use and hard drug history emerged as predictors, marijuana use did not, when controlling for gender and age. Moreover, competing explanations regarding personality were ruled out. Thus, although the sample characteristics limit the generalizability of these findings, our results suggest that marijuana use is either not associated or indirectly associated with self-reported aggression among frequent, long-time marijuana users. Indeed, our data are consistent with the majority of research showing no relationship between marijuana use and aggression.

NOTE

1. The robust statistics were computed using functions written by Rand Wilcox for the computer program R. R is available for free at <http://www.r-project.org>, as are the functions at <http://www-rcf.usc.edu/~rwilcox/>

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